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Scammon, C. M. On the Cetaceans of the Western Coast of N. America. 13
The President, Dr. Hays, in the Chair.

Twenty-nine members present.

Jan. 12th.

The President, Dr. Hays, in the Chair.

Thirty-one members present.

Jan. 19th.

Dr. Bridges in the Chair.

Thirty-three members present.

A committee having been appointed to draught resolutions with reference to the death of John Cassin, late Vice-President and Curator of the Academy, the following were offered and adopted:

The members of the Academy of Natural Sciences of Philadelphia having learned with great regret of the decease of their late Vice-President and Curator, John Cassin, do, in commemoration of the bereavement they have suffered, resolve,

1. That in the death of Mr. Cassin the Academy has lost a member and officer whose thoughts and acts were ever devoted to its interests and prosperity.

2. That in addition to the devotion thus manifested, they have been deprived of the counsel and exertions of one who was always ready to aid in every enterprise tending to the objects of the institution.

3. That in this unexpected termination of the scientific pursuits of their deceased associate, science has suffered a loss which cannot be repaired; the loss of one who, more than any other student of Natural History in America, 1869.
has advanced the science of Ornithology, and whose matured and well cultivated mind enabled him to render cheerfully and generously much assistance to younger students and to institutions of learning in that and other branches of knowledge.

4. That we deeply sympathize with the family of our respected colleague in this severe affliction.

5. That the Recording Secretary be directed to transmit a copy of these resolutions to the family of the deceased.

**Jan. 26th.**

Dr. Bridges in the Chair.

Fifty-five members present.

Pursuant to the By-Laws, an election of members of the Standing Committees for the ensuing year was held, with the following result:

**Ethnology.**


**Herpetology and Ichthyology.**


**Entomology and Crustacea.**

John L. LeConte, Geo. H. Horn, Tryon Reakirt.

**Geology.**

Isaac Lea, F. V. Hayden, T. A. Conrad.

**Comp. Anat. and Gen. Zoology.**

Jos. Leidy, Harrison Allen, S. B. Howell.

**Physics.**

Robt. Bridges, R. E. Rogers, Jacob Ennis.

**Ornithology.**


**Library.**

Jos. Leidy, J. L. LeConte, Robt. Bridges.

**Mammalogy.**

Harrison Allen, Edw. D. Cope, R. S. Kenderdine.

**Botany.**


**Conchology.**

Geo. W. Tryon, Jr., E. R. Beadle, C. F. Parker.

**Mineralogy.**


**Paleontology.**


Dr. W. S. W. Ruschenberger was elected Vice-President, and member of the Publication Committee, and Geo. W. Tryon, Jr.
was elected Curator, thus filling the vacancies caused by the death of Mr. Cassin.

The following gentlemen were elected members:

The following were elected correspondents:

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Feb. 9th.

Mr. Jos. Jeanes in the Chair.

Twenty-two members present.

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Feb. 16th.

Dr. Ruschenberger, Vice-President, in the Chair.

Thirty-four members present.

The following paper was presented for publication:
Note on Microscopic Crystals contained in some minerals. By Isaac Lea.

The death of Chas. N. Bancker was announced.

Professor Cope made some remarks on a new series of fossils, from the limestone caves in the Southern States. He enumerated the species of extinct mammals, reptiles and fishes, discovered by him in the lime-stone breccia, which is the remnant of a cave in Wythe Co., Virginia.

He gave twenty species of mammalia, of which nine only could be demonstrated to be different from existing species. These were Megalonyx Jeffersonii, Stereodectes tortus Cope, Dicotyles nasutus, Mixophagus spe- laeus Cope, gen. et sp. nov., Sciurus panolius Cope, sp. nov., Tamias laevidens Cope, sp. nov., Tapirus haysii, Ursus amplidens. Hemiacis perdidica Cope, sp. nov. Stereodectes was stated to be based on incisor teeth, which are more solid than in existing allied genera. Its pulp cavity is almost entirely closed throughout a large part of the length of the tooth. General character similar to those of the Marmot; size that of the porcupine.

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Feb. 23d.

The President, Dr. Hays, in the Chair.

Thirty-six members present.

The report of the Biological and Microscopical Section was presented.

The following gentlemen were elected members: Wm. Dutty, Gen. Hector Tyndale, Charles Morris, Theodore Cuyler.

On favorable report of the Committee, the following paper was ordered to be published:
1869.]
Notes on MICROSCOPIC CRYSTALS included in some Minerals.

BY ISAAC LEA.

During some years past I have given much attention to the examination of minerals under the microscope, and some of the observations were published in the Proceedings of the Academy in 1866.

About a year since, in the examination of a thin fractured piece of a large garnet from North Carolina, I was surprised to observe a number of very minute acicular crystals, which generally took two or three directions. This induced me to examine more closely into the varieties of garnets which were accessible to me, and supposing these crystals might have been observed by others, I referred to the principal works on mineralogy which have been published in France, Germany and in this country.

In none of these have I found any mention of these inclusions. But in that excellent work "Répertoire D'Optique Moderne," by M. l'Abbé Moigno, where he treats of optical mineralogy, I found that he states M. Babinet to have examined "star garnets" (Granats asteriques) some with four and some with six branches. He says that the star garnets with four branches are not very rare, —20 to 30 in 1000 to 1200—but that the star of six rays he found only one in 6000 specimens. Whether the filaments or fibers, as M. Babinet calls the asteroid reflections, are the same as the acicular crystals observed by me I cannot say, but certainly these latter are more common so far as my observation has extended, and I have observed no asterisms whatever.

In 154 specimens of Bohemian polished garnets, I found 48 with acicular crystals! This far exceeds the proportion stated by M. Babinet.

In the precious garnet from Green's Creek, Delaware Co., Penn., (uncut specimens), I found in the close examination of 310 specimens that 75 were possessed of acicular crystals, being nearly 25 per cent.—a very much larger percentage than mentioned by M. Babinet. Of the Brazilian Pyrope I examined 40 specimens. They were very pure and free from spots and cavities. I could not find a single acicular crystal in any one of them.

In Essonite I found no acicular crystals in the few specimens which I had in my power to examine, nor in grossularite, ouvaronite, colephonite or massive magnesium garnet.

Cinnamon-stone from Dixon's, near Wilmington, Del., was carefully examined in nearly 60 specimens, none of which showed any trace of acicular crystalization.

Spinelle ruby, of which I examined 28 specimens, produced no microscopic crystallized forms.

It will be difficult to ascertain what composes these microscopic crystals in garnets, but they may prove to be rutile when chemical analysis shall be able to resolve the difficulty.

March 2d.

The President, Dr. HAYS, in the Chair.

Thirty members present.

March 9th.

The President, Dr. HAYS, in the Chair.

Thirty five members present.

The following papers were presented for publication:


Thomas Meehan presented some hickory nuts sent by Mr. W. H. Ravenel, of Aiken, South Carolina, supposed to be a hybrid between *Carya olieformis* and *Carya aquatica*, because they were produced from trees raised from seed of the former which had trees of the latter growing near them; and because the fruit exhibited had the characters of both. Mr. Meehan said that there was a great difference of opinion amongst botanists whether the numerous forms of hickory nuts, so puzzling to botanists who attempted to classify them, were the result of hybridization, or were produced by the plant's own innate power of change by ordinary external circumstances acting on a supposed germ of form. Exact experiments were difficult, on account of the many years it would take to get at the results. He thought this instance furnished by Mr. Ravenel useful, as being one of the nearest he had known to an actual fact that hybridization has some influence on these varying forms.

Prof. Cope exhibited a specimen of the *Heloderma horridum*, of Wiegmann, from Tehuantepce, belonging to the Smithsonian Institution. He stated that the *Heloderma* of the Sonoran region proved, on comparison, to be a different species, differing in the more numerous scales on the head and body, in the shorter tail, and in coloration. He said it had been well figured by Baird in the Mexican boundary survey. He called it *H. suspectum*. He stated that though the lizards of this genus could not be proven to inflict a poisonous bite, yet that the salivary glands of the lower jaw were emptied by an efferent duct which issued at the basis of each tooth, and in such a way that the saliva would be conveyed into the wound by the deep groove of the crown.

**March 16th.**

The President, Dr. Hays, in the Chair.

Twenty-eight members present.

**March 23d.**

The President, Dr. Hays, in the Chair.

Twenty-nine members present.

The death of Jason L. Fenemore was announced.

**March 30th.**

The President, Dr. Hays, in the Chair.

Thirty-three members present.

The Report of the Biological and Microscopical Section was read. The following gentlemen were elected members:


On favorable report of the Committee, the following paper was ordered to be published:

1869.]
Third Contribution to the Fauna of the Miocene Period of the United States.

BY EDWARD D. COPE.

PLATANISTIDÆ.

A more than usually complete skeleton of Tretosphys grandævus furnishes some characters, which, taken in connection with others known to exist in many other species of our Miocene dolphins, suggest that the true position of all of the latter is in or near the family above named.

In the skeleton mentioned there are preserved some twenty-four ribs, more or less completely, and the anterior segment of the sternum. No pieces can be referred as osseous hemapophyses. The sternal piece also presents no pits for articulation with such hemapophyses, either anteriorly or posteriorly, but rugose surfaces only. The probabilities are, therefore, that these elements were cartilaginous, a feature which Flower considers to be characteristic of the family Platanistidae. The ribs present the same type. The capitulum and tubercle are well developed to near the posterior part of the vertebral column, where they become approximated, neither disappearing more than the other. In the Physeteridae the tuberculum disappears posteriorly, while in the Delphinidae the capitulum vanishes. In the Platanistidae both remain and become united.

The cranium of Lophocetus exhibits features of the same family. The pterygoids are long, flat and extended anteriorly. The cavity which they roof is long and narrow, not short and inflated as in the Delphinidae. The nasals and frontals are elongate as in Pontoporia.* In another cranium of uncertain reference, but probably of the same type, these elements are rather more shortened.

The species referred to this family, which are so abundant in our miocene beds, appear, so far as known, to have the cervical vertebrae all distinct, and generally much more elongate than in any recent forms. This peculiarity has been observed in Priscodelphinus atropus, and P. conradi, in Tretosphys grandævus, as well as in several smaller species of the family. The only cervical vertebrae referable to those of Ixanathus caelospondylus are less elongate, and nearly as thin as some of those of Beluga canadensis; the reference to that species is, however, quite uncertain. Of an even more attenuated form is the cervical of Pontogenus priscus Leidy, a Delphinoid from the tertiary of Louisiana.

The teeth of Tretosphys are known, and these show some affinity to those of Squalaodon, in the striate enamel surface, and anterior and posterior edge separating the inner and outer faces. The fang is cylindric, the crown regularly conic, the two together strongly curved.

A cast of a tooth of Lophocetus calvertensis is quite similar in form to the preceding, and small for the size of the animal.

Such teeth belong, perhaps, to T. grandævus. The muzzle of a species of similar size, also from Shiloh, N. J., is very long, narrow and depressed, the intermaxillaries forming a broad obtuse elevation. The fragments of the muzzle of T. lacertosus, and those of some of the Maryland Priscodelphinus indicate a similar form. Lophocetus Cope presents a somewhat similar form. This genus (Proceed. A. N. Sci., 1867, p. 148) will perhaps be found to be identical with one of the four which I have recognized through vertebral characters among the miocene Dolphins; but to which this reference is to be made is not as yet certain. When the portions of crania at present in my possession are carefully studied, this identification can no doubt be readily made.

The compressed roots of the teeth of Rhabdostens distinguish them from those of the above genera, and constitute a point of resemblance to the existing Platanistidae.

* A fine specimen of the cranium of this species from Montevideo is in the Museum of the Academy.

[March,


The species of this genus I formerly referred to Lesson's genus as above, the Beluga of Gray, as one of the few genera of existing Delphinideæ, in which the cervical vertebrae are all similarly distinct. I could find no characteristic feature by which to separate the two. I am, however, now entirely able to separate the miocene from the recent species, in respect to generic structure. The new genus is defined as follows, so far as known:

Cervical vertebrae elongate as in the seals, and all distinct. Their di- and parapophysies all united and embracing a small foramen for the vertebral artery.

In the existing genus the cervical vertebrae are thin and disc like, and none but the anterior one or two embrace a foramen, and that rarely. In the genus Tretosphys the structure is quite similar to that seen among the seals, and has given the species a physiognomy quite distinct from the modern dolphins. They have evidently had a well marked neck, endowed with considerable flexibility. This constitutes an approach to the Zeuglodonta, which is still more marked in the genus Priscodelphinus. In this also there is the same elongate series of cervical vertebrae, and well enclosed cervical canal.

The species of the genus may be defined briefly as follows:

I. But few and only posterior caudals with venous foramen at base of diapophyses.
   a. Posterior lumbars three-sixteenths or less, longer than wide before dia-
      pophysies.
   ** Neural canal with obtuse epapophysial ridge.

Articular surface with incised median impression, central rugulose disc, and broad circumference with raised concentric striae; lumbar straight and strongly keeled below; caudals short and broad; large ............ T. lacertosus.

Articular surface without striae, and with a deep punctiform median impres-
   sion which is below the middle; most lumbars concave below; caudals more
   elongate, 35 lines long in young: smaller ............. T. grandaevus.

Articular face without striae, and with punctiform impression (on caudal);
   caudal stouter, 24 lines long in adult; smallest ..................... T. gabbii.

aa. Posterior lumbars ½ longer than width before diapophysies.

Articular face with punctiform impression, and no raised striae; an epapo-
   physis; caudal narrow, 39 lines long in adult .......... T. uraeus.

II. An anterior caudal with vascular foramen at base of diapophysis.

Articular face of lumbar with weak incised impression, smooth; below
   weakly keeled; length in adult 21 lines; the smallest species.

T. ruschenbergeri.

The species which I described as Delphinapterus tyrannus (Proc. A. N. Sci. 
Phila., 1868, 189,) probably belongs to the toothless whales, and would cor-
respond in size with the Eschrichtiuspusillus. The collation of differ-
ent parts of each of these species must be left for future opportunities. The 
vertebrae are distinguished by having the neural canal without epapophysis,
the articular face with open median impression, and no striae. The epiphy-
physial ridges are much interrupted and slightly tuberculiform.

Tretosphys lacertosus, Delphinapterus (Tretosphys) lacertosus and D. hau-
kinsii Cope, l. c. p. 190.

This species is known by portions of two individuals from Charles Co., 
Maryland, of one from the mouth of the Patuxent, and of five at least from the 
marl pits of John Hummel, Henry Ware and others, near Shiloh, Cumberland 
Co., N. J. Portions of crania with teeth, etc., are mingled with the vertebræ, 
and furnish material for a partial analysis of the characters of the species.

1869.]

The caudals of this dolphin were the parts of it first discovered. Since then a lumbar of one, and a large part of the skeleton of another individual have been received by the Academy, all being from the same locality, Shiloh, Cumberland Co., N. J. Unfortunately the last series contained no caudal vertebrae; its reference to this species is not entirely established, though the correctness of the same is very probable.

The remains of the most perfect individual consist of seven cervical, nine dorsal, and seven lumbar vertebrae; there are twenty-four ribs and the anterior element of the sternum. The distinctive features of the vertebrae have been already given. The manubrium of the sternum is T-shaped, and is somewhat expanded posteriorly. The anterior (inferior) face is plane, (slightly concave antero-posteriorly); the margins rounded. The superior face is roof-shaped to a median keel, which disappears posteriorly.

Tretosphyus gabbi, Delphinapterus gabbi Cope, l. c. 191.

No material characteristic of this species has been found since its description.

Tretosphyus uraeus Cope, sp. nov.

This species is established on a lumbar vertebra from the miocene of Shiloh, Cumberland Co., N. J., with which I have associated a caudal vertebra from near the mouth of the Patuxent, which was lent me for determination by Philip P. Tyson, State Geologist of Maryland.

The character of elongation seen in the genus Zarachis strikes the eye at once in this species. Although not carried so far as in that genus, it exceeds considerably species of this, or of Priscodelphinus, with which we are acquainted; hence, though the material is slight, there can be no doubt that it represents an animal not previously known.

The articular face of the lumbar is not complete in all its outlines, but has evidently been as deep as wide, and perhaps nearly round. The median impression is punetiform and remarkably strong. The profile of the inferior outline is concave and is constituted by an obtuse keel, on each side of which is a short longitudinal depression. The diapophyses have been broken off, but their bases are both broad and deep, slightly filling the concavity of the inferolateral face. Supero-lateral face strongly concave in both directions.

<table>
<thead>
<tr>
<th>Lines.</th>
<th>Length of centrum</th>
<th>39</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot; basis neurapophysis</td>
<td>28.5</td>
</tr>
<tr>
<td></td>
<td>&quot; basis diapophysis</td>
<td>20</td>
</tr>
<tr>
<td>Width neural canal</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

The caudal has broad diapophyses and the band-like impression passing in front of them, and converging the centre of the median line below, a character seen in many species of the genus. The points of attachments of chevron bones are well marked; they entirely disappear on the middle portion of the centrum. The articular face is similar to that of the lumbar, but is a little broader than high. The surfaces are everywhere concave, and are not marked by any longitudinal ridges.

The same vertebrae of T. grandaevis present many ridges; those of T. lacertosus are variable.

<table>
<thead>
<tr>
<th>Lines.</th>
<th>Total length</th>
<th>39</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot; basis neurapophysis</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>&quot; diapophysis</td>
<td>24</td>
</tr>
<tr>
<td>Width neural canal</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>&quot; articular face</td>
<td>23.5</td>
<td></td>
</tr>
<tr>
<td>Depth articular face</td>
<td>21.3</td>
<td></td>
</tr>
</tbody>
</table>

This is probably the second of the genus length, and the third in bulk.

[March,
NATURAL SCIENCES OF PHILADELPHIA.


This is the smallest of the genus. It is known only from a caudal and lumbar vertebra of one individual, from Charles Co., Maryland.

ZARHACHIS Cope.


Examination of additional material renders it necessary to correct the characters of this genus as originally given. It was stated to differ from Priscodelphinus in that, while some caudals had spinous diapophyses, others possessed them flat, but imperforate. A vertebra supposed to indicate the latter characters I am now compelled to refer to another species and probably a genus. Other vertebrae assigned to Z. flagellator, must be referred elsewhere. A lumbar vertebra represents another species of probably the same genus, while a third has evidently pertained to still a third species. The genus will be characterized by the extraordinary length and slenderness of the lumbar vertebrae, and similar, though slightly abbreviated form of the caudals. The latter have spinous diapophyses, and in one species the former also. While the width of the articular faces of the centra of these vertebrae in the typical Priscodelphinus is but few lines less than in the species of this genus the diameter of the same is only from four-sevenths to one half the length. The nearest approach is made by Priscodelphinus stenus, m., where this diameter is 6-7ths of the length.

The three species of Zarhachis may be distinguished as follows:

I. Median or anterior caudal with a strong longitudinal keel above the diapophysis—which is therefore probably present on the distal lumbar.

Diapophyses thicker, larger.............. .......... .......... Z. flagellator.

II. No longitudinal keel on lumbar. Diapophyses broad, flat; epiphyses thin; large .............. .............. Z. tysoni.

Diapophyses narrow, subspinous; epiphyses thin; small............ Z. velox.


The caudal vertebra, described as above, is the only indication which we have as yet of this large delphinid.

Miocene, Charles Co., Md.

ZARHACHIS TYSOXI Cope, sp. nov.

This species is established on one posterior lumbar vertebra only, but its form is so characteristic as to render its identification a comparatively simple matter. The attenuated form characteristic of the genus is accompanied by broad diapophyses, showing that, as in Priscodelphinus, the species differ in the number of the posterior vertebrae which exhibit the contraction of the diapophyses.

The specimen preserved belonged to an adult animal. It was apparently one of the most posterior lumbars, as there are two feeble longitudinal ridges beneath, whose interval is again obtusely ridged and perforate by several foramina. The inferior outline is strongly concave in longitudinal section, and all the planes are concave in transverse section. The articular faces are a little wider than deep. The neurapophyses occupy a base of .75 the length of the centrum. The diapophyses are about equidistant between them and the nearest inferior ridge.

<table>
<thead>
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<tr>
<td>Total length centrum</td>
<td>48</td>
</tr>
<tr>
<td>Transverse diameter articular face</td>
<td>29</td>
</tr>
<tr>
<td>Vertical</td>
<td>27</td>
</tr>
<tr>
<td>Width neural canal (internal)</td>
<td>5</td>
</tr>
<tr>
<td>&quot; between inferior ridges</td>
<td>8</td>
</tr>
</tbody>
</table>

This specimen was found at the miocene beds at the mouth of the Patuxent River, Maryland. It is water worn, and has been probably washed from the cliffs, and been covered by the tide.

1869.]
The animal to which it belonged was not less attenuated in the posterior part of the vertebral column than the great Basilosaurus.

**Zarhachis velox** Cope.

This species is likewise only represented by a single vertebra, which is from the lumbar series anterior to the position of that of *Z. tuxsoni* just described. It has pertained to an adult animal of half the size of the preceding, and one which carried the narrowed subspinous diapophyses forward, though perhaps not so markedly as the *Priscodelphinus spinosus*, m.

The inferior outline is straight, and is the edge of a very strong thin keel, whose greater median prominence is due to the strong concavity of the inferior surfaces. The same concavity with that of the upper surface causes the existence of a strong longitudinal lateral keel, from the middle of which springs the diapophysis. The basis of the neural arch is thin and does not extend over more than 0.6 the length of the centrum.

The articular faces are discoid, and if one diameter exceed another it is the vertical; they have a somewhat expanded appearance from the concavity of the sides. Surfaces smooth.

<table>
<thead>
<tr>
<th>Lines.</th>
<th>Length centrum</th>
<th>Transverse diameter of extremity.</th>
<th>Vertical &quot;    &quot;</th>
<th>Internal width of neural canal</th>
<th>Length of basis of diapophysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>17</td>
<td>3-1</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This species was taken from the miocene marl from the pits of Reuben Ayers, near Shiloh, Cumberland Co., N. Jersey.

It indicates an even more slender and snake-like cetacean than the preceding, of much smaller size.

**Eschrichtius** Gray.

There is in the Thomas collection a portion of the cranium of a small Balaenoid, which from its resemblance to those of the existing inner whales, its small size, locality, and black color, I attribute provisionally to the *Eschrichtius pusillus*. It serves to confirm the affinities expressed in the name established on the ramus of the mandible. The alisphenoids present a deep, smooth posterior excavation, as in *Sibaldius*, while the infero-lateral processes of the basioccipital are stronger than in that genus. The conchs of the pterygotic bones are preserved; they are characterized by the possession of a hooked process turned upward, on the outer and more elevated margin.

An examination of additional material of these extinct Balaenidae, has enabled me to trace the affinities of species of which little has been hitherto known. Thus the *Balaena priscus* Leidy appears nearly affined to species referred by me to *Eschrichtius* through intermediate forms. Vertebrae very similar to those referred to the *Megaptera expansa* Cope are accompanied by mandibular rami of the same general type, and would be better referred to the same genus, in the absence of evidence to the contrary. It appears that there are six species of the genus, whose characters offer nothing as yet to separate them from the scarcely extinct type *E. robustus* Lillj. Five of these can be characterized from the forms of their mandibular rami, and are therefore compared in the following table. The other species, *E. leptocentrus*, m., is indicated by vertebræ alone.

Much compressed, outer face little convex; superior margin a narrow ridge without any truncation, with a series of foramina on each side, the inner extending for a very short distance only; no marginal groove; inferior edge narrow. Very large....................... ..................... *E. cephalus*.

Upper edge broad, with *outer* series of foramina, and meeting inner-edge at a right angle, which is the highest line, and with inner series of foramina just below it; most convex externally. Large....................... *E. priscus*.

[March,
Upper edge broad behind only, and these bearing only the inner series of foramina. Elsewhere with a median ridge and rows of foramina below on each side; much decurved; less convex externally. Medium... E. expansus.

Upper edge nowhere broad, and with a deep or shallow groove below it on inside; less decurved, less convex externally; small......... E. pusillus.


The largest of the miocene species, the vertebra considerably exceeding corresponding ones of the E. cephalus.

**ESCHRICHTRUS CEPHALUS Cope, loc. cit. p. 148.**

Indicated by a large part of the cranium and other parts of the skeleton, with flipper, etc., from Charles Co., Md., and by a portion of the mandible of a second individual from near the mouth of the Patuxent River, Md.

**ESCHRICHTRUS PRISCUS Leidy. Balana priscus Leidy, Pr. A. N. S. Phil., 1851, 308. Balanoptera priscus Cope, l. c. 1867, 144.**

A portion of a mandibular ramus of this species furnishes all that we know of it. In size it is intermediate between the two here preceding and following it.

The miocene of Westmorland Co., Va.

**ESCHRICHTRUS EXPANSUS Cope. Megaptera expansa Cope, l. c., 1868, 193.**

In addition to numerous vertebrae, portions of the limbs and of three mandibular rami of two individuals have been discovered. The latter present, for a marked distance on the proximal portion, a flat plane on the upper face, instead of the usual argulate ridge, which is equally distinct from the outer and inner faces. In E. priscus the superior plane is only a continuation of the outer convex face, and accordingly the external series of nutritive foramina extends along it. The plane is occupied on the other hand, in the E. expansus, by the inner series.

The inferior margin is a rather obtuse angle; the general form is not compressed, nor much convex externally, as in E. priscus.

Depth ramus................................. 2-75
Thickness "t".................................. 1-65
Foramina (internal) two in.............. 2-50

From the mouth of the Patuxent; coll. of P. T. Tyson, State Geological Survey of Maryland.


A ramus of the mandible of this species from the mouth of the Patuxent River differs from the type in having the inner groove of the superior margin much less marked; the inner face is plane, but leaves the superior groove with a marked convexity. The outer face is gently convex, and the outer foramina open externally. Slightly decurved, as well as curved longitudinally. Behind the foramina, the superior margin rises to a well marked base for a coronoid process, which is not preserved.

Depth ramus................................. 1 10-5
Thickness.................................... 1 2-5
Foramina (internal) intervals............. 1

**CROCODILIA.**

**THECACHAMPSA Cope.**

Further investigation shows that this genus is gavial-like, and that the peculiarity which characterizes its dentition also belongs to Plerodon Meyer of the European Miocene. Thoracosaurus, of the American Cretaceous, presents also the same character. Plerodon differs from the American form in 1869.]
being like Crocodilus in cranial characters, while Thecachampsa is a gavial. The species of the latter are T. sericodon Cope, abundant in New Jersey, at Shiloh and elsewhere, with long curved cylindrical teeth. T. sicaria Cope, from Maryland, with much compressed crown of the tooth, with prominent cutting edges. T. antiqua (Crocodilus Leidy,) with teeth less curved, cylindric and with very short cutting ridges. From Virginia.

The characters of the three species may be thus compared:

The crowns of the teeth not compressed, with short cutting edges.

Crows cylindric, curved, with long and delicate cutting edges. T. antiqua.

Crows compressed with very prominent crenulate cutting edges, on a marginal base. T. sericodon.

The last named also possesses a large maxillary tooth, near the position of the ninth of Crocodilus, which fits a corresponding concavity between two of the mandibular teeth, resembling in this the existing genus Tomistoma.

**TESTUDINATA.**

**TRIONYX Geoff.**

Trionyx lima Cope, sp. nov.

Represented by one costal-bone from Shiloh, N. Jersey. It is massive, and strongly sculptured by numerous approximated narrow raised ridges, which extend across the bone, with little inosculations, and which leave intervals between them a little wider than themselves.

The characters may be compared with those of the three species from the cretaeous of New Jersey, as follows:

Costal bone transversely figured by narrow elevated ridges. T. lima.

Costal bone with thick, low, transverse ridges, which are connected by cross-ribs which leave series of pits. T. priscus.

Costal bones with transverse irregular grooves proximally which remain along the sutures only distally, leaving an area of a shallow honey-comb pattern medially. T. pennatus.

Costal bones with a shallow coarse honey-comb pattern, tending to confluence distally. T. halophilus.

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April 6th.

The President, Dr. Hays, in the Chair.

Twenty-six members present.

The following papers were presented for publication:

Notice of some Extinct Vertebrata from Wyoming and Dakota. By Jos. Leidy, M. D.

Description of new Crinoidea and Echinoidea from the Carboniferous Rocks of the Western States, with a note on the Genus Onychaster. By F. B. Meek and A. H. Worthen.

Remarks on the Blastoidae with descriptions of new species. By F. B. Meek and A. H. Worthen.

The publication of the fifth number of the Proceedings for 1868, was announced.

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April 13th.

The President, Dr. Hays, in the Chair.

Twenty-two members present.
April 21st.

Dr. Bridges in the Chair.

Fifteen members present.

Mr. Redfield called the attention of the meeting to the following Memoranda attached to specimens of Schizsea pusilla, in the Herbarium of N. Y. Lyceum of Nat. Hist.

"First discovered by Dr. C. W. Eddy, near Quaker Bridge, in the pine barrens of New Jersey, about 30 miles from Philadelphia. Dr. E. was in company with J. LeConte, Pursh and C. Whitlow, and though he and Mr. LeConte found all the specimens, Pursh has claimed the honor of the discovery himself."

Signed,

Torrey and Cooper.

1868.

Above is in handwriting of Dr. Torrey.

"First found in 1805; not found again till detected by me in company with Dr. Torrey, in June, 1818."

Signed,

Cooper.

April 27th.

The President, Dr. Hays, in the Chair.

Twenty-three members present.

The issue of the sixth number of the Proceedings for 1868 was announced.

The following gentlemen were elected members:


The following were elected correspondents:

Albany Hancock, of New-Castle-upon-Tyne, England; and Brevet-Major F. Curtis, M. D.

On favorable report of the Committees the following papers were ordered to be published:

On the CETACEANS of the Western Coast of North America.

BY C. M. SCAMMON, UNITED STATES MARINE.

Edited by Edward D. Cope.

Introductory note by the Editor.

The present article, by Capt. Scammon, is the result of many years' observation in an almost unexplored and with difficulty explorable department of zoology. It was submitted by the author to the Smithsonian Institution, with the request that it might be rendered beneficial to science. The Secretary, Prof. Henry, referred it to the editor, with a request to publish such parts as should be deemed valuable to zoology, and to add such elucidation and explanation as would contribute to the same end.

In the carrying out of these views of the Secretary of the Smithsonian Institution, a general classification has been made, and a systematic record of the species and genera mentioned in the essay has been prefixed. A few species have been inserted from other sources, and the opportunity improved to give descriptions of some species from the Atlantic coasts.

1869.
The scientific student will await with interest the receipt by our national institution of further materials, so that the structure and affinities of these remarkable beings may be fully made known.

PART I.

SYSTEMATIC SYNOPSIS

Of the species of the Cetacea of the West Coast of North America. By Prof. E. D. Cope, Corresponding Secretary of the Academy of Natural Sciences of Philadelphia.

CETACEA.

Two sub-orders of this order are known to exist at the present period, which differ as follows:

Mysticeti.

Mandibular rami distinct from each other, without symphysis. Teeth none in either jaw. A series of transverse corneous laminae on each side of the roof of the mouth.

Denticeti.

Mandibular rami united distally by a symphysis. Teeth present in one or both jaws. No corneous laminae in the mouth.

I. MYSTICETE.

There is but one family of this group, characterized as follows:

Spiracles two. Front of cranium plane, much raised above the orbital processes; no transverse or longitudinal crest on the cranium.............. Balanidae.

I. BALANIDÆ.

Of this family numerous genera and species have been discovered and described. It embraces the most gigantic of vertebrated animals, and some of the most useful. They inhabit all oceans, but are rarer in the equatorial regions, abounding most in the frigid and temperate seas. Their pursuit gives occupation to many men of all nations.

Owing to their vast bulk and the want of appreciation on the part of those who are engaged in their capture, their study has been one of great difficulty. It is only within a few years that a sufficiently extended amount of material has been accumulated to enable the genera and species to be properly discriminated. The works of Gray, Eschricht, Reinhardt, Lilljeborg, Van Beneden, Flower and the writer, contain the most recent results of these investigations.

The genera are as follows:

I. Cervical vertebrae coossified; fingers five.
   No dorsal fin or gular folds; coracoid rudimental.
   Ribs single headed ........................................... Megaptera.
   First rib double headed...................................... Eubalaena.

II. Cervical vertebrae free; fingers four.
   A. The throat without pleiæ; no dorsal fin; ribs? single headed.
      No acromion ...................................................... Rhachianectes.
      An acromion .................................................... Agaphius.
   B. Throat and breast pleiæ; a dorsal hump or fin.
      a. The vertebral canal not closed by the processes of the cervical vertebrae; ribs single headed.
         No acromion .................................................... Megaptera.
         A well developed acromion .................................. Eschrichtius.
         aa. The canal is vertebralis enclosed by diapophyses and parapophyses of cervical vertebrae; both acromion and coracoid.
Anterior ribs single headed............................... Balænoptera.
Anterior ribs double headed............................... Sibbaldius.

Those engaged in the pursuit of whales recognize these natural groups without difficulty, as evidenced by their vernacular names of long standing. Thus the species of div. I are "right whales," of div. II A, "scrag whales;" of div. II B, "hump-backed whales;" and the Balænopteras, etc., "finner whales." The last are most numerously represented by species.

Balæna Linn.

Two species of this genus have been described by authors as inhabiting the North Pacific Ocean, though the materials upon which their identification has been based is of the most slender description. I am as yet unable to determine to which of them the right whale mentioned by Capt. Scammon should be referred. I therefore enumerate both here. A third species, the Bow Head of American whalers, is stated to pass south of Behring's Straits at certain seasons of the year, according to Capt. Scammon. I enumerate it as the same as the Greenland Right Whale of English authors, which is the "bow-head" of the Eastern American whalers, in contradistinction to the Right whale, (B. c i s a r c t i c a).

Balæna mysticetus Linn.


Balæna sieboldii Gray.


Balæna cullamach Chamisso.


Rhachianectes Cope.

This genus is now first characterized. Its only known species I originally united with Agaphelus Cope, but the form of the scapula is so different that it must be distinguished. While that of Agaphelus is identical with that of Balænoptera, it is in the present genus quite like that of Balæna.

Rhachianectes glacialis Cope.


This species was originally described from specimens by Wm. H. Dall, of San Francisco.

Megaptera Gray.

In this genus the rudiment of a dorsal fin exists as a hump on the posterior part of the dorsal region. The fins are longer than in any other genus, and two or more of the cervical vertebrae are occasionally more or less coossified. The following species are known more or less imperfectly: M. l o n g i m a n a Rudolphi, from the Arctic Seas; M. o s p h y a Cope, from the Western Atlantic; M. b r a s i l i e n s i s Gray, (Balænoptera Gray), from the coast of Brazil; M. i a l a n d i i Fischer, from the Cape of Good Hope; M. k u z i r a Gray, from the Western Pacific. The full measurements and description of Capt. Scammon enable me to add another species, viz.:  

Megaptera versabilis Cope.

Spec. nov. The North Pacific hump-back.

This species possesses pectoral fins, apparently intermediate in length between those of the M. l o n g i m a n a and the species with shorter fins, as M. 1869.]
o s p h y i a and M. k u z i r a. They are between one-third and one-fourth the length; in the two last mentioned, between one-fourth and one-fifth. It has 26 pectoral and gular folds. Siebold states that the M. k u z i r a pos-
sesses but ten. In this animal the warts extend to the top of the front, a
character not ascribed to any Atlantic Megaptera. It differs also from M. l o u-
gi m a n a, and resembles M. l a l a n d i i and M. k u z i r a, in having the pect-
toral black on the external face; in the Greenland species and in the white
of the Aleutian Islanders, described by Chamisso, it is white. The character-

istic color of the belly, in the most typical form, is said to be entirely black.
In this respect it differs from all other Megapterae, which present more or less
white or grey, on the inferior surfaces at least.

BALÆNOPHERA Lacep.

Many species of this genus inhabit the immense area of the ocean. They
are regarded as pertaining to two genera by Gray. Thus the known species
fall into two groups, viz.: I, those in which the dorsal fin is at the commence-
ment of the third fourth of the length from the head; and II, those where this
fin measures only the second third. To the first belong certainly only B. r o s-
t r a t a and B. v e l i f e r a; to the second B. p h y s a l u s, B. d u g u i d i and B.
s i b b a l d i i Gray (C u e r i r i u s Gray), all Atlantic. There is not enough
known of the following species to determine their characters in this respect:
B. a r c t i c a Schlegel, N. West Pacific; B. s w i n h o e i Gray, China Seas; B.
p a t a c h o n i c a Gray, S. W. Atlantic; B. a n t a r c t i c a Gray, New Zealand
Sea. The following species have been named: B. f a s c i a t a (Physalus Gr.),
B. a u s t r a l i s Desmoul. The species of the North West coast of North
America is sufficiently described and figured by Capt. Scammon to furnish
means of comparison with most these species. It differs from these, and may
be called

BALÆNOPHERA v e l i f e r a Cope.
The Finner Whale of the Oregon coasts.

This species differs from all that have been described in that, respect, in
the color of the baleen; from the B. a r c t i c a of the Japanese Seas, the colora-
tion of the body separates it; in the latter the sides are spotted black and
white, in the present shaded from the brown of the upper to the white of the
lower surfaces. The large size of the dorsal fin and its anterior position are
marked characters; the northern species, with larger fin, is still more differ-
ent from the B. a r c t i c a, the only one with which it would be probably
identical.

The more southern form, with very small fin, may be another species—pos-
sibly a Sibbaldius. The B. v e l i f e r a cannot unfortunately be compared with the
B. s w i n h o e i and B. p a t a c h o n i c a, as no similar parts are figured or
described.

The baleen, says Capt. Scammon, is of a light lead color, streaked with
black, and its surface is marked with transverse roughening. In the B. p h y-
s a l u s the whalebone is, according to Gray, slate-colored on the inner side,
white streaked; on the outer side nearly black and with still darker streaks.
In the B. r o s t r a t a it is nearly all white, with some black at the base.

SIBBALDIUS Gray.

Species of this genus have been discovered in arctic, antarctic and tropical
seas. S. b o r e a l i s (Phenacius Lilljeberg), the most gigantic of the finners,
occurs in the northern Atlantic and Polar Seas, but appears to be rather rare.
S. l a t i c e p s, a much smaller species, has, so far as known, a high arctic
range, while S. t u b e r o s u s, sp. n o v., has been found on the eastern North
American coast. S. s c h l e g e l i i is known to occur on the coast of Java.
A doubtful species has been named S. a n t a r c t i c u s. The species may be
divided into three groups, thus: I, the dorsal fin of ordinary form, two-thirds

[April,
the length from the muzzle; dorsal line behind it smooth. \textit{S. tectirostris} Cope, \textit{S. laticeps} Gray. II, the dorsal a small conical mass, situated well posteriorly; the dorsal line with several humps behind it; several cervicals with complete cervical canal; \textit{S. tuberous} Cope. III, the dorsal fin a small conical mass situated three-fourths the length from the muzzle, the dorsal line smooth behind it; the axis only, with complete cervical canal; \textit{(Flowerius Lilli)} \textit{S borealis} Fisch.

The \textit{S. tuberous} \textit{m.} differs from the \textit{S. laticeps} as above, and probably in its five or six humps above the caudal portion of its vertebral column. The latter peculiarity is not mentioned in authors' descriptions of \textit{S. laticeps}, and though its existence is not denied, it is probably wanting. I have heretofore considered this whale as the latter species, and described it as such. — Proceed. Acad. Nat. Sci. Phila. 1866, 297.

The smaller whale, above mentioned as \textit{Sibbaldius tectirostris} Cope, is established on a nearly complete specimen of a young \textit{S} in the Museum of the Academy. Its length when fresh, in a nearly straight line from the end of the muzzle to the emargination of the flukes, is between 47 and 48 feet. This depends on independent observations of several persons. The skeleton as preserved lacks a number of caudal vertebrae* and a few dorsals. Restoring those that are at present wanting, from the obvious extent of interruption, and the last caudals, according to Flower's estimates for the \textit{S. laticeps}, we have the following total length:

<table>
<thead>
<tr>
<th>No.</th>
<th>Length ft. in</th>
<th>Restored</th>
<th>ft. in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervicals</td>
<td>7</td>
<td>2 6</td>
<td>0 0</td>
</tr>
<tr>
<td>Dorsals</td>
<td>11</td>
<td></td>
<td>2 0</td>
</tr>
<tr>
<td>Lumbosacrales</td>
<td>16</td>
<td></td>
<td>0 0</td>
</tr>
<tr>
<td>Caudals—diapophyses perforate</td>
<td>4</td>
<td>28 10</td>
<td>0 0</td>
</tr>
<tr>
<td>&quot;</td>
<td>10</td>
<td>1 0</td>
<td></td>
</tr>
<tr>
<td>&quot;—diapophyses imperforate</td>
<td>10</td>
<td>3 0</td>
<td></td>
</tr>
<tr>
<td>&quot;—no diapophyses</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Cranium</td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Restored</td>
<td></td>
<td>41 7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>45 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The individual is in the young stage, since not only are all the epiphyses of the vertebrae separated, but those of the humerus also. According to Flower, the ossification of the epiphysis of the humerus takes place when the animal has developed somewhat beyond one-half the adult dimensions. This animal may therefore be considered as being at least half grown, which renders a length of 70—80 feet probable for the adult. The present specimen was a female, according to those who had seen it in the flesh, and who described to me the mamme and the vulva. In its larger dimensions it thus exceeds the \textit{B. laticeps}, and especially the \textit{B. tuberous}, as the latter is adult at about the size of this young specimen.

The atlas has not yet reached the Museum. The axis presents below no surface adapted to a \textit{tuberculum atlantis}. The median portion of the anterior face of the centrum presents a low conic projection, the \textit{processus odontoides}. The di- and parapophyses are united distally, embracing a large ring, whose outside longitudinal diameter is two-thirds the transverse diameter of the centrum of the same. The neural arch presents no spine, but a pair of lateral prominences like rudimental zygapophyses. The parapophyses of the remaining cervicals are long, except on the seventh, where they are almost wanting. The diapophyses are long in all, longest and curved on the seventh, where it

* All are in possession of the Academy, but those alluded to are yet in a compost heap and unfit to handle.

1868. J
stands above the paraphysis of the sixth. They are nearly united with the paraphysis on the third cervical, and are no doubt fully so in mature age. The fourth cervical is lost, but it is scarcely probable that it presented a complete ring for the transmissal of the vertebral artery, etc. There are no rings attached to the vertebrae from the fifth inclusive. The centra are all transversely oval.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height centrum and arch of axis</td>
<td>12·25</td>
</tr>
<tr>
<td>&quot; centrum</td>
<td>7·1</td>
</tr>
<tr>
<td>Transverse extent of axis</td>
<td>25·5</td>
</tr>
<tr>
<td>&quot; &quot; centrum of do</td>
<td>11·5</td>
</tr>
<tr>
<td>&quot; &quot; neural canal</td>
<td>5·75</td>
</tr>
<tr>
<td>&quot; &quot; of third cervical</td>
<td>23·7</td>
</tr>
<tr>
<td>&quot; &quot; centrum do</td>
<td>11·5</td>
</tr>
<tr>
<td>Length paraphysis sixth cervical</td>
<td>5·7</td>
</tr>
<tr>
<td>Vertical diameter centrum (? 5th) dorsal</td>
<td>7·0</td>
</tr>
<tr>
<td>Length centrum do</td>
<td>6·0</td>
</tr>
<tr>
<td>Vertical diameter centrum second caudal, with perforate diaphyses</td>
<td>10·5</td>
</tr>
<tr>
<td>Height spine and arch middle lumbosacral</td>
<td>14·5</td>
</tr>
<tr>
<td>&quot; from floor canal to top anterior zygapophysis do</td>
<td>6·0</td>
</tr>
</tbody>
</table>

There is no neural spine on the second, third and fourth cervicals, and it is rudimentary and small on each of the remainder. Those of the dorsals and lumbars are not particularly elevated.

The humerus is very short and thick, and the hand remarkably small. The scapula, as in other Sibbaldii, has considerable antero-posterior extent, and well developed acromion and coracoid. The disk is divided into three areas on the inside, by two slight ridges.

**Dimensions.**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antero-posterior width</td>
<td>33·0</td>
</tr>
<tr>
<td>Vertical</td>
<td>21·0</td>
</tr>
<tr>
<td>Length acromion</td>
<td>7·5</td>
</tr>
<tr>
<td>&quot; coracoid</td>
<td>4·5</td>
</tr>
<tr>
<td>Diameter of glenoid cavity</td>
<td>8·0</td>
</tr>
</tbody>
</table>

The muzzle is elongate, and with a narrow acumination. The supraorbital plates of the frontal are.

Each nasal is as wide as long medially; anteriorly concave above, the line of junction of the two in one plane, forming a median ridge, which is prolonged into a prominent median point. The otic bulla are slightly compressed and carinate below, and their surface is not markedly rugose. The malars are in shape something like first ribs; that is, with an enlarged head, with prominences imitating capitulum and tubercle, a short narrowed shaft, and expanded distal extremity. The distal third is occupied by an ovate articular surface, thinning out the margin on one side. The shaft is thin and concave, both longitudinally and transversely, on one side.

The inner margin of the palatine bones is regularly continuous with the short pterygoids, which are very short, and do not approach near the otic bulla; Rudolph represents the latter as prolonged to beyond the extremity of the bulla. The posterior plate of the vomer in *S. tectirostris* extends much further posteriorly than Rudolph represents for the *S. laticeps*, and though there is no doubt some variation in this respect in the same species, the difference is here very considerable. In *S. laticeps* it extends to a little behind the anterior margin of the bulla; in *S. tectirostris* to behind the posterior margin, concealing much of the basioccipital. The mandibular ramus is strongly curved, and very convex externally, less so internally. The vascular foramina are very large externally, and very much reduced in size on the inner face. The coronoid process is strongly elevated,

[April,
curved outwards, and acuminate. There is a distinct angular process below the condyle.

Measurements.

<table>
<thead>
<tr>
<th>Description</th>
<th>Ft</th>
<th>In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of cranium (axial)</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Greatest width of occipitals</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Width at supraorbital plate</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>of each maxillary at middle</td>
<td>9</td>
<td>75</td>
</tr>
<tr>
<td>of supraorbitals above orbit</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>(least) of frontal region</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>of nasals</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>intermaxillaries at middle</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Length nasal</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>malar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maxillary above</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>ramus mandibuli (in curve)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>&quot;          &quot; &quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to coronoid</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>&quot;          &quot; &quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at condyle</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>&quot;          &quot; &quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at coronoid</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Length otic bulla</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

The baleen is short, and of a dark lead color, the inner and shorter margin white for varying widths. The bristles are fine for the size of the animal, and not nearly so coarse as in Megaptera o s p h y i a or Rhachianectes g l a n c u s.

Length of longest plates with gum                   | 15  |
Width at base                                      | 10  |
No. plates in four inches                           | 10  |
Whole number plates on one side, 126 preserved—add about 24 |      |
lost from extremity                                | 150 |

Most of the ribs are yet in process of cleaning, and will be introduced into the final monography and illustration of the North American Cetacea in course of preparation. That which by its deeply bifurcate head indicates the generic affinities of the species, is in form much like the first of S. l a t i c e p s. It measures in

<table>
<thead>
<tr>
<th>Description</th>
<th>Ft</th>
<th>In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total length</td>
<td></td>
<td>7:25</td>
</tr>
<tr>
<td>Distal width</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

The anterior head is the narrower, and its line of junction with the posterior extends to near the middle of the length of the same.

The animal's color above was a uniform black; the exterior face of the flippers and stripes along the gular plate were also black. The belly was white, separated, according to my informant, from the black abruptly, forming a "water line." The posterior face of the flippers white for the distal half. The under side of the caudal fluke white also. These points I derived from Joshua Carey, who stripped the carcass.

The dorsal fin was not seen by me, but was described by a number of parties, whose statements agreed. It was of the usual form and elevation common among finner whales, compressed, with a long base, and eighteen inches in height; the dorsal line behind it clean and smooth.

The species appears to be most nearly allied to the S. l a t i c e p s of Gray, of the Arctic Seas. It differs distinctly in the following points: 1. The nasal bones of the latter are longer, more parallelogrammic, and not strongly keeled and mucronate. 2. The coronoid process of the mandible is less elevated. 3d. The cervical vertebrae, including the axis, are furnished with well developed spinous processes. 4. The mandibular ramus is more compressed. 5. The vomer is more, and (6) the pterygoids are less prolonged posteriorly.

The difference from the S. t u b e r o s u s is found in the form of the dorsal

1869.]
fin and character of the dorsal line; it is marked, and of a kind which Lilljeborg has regarded as generic in the case of S. gigas (S. borealis), but which appears to me to be specific in this case. This species is distinctly smaller than the S. tectirostris, and presents a tuberculum atlantis articulating with the epiptrophus below, which is not indicated by the latter in S. tectirostris.

In many respects the species appear to be quite similar. The deposit of the specimen of S. tuberosus in the Museum of the Academy having been delayed, the nearer comparison must be made when it arrives, which will be in a short time, it is anticipated.

As compared with the S. gigas there is a marked difference in the form of the nasal bones, if Dubar is to be relied on; he represents them as even more elongate than in the S. laticeps. The first rib of this animal is apparently much wider. The annulate cervicals are less numerous. The dorsal fin has a different form and position.

The type of the S. tectirostris came ashore during the winter of the present year, on the coast near Sinepuxent Bay, on the Maryland peninsula. It had been dead some time; the stomach contained but little, and that a mixture of finely divided scaly and stringy material, not readily recognizable. Bottles dropped at numerous points off the coast of Maryland and Virginia by the Coast Survey, were always carried ashore in the course of a few days or weeks, to the south-west of the point where dropped. It is therefore probable that this whale is a native of the ocean from which it drifted, and that it is one of the "fin-backs" of the Western Atlantic.

The species described by Capt. Scammon, if of this genus, belongs to the sub-group of the S. borealis, so far as the proportions and position of the dorsal fin are concerned; the cervical vertebrae are not yet known. Its size would also distinguish it from the species of the other groups, as well as from the S. schleegeli Flower, from the Malaysian Seas.

Sibbadilus sulfuris Cope.

The Sulphur-Bottom of the North West Coast.

This immense whale is as yet too insufficiently known to be distinguished as fully as desirable, but the marked peculiarity of coloration separates it from the only species with which a comparison is necessary—the S. borealis or gigas of the North Atlantic. Capt. Scammon describes it to be a gray or brown above, paler than in the Balaenoptera velifera, and beneath, a sulphur yellow. Length from seventy to ninety feet. The colors of the S. borealis are described as polished black above, milky white beneath, by Dubar.

DENTICETE.

Three families of this order are known, which differ as follows, according to Flower:

Costal cartilages not ossified. The hinder ribs losing their tubercle and retaining their capitular articulation with the vertebrae. The greater number of the cervical vertebrae ancylosed together. Pterygoid bones thick, produced backwards, meeting in the middle line, and not involuted to form the outer wall of the postpalatine air-sinus........................ Physeteride.

Costal cartilages not ossified. The tubercular and capitular articulations of the ribs blending together posteriorly. Cervical vertebrae all free. Pterygoid bones thin, not conforming in their mode of arrangement with either of the other sections................................. Platanistide.

Costal cartilages firmly ossified. Posterior ribs losing their capitular articulation, and only uniting with the transverse processes of the vertebrae by the tubercle. Anterior (2—6) cervical, in most, ancylosed together. Pterygoid bones short, thin involute, to form, with a process with the palatine bone, the outer wall of the postpalatine air-sinus........................ Delphinidide.
DELPHINIDÆ.

This family is most numerousley represented by species in the order. The genera are also numerous. Those represented in the ocean bordering North America are the following:

I. The phalanges numerous.

Pectoral fins, long narrow, on the lower part of the sides; cervical vertebrae consolidated; the teeth few, obtuse; dorsal fin ............... Globiocephalus.

II. The phalanges not more than 4—5 in the same digit.

α. Two or more cervical vertebrae consolidated.

β. Teeth cylindrical.

γ. Beak of skull short, broad; teeth few, large; a dorsal fin.

Teeth early deciduous ................................................. Grampus.

Teeth permanent, acute .............................................. Orca.

δ. Beak of skull elongate, exceeding brain case; teeth small, numerous.

Dorsal fin present; teeth long, more or less acute ............... Delphinus.

Dorsal fin none; teeth as last ..................................... Delphinapterus.

Dorsal fin? teeth short, obtusely rounded ....................... Sagmatias.

ε. Teeth compressed, spade-shaped.

Dorsal fin present ................................................. Phocaena.

Dorsal fin none ..................................................... Neomeris.

αα. Cervical vertebrae all distinct.

βα. No dorsal fin.

Teeth little deciduous; incisors normal ............................ Beluga.

Teeth deciduous, except one incisor, which is prolonged into a tusk.

Monodon.

GLOBIOCEPHALUS Gray.

The "black-fish" of whalers are included in this genus; the species represent it in all seas as yet known. They differ less in remote regions than the species of some other genera do. The species of the eastern coasts of North America appears to be the same as that found on the coasts of Europe, the G. melas. The species of the Pacific coasts is fortunately so fully described by Capt. Scammon, that it can be distinguished very readily from those heretofore recorded.

Globiocephalus scammonii Cope.

For details of character of this abundant species I refer to Capt. Scammon's description, and only contrast it here with the species to which it is allied. It pertains to the section of the genus characterized by the absence of white band or other mark on the abdomen, and is among these one of the most uniformly black species. Its more numerous teeth \( \frac{14}{10} - \frac{10}{10} \) distinguish it from G. mac h r o r y n c h u s of the South Seas. In Gray's Catalogue three species remain for comparison, the G. c h i n e n s i s, which probably does not belong to the genus; the G. s i e b o l d i i, which, not being described, cannot be regarded as valid; and G. i n d i c u s Blyth. The measurements of the latter indicate a much wider pectoral fin, a longer and lower dorsal fin, and considerably wider flukes. The measurements given by Blyth are as follows:

<table>
<thead>
<tr>
<th>Ft.</th>
<th>In.</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
</tr>
</tbody>
</table>

It inhabits the Bay of Bengal.

The present species is named in honor of Capt. Scammon, who has furnished us with a mass of information on the subject of the Marine Mammalia, and an amount of novelty in connection with it seldom equaled in the history of zoology.

1869.]
ORCA Gray.

The species of this genus are the wolves of the ocean, and occur in all seas, swimming in small companies, and living by violence and plunder.

Two species of the genus are described briefly by Capt. Scammon, which differ from each other much as the two Atlantic species do, in respect to the form of the dorsal fin. In one in each case the fin is exceedingly high and erect, in the other broader, more oblique and less elevated.

**ORCA rectipinnia Cope.**

The dorsal fin extremely elevated—"six feet or more in the larger males," whose length "averages 25 feet" at right angles to the axis of the body, and one-third the length from the end of the muzzle. Muzzle slightly acuminate. Color black, more or less white below ("most in females") with white lines on the sides from the eye sometimes to the hinder margin of the dorsal fin. ? No large white spot behind eye. This species appears to be distributed from California southwards.

**ORCA ater Cope.**

The dorsal fin much shorter, wider, and more obliquely directed. Black, with a large white spot behind the eye. Muzzle ? not acuminate. ? A brown dorsal crescent behind fin.

The North West coasts from Oregon to the Aleutian Islands.

The species of this genus from the Atlantic Ocean, whose colors are known, reverse the arrangement existing in the Pacific species. According to Lilljeborg, the O. gladiator has the straight elevated fin, and the large white spot on the side, while the O. eschrichti, which has the less elevated and oblique fin, does not present this peculiar mark. In both these animals the belly is white, as is also the case with O. eschrichti. In O. ater the inferior surfaces appear to be entirely black, or nearly so.

It will no doubt be found to be the case with both these Orca's that their females will have less elevated dorsal fins than the males. This is known to be the case with the Atlantic species, as described by Eschricht and Reinhardt.

**DELPHINUS.**

Many species of true dolphins have been described as inhabiting the Pacific Ocean, by French and American travellers. Those enumerated by Capt. Scammon are not sufficiently described to be identified. They are probably the following:

**Delphinus obliquidens Gill.**


? *Delphinus styx* Gray.


The cranium described by me as above accompanied one of the *Phocena vomerina* Gill, and was, like it, covered with a dark varnish, which is not the case with any other specimen in the Museum of the Academy. Whether it really came from the California coast or not is entirely uncertain. It is equally uncertain whether it is the species mentioned by Capt. Scammon, in case this should prove to be the fact. It is a species of the size and proportions of the typical dolphins or porpoises.

**Delphinapterus Less.**

**Delphinapterus borealis** Peale.


This species was taken in the North Pacific, nearer the coast of Oregon than any other land. It may possibly be the Right Whale Porpoise of Scammon.

[April,
The cranium is peculiar for the breadth and shortness of the muzzle and its sudden contraction; the fewness of the teeth; the large extent of the vomer produced behind the palatines; and the long proportion of the maxillaries in front of the nares uncovered by the intermaxillaries.

The length of the muzzle to the notch equals the distance from the latter point to the crest at the inner extremity of the os parietale; its breadth at the same point is about three-fourths the length and less than the width of the cranium at the orbits. The premaxillary exposed portion of the maxillaries is parallelogrammic, the length about two and a half times the width, and extends very nearly to a line connecting the fundus of the maxillary notches. The maxillaries present no other carina than a short one on each side the o. o. nasalia.

The premaxillaries terminate opposite the posterior extremity of the vomer, and are deeply grooved for the outlines of the "triangle," which terminates with the basal third of the muzzle. They are one-third wider than the maxillaries (from a vertical view) at the middle of the muzzle, where the contraction is strongest, and form with them an arch of nearly 180° width at the internal foramen three-fifths width from outer margin to notch of maxillary.

The median portion of the palatines is narrowed, and with an inner angle just prevent the contact of the maxillaries and vomer. The outer wing is also narrow, and impressed externally with a broad groove; it extends as far as opposite the squamosal process. The latter bone is not in contact with the postorbital process, and presents a large internal lamina, which overlaps without touching the alisphenoid. Posterior upper vomer plate with the deep corner emarginations seen in Phocaena.

Posterior temporal crest not developed; exoccipitals flat, slightly concave externally. Supraoccipital with two large fontanelles and above the foramen two impressions for insertion of muscles. Line to the weak spine straight, Crest not developed; frontal band broad, flat; knob above nasals slight.

Length from end of muzzle to concavity of occ. condyle 16 0·8
" " occipital spine 14 8·8
" " nares 9 10
" " maxillary notch 7 7·5
" of temporal fossa 5 1
" of orbit 1 11·4
" of ramus mandibuli 12
" of gony 1 9·5
Breadth at distal 2-5ths of muzzle 2 5
" at notch 5 6
" at orbits 8 11·4
" at frontal margins 8 6·8
" of foramen magnum 2 2·5
" of paroccipital alae 7 2·8
" of external nares 2 2·2

Teeth

1869.]
Behind the alveoli of the *O. maxillare* is an indication of a groove, as though a full series of teeth had existed in early life, and been shed, and the alveoli obliterated by deposit of bone. This appearance is, however, deceptive, as the teeth in these animals are not developed from deep seated capsules, but more superficially; perhaps a few very weak teeth were supported by the integument posteriorly. In *B. declivis*, where the posterior teeth are mainly so held in position, the alveoli are very distinct.

In the teeth of the *B. rhinodon* certain specific characters may be noticed; though the animal is much smaller than the *B. declivis*, the teeth are quite as large and as much worn. The median or vertical mandibulars, instead of a conic or curved crown, terminate in a broad, rounded, slightly elevated summit; the form of these teeth is clavate. A pair of the oblique mandibulars have a similar form.

<table>
<thead>
<tr>
<th>Vertebra Type</th>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical vertebrae</td>
<td>7</td>
<td>4³⁄₄</td>
</tr>
<tr>
<td>Dorsal vertebrae</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Lumbar (imperforate)</td>
<td>12</td>
<td>36³⁄₄</td>
</tr>
<tr>
<td>Caudal (perforate by lateral foramen)</td>
<td>6</td>
<td>11³⁄₄</td>
</tr>
<tr>
<td>Caudal from first wanting neural spine</td>
<td>11</td>
<td>14³⁄₄</td>
</tr>
<tr>
<td>With cranium</td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

Total: 7 ft. 10³⁄₄ in. [April,
The atlas is characterized by the nearly equal width of the portion of the neural canal above and below the constriction, the narrowness of the wing outside the articulating surfaces, and the elongation of the latter. The inferior apophysial articulating surface is broad, rounded, and separated by a high ridge from the anterior face of the inferior limb. The inferior lateral process is opposite the middle of the articulating surface; it is short, obtuse; the superior is small, acute.

Width of canal above constriction ... ........................................... 2 2·6
" " below " ................................................................. 2 2·6
" wing from posterior articular surface ...................................... 6
Vertical diameter of posterior articular surface .............................. 2 3

The body of the axis is short, and the lateral ala longer and thinner than in the *angustata*, though not extending so far beyond the articular facets. The inferior articular surface is longer than broad and occupies two-thirds the surface of the body. The neural spine is short, flat, and terminates obtusely, over the penultimate cervical. The zygapophyseal articulation marks three-fifths the distance between the external alar angle and the tip of the neural spine.

<table>
<thead>
<tr>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total transverse diameter .................................................. 6 10·2</td>
<td></td>
</tr>
<tr>
<td>&quot; of centrum ................................................................. 2 4·6</td>
<td></td>
</tr>
<tr>
<td>Heighth of neural canal ..................................................... 1 8·2</td>
<td></td>
</tr>
<tr>
<td>Length of neural spine .................................................... 2 1·2</td>
<td></td>
</tr>
</tbody>
</table>

Of the remaining cervical vertebrae, the third is distinct, and has very short lateral processes, the superior longer, originating with the neurapophysis from a very broad base. Its neural arch is completed above by a loose suture. The superior lateral process diminishes and is reduced to nothing on the fifth, appears higher up on the sixth, and commencing at the zygapophysis on the seventh is very elongate and much recurved, its extremity being opposite the articulation of the fourth or fifth. The inferior lateral process increases to the fifth, where they are nearly cylindrical, three-quarters inch long by a half broad, and directed downwards at an angle of 45°. These processes rapidly diminish and are reduced to nothing on the seventh vertebra.

Dimensions of seventh cervical vertebra:

<table>
<thead>
<tr>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of body .............................................................. 7·4</td>
<td></td>
</tr>
<tr>
<td>Transverse diameter of same ................................................ 2 6·2</td>
<td></td>
</tr>
<tr>
<td>&quot; of neural canal ............................................................ 2 7·8</td>
<td></td>
</tr>
<tr>
<td>&quot; extent of diapophysis from canal ....................................... 1 10·8</td>
<td></td>
</tr>
<tr>
<td>Height of neural canal ..................................................... 1 7·4</td>
<td></td>
</tr>
</tbody>
</table>

The dorsal, as well as the other vertebrae, are distinguishable from those of other species by their great breadth as compared with their length. The costal articular surfaces of the centra are not distinct.

Dimensions of the third dorsal:

<table>
<thead>
<tr>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of body .............................................................. 1 3·3</td>
<td></td>
</tr>
<tr>
<td>Span of neural arch .......................................................... 2 4</td>
<td></td>
</tr>
<tr>
<td>Anterior vertical diameter .................................................. 1 4·8</td>
<td></td>
</tr>
<tr>
<td>Width &quot; ................................................................. 1 4</td>
<td></td>
</tr>
<tr>
<td>Anterior height of canal ................................................... 2 1·8</td>
<td></td>
</tr>
<tr>
<td>Height of neural spine (from behind) ................................... 3 3</td>
<td></td>
</tr>
<tr>
<td>Breadth canal at diapophysis .............................................. 2 8</td>
<td></td>
</tr>
<tr>
<td>Height of neural spine (from behind) ................................... 3 3</td>
<td></td>
</tr>
</tbody>
</table>

The lumbar vertebrae possess longer diapophyses than those of the *angustata* and *concreta*, which are also less dilated distally on the anterior margin. That of the first is nearly truncate.

Its dimensions are:

<table>
<thead>
<tr>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length body .............................................................. 2 3·16</td>
<td></td>
</tr>
<tr>
<td>Same to posterior extremity .............................................. 3 1·5</td>
<td></td>
</tr>
<tr>
<td>Anterior transverse diameter ........................................... 2 1·5</td>
<td></td>
</tr>
<tr>
<td>Floor of canal to zygapophysis ....................................... 2 1·16</td>
<td></td>
</tr>
<tr>
<td>Height canal (anteriorly) .............................................. 1 15·16</td>
<td></td>
</tr>
<tr>
<td>Zygap. to apex of neural spine ....................................... 2 7·16</td>
<td></td>
</tr>
<tr>
<td>Width at diapophyses .................................................... 1 4</td>
<td></td>
</tr>
<tr>
<td>Epiphysis to anter. extremity of diapophysis ........................ 2 15·16</td>
<td></td>
</tr>
</tbody>
</table>

1869.]
The fifth or typical lumbar offers the following proportions:

<table>
<thead>
<tr>
<th></th>
<th>In</th>
<th>Lin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of body</td>
<td>2.7-16</td>
<td></td>
</tr>
<tr>
<td>Anterior breadth</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td>Length of diapophys</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Breadth diapophys distally</td>
<td>1.15-16</td>
<td></td>
</tr>
<tr>
<td>Height of canal</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Zygapophysis to apex neural spine</td>
<td>2.5</td>
<td></td>
</tr>
</tbody>
</table>

The series of caudals diminishes gradually in size to the last.

The dimensions of the fourth (perforated) are:

<table>
<thead>
<tr>
<th></th>
<th>In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length body</td>
<td>1.3-16</td>
</tr>
<tr>
<td>Transverse anterior diameter</td>
<td>2.5</td>
</tr>
<tr>
<td>Neural arch and spine</td>
<td>1.5</td>
</tr>
</tbody>
</table>

The neural canal is laterally compressed, or oval. The articulating ridges of the epiphyses and corresponding vertebral bodies are fewer, coarser, and more elevated in this species than in the angustata. In the latter they are more delicate, and have a less number of complete radii.

There are ten pairs of ribs as in the catodon, one pair less than in the concreta. The first is destitute of the anteriorly curved angular process of the catodon, but the tubercle is on an elevated base. The sixth, seventh and eighth ribs are flat on the posterior face; the last three are without neck and head, and this portion of the seventh is much less than the same of the sixth; in the seventh also the angle is furthest from the tubercle. The anterior ribs are not so dilated at the extremities as in the angustata.

First rib; head to angle | 3.5 |
Seventh rib; length | 17.10 |

The stylohyal of the specimen of this species is of relatively the same size as that of the angustata, but is flatter, less narrowed at its anterior extremity, not swollen on its posterior border, nor constricted at its posterior extremity. Its hinder border is somewhat rugose. The body and posterior hyoid cornua are much like those of the angustata and declivis and coossified.

Length of body | 2.1 |
Expanse of posterior cornua | 4.1 |

The sternal pieces are separate. The anterior has been found like that in the angustata, with equally strong lateral vertical processes. The haemapophyses are relatively shorter than in concreta; the fourth wants the produced thin anterior margin of the third, and is about the same length as the fifth. Sixth, slender, flattened.

Length of first haemapophysis | 4.8 |
Width (medially) | 1.2 |

The scapula is not different from that of the angustata. The brachial and antebrachial elements are in this species also identical with those of the angustata; in the specimen from Upernavik the epiphysis of the humerus has not coalesced, while it is completely united in that of the latter species. In both the exterior (bicipital) process is more prominent and occupies a less portion of the circumference than in the concreta. The humerus is also much constricted in both except on the exterior aspect.

Length of humerus | 3.11 |
Diameter at condyle | 3.11 |
Length of radius | 3.10 |
Breath | 3.05 |

Habitat, Baflin's Bay.

[April,
A skeleton of this species in the Museum of the Academy of Natural Sciences was brought by Dr. Isaac I. Hayes, from Upernavik, Greenland, in lat. 74°.

I was at first disposed to regard this as a young individual of one of the species under observation, perhaps B. angustata or declivis. A very brief study was sufficient, however, to reveal its manifold differences from these. In cranial features it resembles most the B. declivis, but I am satisfied that no such difference in the form of the muzzle of the cranium as obtains here can exist between young and adult of the same species.


This species resembles the angustata in the general proportions of the cranium; the muzzle is relatively shorter in the specimen, and its margins decurved toward the end; it therefore resembles also the catodon, which has much less marked maxillary notches, a different premaxillary space and shorter, heavier mandible. The inferior view presents some analogy with that of the B. rhinodon, in the largely developed vomerine tablet; but the palatines are even further separated by an interval of three-quarters of an inch. The horizontal palatal surface of these bones mark a narrow incurved longitudinal process only, and they appear in the inferior half of the anterior wall of the nasal meatus, as narrow strips lying next to the vomer. The pterygoids are nearly exactly parallelogrammic, their exterior angles alone in contact on the horizontal plane. The exposure of the premaxillaries extends, as in the other species, to beyond opposite the fifth maxillary tooth. Of the superior portion of the palatines the anterior portion extends to opposite the notch; the vertical portion of the posterior ala is broader than the horizontal. The middle of the palate is prominent without lateral angulation. The proportions are explained by the following measurements.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length from end of muzzle to convexity of condyle</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>of temporal fossa</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>of foramen magnum to occipital crest</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>orbit</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>ramus mandibul.</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>gonyx</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Breadth at distal two-fifths muzzle</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>of maxillary</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>orbits</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>frontal margins</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>of foramen magnum</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>external nares</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>between spires of paroccipital crests</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

The sella turcica is little marked, and the suture between the sphenoid and presphenoid distinct, as indicated in the figure in Huxley's Elem. Comp. Anat. 277. The teeth are relatively much smaller than in the concreta, and the posterior but loosely attached to the alveole, being principally held in position by the palatal integument. The anterior above are considerably worn on their inner faces.

*The tympanic and periotic elements are much like those of the rhinodon, and though the latter is known from a much smaller animal, its tympanic bone is about the size of that of the former. The only noticeable difference is the greater elevation of the prootic. The corresponding portions of the Beluga angustata are larger and considerably heavier, though the cranium is a little less in all dimensions than that of the declivis. The opisthotic process is more prolonged than in the 1869.]*
others, and the region around the foramen for the seventh pair is very rugose and gives rise to a process behind the formen. The prootic is acuminate anteriorly, and ends in an acute process. The inner lip of the tympanic is much elevated at its anterior extremity, causing the profile of this extreme of the bulla to be truncate instead of acuminate; the Eustachian sinus is thus shorter and broader. Of the longitudinal lobes of the inferior surface of the bulla, the interior is weaker and the external more prominent and narrower than in the declivis. The anterior end of the inferior view is broader, more oblique, and more truncate than in the other species.

<table>
<thead>
<tr>
<th>angustata.</th>
<th>declivis.</th>
<th>rhinodon.</th>
<th>Steno frontatus.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of tympanic bulla 1 in.</td>
<td>1 11 l.</td>
<td>1 10</td>
<td>1 9.5</td>
</tr>
<tr>
<td>&quot; &quot; other elements</td>
<td>3 5</td>
<td>1 11.5</td>
<td>1 10</td>
</tr>
<tr>
<td>Total depth</td>
<td>2</td>
<td>1 8</td>
<td>1 7.5</td>
</tr>
</tbody>
</table>

**General Measurements.**

<table>
<thead>
<tr>
<th>Cervical vertebrae</th>
<th>No.</th>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal</td>
<td>7</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Lumbar (to 1st chevron bone)</td>
<td>11</td>
<td>28</td>
<td>7</td>
</tr>
<tr>
<td>Caudal (imperforate)</td>
<td>10</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Caudal (perforate)</td>
<td>18</td>
<td>31</td>
<td>9</td>
</tr>
<tr>
<td>Caudal (from first wanting neural spine)</td>
<td>(11)</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>With cranium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11 ft. 1 in. 2 l.</td>
<td>133</td>
<td>2</td>
</tr>
</tbody>
</table>

The cervical vertebrae are in general similar to those of B. angustata; they present the same acute inferior-posterior process of the atlas, short truncate inferior lateral processes and longer but weak superior lateral. As in it the last is longest and recurved to opposite the sixth. There is nowhere a vertebral foramen. They differ from those of the angustata in the heavier proportions of the atlas and axis, and the high compressed carinate neural spine of the latter. The axis is also peculiar in that the inferior (circular) surface of articulation with the atlas process occupies a median position of the inferior face, and is separated by a deep groove from an anterior transverse articular surface, which belongs to an apparently decurved odontoid process. The latter fits a corresponding and separate surface just behind the margin of the spinal canal of the atlas.

Width of spinal canal above | | | |
| " " below | 8 5 |
| Transverse diameter of atlas | 7 10 5 |
| Vertical | 4 | 1 |
| Transverse diameter of axis | 7 | 0 8 |
| " " of centrum of do. | 2 | 10 5 |
| Height of neural canal | 1 | 8 |
| Length of neural spine (superiorly) | 3 | 5 7 |

The neural canal is rather depressed, and angulate above; the arches of the fourth and seventh are incompletely united above, and the latter has a trace only of neural spine. Its dimensions are

Length of body | 11 |
| Transverse diameter of same | 2 6 4 |
| " " of neural canal | 2 | 9 5 |
| " extent of diapophysis from canal | 1 | 11 |
| Height of neural canal | 2 2 |

The dorsal vertebrae are not so short as in the B. rhinodon, and the neural spines are low; seven of them furnish an entire articular surface near their posterior border for the ribs, commencing with the second pair.

The lumbar are heavy, and have long diapophyses which are dilated dis-

* From specimens described in Proc. Acad., Phila., 1895, p. 291.
tally, anteriorly, as in *angustata* and *concreta*. The diapophysis of the first is obliquely truncate, and furnishes a ligamentous attachment to the angle of the last rib.

Its dimensions are:

<table>
<thead>
<tr>
<th></th>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length body</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Anterior transverse diameter</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Height of canal</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Width of diapophyses</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Epiphysis to anter. extrem. of do</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

Same to posterior extremity... | 5 | 10 |
Floor canal to zygapophysis... | 2 | 9  |
Zygapophysis to apex of neu- | 1 | 7  |
ral spine........................... | 4 | 1  |

Of the caudals, the last five are transverse.

The dimensions of the fourth perforated are as follows:

<table>
<thead>
<tr>
<th></th>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of centrum</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Transverse anterior diameter</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Neural arch and spine</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Hæmal arch and (very low) spine (from centrum)</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Diapophysis projection</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

The neural canal is compressed.

The radiating ridges of the epiphysial articulations on all the vertebrae are very coarse and much broken up into mammilæ.

The ossified body and lesser cornua of the *os hyoides* do not resemble those of *angustata* as much as the latter do those of *rhinodon*. The body is not so long as its greatest breadth, and the surface articulating with the cornua the shortest of all. Viewed from below, the posterior area is one-half the anterior (equal in *angustata*) has a heavy double posterior margin, and is marked by a median process. The cornua are of nearly equal width throughout, and not expanded on the margins. Their proximal extremities would have a trigonal section, owing to their inferior thickened angle.

<table>
<thead>
<tr>
<th></th>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length body</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Breadth</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Length of cornu</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Expanse of cornua</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

There are eleven ribs, of which the three posterior have no head, and the first articulates by head with the seventh cervical vertebra. The first, like that of *angustata*, has the tubercle on a backward curved process. The superior half of the shank of this rib is thin and expanded on its outer margin, while on the lower half it is obliquely flattened. The ribs from the second to the fifth are considerably dilated distally; the posterior aspects of sixth, seventh and eighth are rounded.

<table>
<thead>
<tr>
<th></th>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>First rib ; head to base of angular process</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>&quot; length of &quot;</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>&quot; base of process to dist. extremity</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Seventh rib ; length</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>Last &quot;</td>
<td>16</td>
<td>10</td>
</tr>
</tbody>
</table>

Seven pairs of ribs are attached to bony hæmapophyses, of which five pairs articulate immediately with the sternum. The first is smooth, flat, and dilated distally; the second narrower and thickened distally; the third is dilated and sharp edged on the middle of the anterior border. The penultimate has a slight curvature, and the last is cylindrical and very slender. The sternum is yet distinguished into three principal pieces, the last narrowest and longitudinally divided. The articular cavities are at the sutures except the two anterior, which are close together at the front of the anterior piece. The latter has a cordate anterior outline, no cornua, and a convex posterior suture.

1869.]
Dimensions:

<table>
<thead>
<tr>
<th>Description</th>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of first hemalophysis</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>&quot; fifth &quot;</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>&quot; last &quot;</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>&quot; anterior sternal segment &quot;</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>&quot; median &quot;</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>&quot; posterior &quot;</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Breadth of anterior &quot;</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Fig. 2.

Fig. 3.
One of the chief peculiarities of this species, and that from which it derives
its name, is seen in the scapula. On placing the glenoid cavity in the same plane
with that of the scapula of the angustata, the acromion is observed to be
in the general plane of the scapula, and not deflected inward, and to be shorter
and much decurved. The coracoid is also decurved so as to be nearly parallel
with the acromion; the extremities of the two are connected by a strong liga-
ment. This direction of the coracoid is the opposite of what is seen in most
other Delphinidae, and all others of this genus, where it is recurved and acumin-
ate.

The superior sinus, while more deeply incised than that of the angustata,
is much more open, having divergent, instead of parallel outlines.

<table>
<thead>
<tr>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greatest length of scapula</td>
<td>10</td>
</tr>
<tr>
<td>Glenoid cavity to anterior angle</td>
<td>9</td>
</tr>
<tr>
<td>End of coracoid</td>
<td>5</td>
</tr>
</tbody>
</table>

The deltoid process of the humerus is as wide as the condyle. Olecranon
distinct. There are two large carpals opposite the inferior digits, and three
smaller of the outer row, opposite the second, fourth and fifth respectively.
The three inferior digits are more closely approximated in the fluke than the
two superior. Phalanges (counting from above), 3—4—5—4—3; fourth digit
longer than second.

<table>
<thead>
<tr>
<th>In.</th>
<th>Lin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length humerus</td>
<td>7</td>
</tr>
<tr>
<td>II ulna and radius</td>
<td>2</td>
</tr>
<tr>
<td>II carpus and third digit</td>
<td>7</td>
</tr>
<tr>
<td>Breadth at carpus</td>
<td>7</td>
</tr>
</tbody>
</table>

The only specimen of this species at my disposal is not fully adult, as the vertebral
and humeral epiphyses are not yet ankylosed. It was brought by
Dr. Elisha K. Kane, on his return from the Arctic regions, from what precise
locality is not stated. He presented it to the Museum of Comparative Zoology,
Cambridge, Mass., whence it was kindly lent me by Dr. Alexander Agassiz, to
whom my acknowledgements are due.

**PHYSETERIDÆ.**

**HYPERAODON** Lacep.

No species of this genus from the Pacific Coasts is mentioned by Scammon,
but the present is embraced as an opportunity of alluding to the species of the
Eastern coasts of North America.

In the Proceedings of the Academy 1865, p. 280, I characterized briefly a
whale of this genus under the name of H. semijunctus, which is represen-
ted by a specimen in the Museum of the College of Charleston, So. Ca.
The characters furnished are meager, and it was anticipated that opportunity
would soon have occurred to amplify them. This has been, however, disappoin-
ted, but is still looked forward to.

Two years ago two individuals of this genus entered the harbor of Newport,
R. I., and after a lively chase one of them was captured. It measured twenty-
seven feet in length. Its bones were preserved, and some of them, including the
cranium, have been sent to the Academy of Natural Sciences, through the atten-
tion of its member, Saml. Powell, of Newport. He has also sent numer-
ous photographs of its carcass, taken just after its capture, from various
points.

These render it evident that the species is quite distinct from that described by
European authors as H. rostratus (or H. bidens). Its most striking feature
is the relatively longer and more slender beak, and less elevated and prominent
front. This is obvious on comparison with the figures of Hunter, of Deslong-
champs (Mem. Soc. Normandie) of Gray, (Zool. Erebus and Terror) and of F.
Cuvier (Cetacea) and constitutes a material distinction. Thus, in the New-
port specimen, it is one-twelfth of the length, or 21 feet; equal three-fourths
the distance between the eye and the spout hole. In a Cape Cod specimen
1869.]
it measures twenty-two inches in a length of twenty-four feet. The prominent swollen front is in the Newport whale, considerably compressed, and the eye is placed in a strong longitudinal prominence on each side of the head.

The dorsal fin, as in Deslongchamp's specimen, is small, and posterior. The caudal fluke is not emarginate. The color is dark, deeper above than below. It remains a question whether this is the *Physeter macrocephalus*. The principal character on which that species rests is the non-coossification of the posterior four cervical vertebrae, a very remarkable character, and one which leads to the question of its pertinence to the genus. The cervical vertebrae of the Newport specimen are entirely coossified. The same character is furnished by a second specimen.

This is the skeleton preserved in the Museum Compar. Zoology at Cambridge, Mass., of an individual cast ashore during the winter of the present year, at Dennis, near Cape Cod, Massachusetts. It was stripped of its blubber by Perez Hall, of that place, who kindly sent me a sketch of it. He stated its length to be twenty-four feet, of which the muzzle measured twenty-two inches: the expanse of the flukes was six feet. The stomach was filled with the beaks of cuttle fish. On inquiry of J. A. Allen, of Cambridge, well known as a naturalist there, I learn that the cervical vertebrae of the animal are solidly coossified, as in the *H. rostratus*. It is therefore distinct from the *Physeter macrocephalus*. The photographs are figured for the further illustration of the species. The characters derived from the portions of the skeleton sent by Saml. Powell are as follows:

**PHYSETER Linn.**

**PHYSETER MACROCEPHALUS Linn.**

The sperm whale.

This species is one of the few that appear to be distributed over all oceans. Flower does not find those from Australian to differ specifically from those from British seas, and I find no peculiarities by which to distinguish a specimen from our own coast from the latter. This is known from a cranium which was found on the coast of New Jersey and is in the Mas. Compar. Zoology, Cambridge.

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**PART II.**

**NATURAL HISTORY.**

*Of the Cetaceans of the seas off the North-West Coast of America, with an account of the Elephant Seal appended.*

**PREFACE.**

Being on the coast of California in 1852, when the "gold fever" raged, the force of circumstances compelled me to take command of a brig bound on a "sealing, sea-elephant and whaling voyage," or abandon sea life—at least temporarily.

Finding the object of pursuit in such vast numbers, and observing their natural habits in connection with their capture, it may not be surprising that it led to the study of their history. The few works treating the subject within reach were sufficient to prove that correct knowledge of the different species of whales was very meager, hence it appeared that, by industrious observation, one might reasonably expect to add something to the little known of their habits.

It is to be regretted that among the number of intelligent and observing American whaling masters, none have hitherto attempted to contribute any thing of moment to the history of whales; nevertheless it has in no wise deterred me from putting my observations on paper and, if eventually this humble treatise shall add to what is already known about Cetacean, it will be regarded as an ample reward.

The drawings of the different species where a scale is attached may be re-

[April,
This whale has a geographical distribution east and west, extending from Nova Zembla to the coast of Eastern Siberia. It is rarely seen further south in Bering Sea than the 55th parallel, and in the Okhotsk its southern range is about the latitude of 54°.

The northern limit of the Bowhead remains undefined. In tracing its history we can revert back to the Dutch and Russian fishery about Spitzbergen anterior to 1615,* and as years passed on it was pursued westward on the Atlantic side to the icy barriers in Davis Strait, and the adjacent waters uniting with the Frozen Ocean.

Right whales were pursued for several years on the North West coast, on the coast of Kamtschatka, about the Kurile Islands, and in the Japan Sea, before Bowheads were known to exist in that part of the Arctic Ocean adjoining Behring Strait, or in the Okhotsk Sea.

In the year 1848 Capt. Ross, in the American bark "Superior," was the first whaling master to work his vessel through Behring Strait into the Arctic Ocean, and then found whales innumerable, some of which yielded 200 barrels of oil.

The habits of the Bowhead are much like those of the Humpback, being irregular in its movements, in its respirations, and in the periods of time either above or below the surface of the water. When going gently along, or lying quietly, it shows two portions of the body: the spout-holes, and a part of the back, on account of the high conical shape of the former, and the swell of the latter, which is about midway between the spout-holes and flukes. The Bowhead of the Arctic may be classed as follows: 1st. The largest whales, of a brown color, average yield of oil 200 barrels. 2d class, smaller, color black, yield of oil 100 barrels. 3d class, the smallest, color black, yield of oil 75 barrels.† This last named class are generally found amongst the broken ice the first of the season, and they have been known to break through when it was three inches in thickness, that had formed over previously upon water between the floes. They do this by coming up under and striking it with the arched portion of their heads. Thence they have been sometimes called "ice-breakers." In point of color, all are found with more or less white on the under side, especially about the throat and flins. The Arctic Bowheads may average from 40 to 65 feet in length.

I am indebted to Capt. J. F. Poole, of the whaling bark "N. S. Perkins," for the following measurements and memoranda of one taken in the Arctic, August, 1867:

Sick female, color black on back and sides, throat white, also occasional white spots on under side of body. Yield of oil, 80 barrels. (The whale was judged large enough ordinarily to have yielded 150 barrels.

Ft. In.

Length of animal.......................... .......................... 47 0

* Subsequent datum enables me to date back to 1608.
† We do not mean to convey the idea of species when mentioning classes, as all observers of our acquaintance agree that the difference in size and shade of color arises from difference in age.

1869.J 3
Distance from nib end to spout holes........................... 16
Length of spout holes............................................ 1
Distance from corner of mouth to nib end........................ 16
Breadth of flukes.................................................... 19
Thickness of blubber................................................ 16
Average thickness of blubber........................................ 11
Thickness of black skin on back.................................... 1
Length of genital slit................................................ 10
Dist. from " " " to arms.......................................... 4
" " " to flukes...................................................... 9
Length of longest bone or baleen.................................. 10
" of fringe or hair on bone...................................... 2*
Breadth of widest bone........................................... 13

Bone is embedded in the gum of the jaw ten inches.
Weight of largest slab of bone, seven pounds.
Number of layers of bone on each side of jaw, 330.†
Bone extends back of spout holes in throat, three feet; falls short of nib end
one foot.
Number of teeth, two.
The tongue is very fat, yielding one-tenth as much oil as the whole of the
"body blubber."

All Bowheads found on this cruising ground are quite free from parasitic
crustaceans, as well as barnacles.
Whalers bound to the Arctic are generally at the "edge of the ice," which
is met with, near lat. 60°, about the 1st of May. They then work their way
northward as fast as the ice will permit, keeping as near shore as practicable
in order to be on the best "whale-ground," and also to avoid the ice. Many
whales were formerly taken off Karaginski Island, lat. 59°, on the coast of
Kamschatka.
Behring Strait is sufficiently clear of ice from the 1st to the 20th of July for
ships to navigate with comparative safety. A large fleet collect, and grope
their way through ice and fog into the Arctic (as termed), and frequently reach
the high latitude of 72° N. Occasionally an open season occurs, when they
hazard their ships around Point Barrow. Capt. Roys entered the ocean the
middle of July, and left the 28th of August, but at the present time ships re-
main till October.
The principal herding places of the Bowheads in the Okhotsk are at the extremi-
ties of this great sheet of water, the most northern being the North-East Gulf
(Gulf of Glijgih), the most southern, Tchantar Bay. The whales do not make
their appearance in North-East Gulf so soon as in the bay. Whalers endeavor
as soon as possible to get to the head of Tchantar Bay, where they are sure to
find the objects of pursuit in the intermediate water between the ice and shore,
long before the main body of the congealed mass is broken up; and before
the ships can get between the ice and the shore, even at high tide, the boats
being sent forward weeks previous to the ships. Soon after the ship's arrival
the whales avoid their pursuers by going under the main body of ice
situated in the middle of the bay, finding breathing holes among the conglom-
erate ice. The boats cruise about the edge of this barrier watching for them
to emerge from their cover, which occasionally they do, and are given chase
to instantly. Frequently, in sailing along this field of ice, you hear distinctly
the sound of whales blowing among it, when no water is visible at the point
from whence the sound comes. The first of the season, before the ice breaks

* Two feet may be regarded as nearly twice the usual length.
† 320 may be a fair average, and 370 is the highest number we have counted.

[April,
up and disappears, when there are "no whales about," the question is frequently asked, "where are the whales?" and as often answered, "they are in the ice," and "when do you think they will come out?" "when the ice leaves."

It has been established beyond question that this species pass from the Atlantic to the Pacific, or rather, if we may be allowed the expression, from the Atlantic Arctic to the Pacific Arctic, by the north; and, too, it is equally certain that numerous air holes always exist in the ice that covers the arctic waters, even in the coldest latitudes. These fissures are caused by the rise and fall of the tides, and storms acting upon the water hundreds of miles distant has its influence in rending asunder the icy fetters of those frozen seas. It appears to us not improbable that the Bowhead or Polar Whale has a feeding and breeding ground in an open polar sea. And as they have never been seen during the winter months in any other quarter of the globe except as before mentioned, it would appear that they must either remain among the rough water and broken ice at the southern edge of the winter barrier, or migrate to some remote sea unknown to man. Hence may not the clear water that Kane saw after passing the coldest latitudes as he pressed northward, be the winter home of vast numbers of these gigantic animals?

**Okhotsk Sea Bowheads.**

The preceding remarks have been confined chiefly to the Bowheads of the Arctic in the vicinity of Behring Strait, north and south. The Okhotsk Sea at one time equalled, if not surpassed, the Arctic as a productive whaling ground. Our memorandum does not state with certainty what year Bowheads were first taken in the Okhotsk. It however was not earlier than 1847, nor later than 1849. They were found to be easy of capture, and yielded a large amount of oil and bone. On making further explorations the whales appeared in great numbers, and, from the peculiar shape of the head, the spouthisholes terminating in a sort of cone, they were at that time called "steeple-tops."

But few years elapsed before a large fleet were pursuing the animals throughout the whole extent of this vast inland water. Tchantar Bay, Taousk and Penjinsk Gulfs soon became noted whaling grounds, as well as several other points about the coasts. The whales of this sea, as far as known, are the same species as those of the Arctic, although in the bays are found, in addition, a very small whale called the Boggy, which yields but little oil (20 to 25 barrels). Many whalemen are of the opinion

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*Capt. J. H. Swift, who was cruising in Behring's Sea about the year 1847, is quite positive that the French ship "And" was the first to take Bowheads in the Okhotsk (in 1847). Capt. Roys, of Arctic notoriety (spoken of in this paper), in a recent interview seemed equally certain that the "Asia" was not the first to take Bowheads in the sea. He thinks none were taken till 1848 or 1849, and that the American ship "Hunter" of Capt. Freeman Smith, was about the first, if not the first, to take Bowheads in that region.

In justice to both of these experienced and very intelligent whaling masters, it is desired to make mention that I am under much obligation to them for valuable data in relation to several species of cetacea, more especially as they are regarded as very correct and close observers of the habits of whales.*

†We are convinced that there are two species of Bowheads, which are found on the same ground. The difference from the animal above described is a bunch or sort of hump which rises from the top of the small; which is situated about six feet forward of the flukes, and extending along the top of the back or small two to three feet, and in some individuals rises in the highest place about six inches. The accompanying sketch will better represent the difference in shape, perhaps, than a written description. Capt. Roys says he has frequently taken them in the Arctic as well as in the Okhotsk. They have been frequently taken in the North East Gulf (Okhotsk sea). Our personal observation was only on a dead one in Tchantar Bay (1852), and upon that individual the protuberance was so slight that it would not have been noticed unless our particular attention had been called to it. Capt. Randoi, of the American whaling ship "South Boston" (1842), informed me at the time that nearly all the whales he had taken that sea in the N. E. Gulf were of that description, and yielded a very large amount of bone in proportion to yield of oil.

Capt. Roys also mentioned that one season he took numbers of them, and to distinguish them from others they were then called "Bunch Backs." Several whaling masters who 1869.]*
that these are a different species. There is little doubt, however, of their being young whales of the same species, as their blubber is close and fine, producing but little oil in proportion to size of body, as is the case with all calves or young whales of every description.*

Bowhead Whaling.

In the Arctic and about Behring Sea the whaling is done from the ship, as it is termed, i.e., the vessels cruise and the look-out is kept aloft as usual, and when whales are seen, the boats are lowered and the pursuit is carried on in sight from the ship, unless obscured by fog. In the Okhotsk much of the whaling is about the bays, particularly Tchantar Bay, and contiguous waters. The nature of the enterprise is such, in these localities, that the modus operandi is quite different.

Vessels bound to Tchantar Bay endeavor to approach the land of Aian if the ice will permit, which is generally sufficiently broken and scattered by the 20th of June; then, working along between the ice and the Siberian coast to the southward as far as practicable with the ships, they dispatch boats to follow along the shore and if possible to reach the head of Tchantar Bay, where whales in former years were expected to be found in large numbers. These boat expeditions were attended with excessive labor, much exposure, as well as risk to the crews. Frequent instances have been known of boats leaving the ships off Aian, then threading their way along the coast, between the masses of ice, or between the ice and shore, as the ebb or flood tides would permit, till they reached the head of Tchantar Bay. As soon as arrived there, finding whales plenty they would immediately commence whaling, and by the time the ships arrived, in several instances, whales enough had been taken to yield 1000 barrels of oil. The elapsed time from leaving the ship till again joining the vessel in the bay would vary from one to three weeks. All this time the boats' crews lived in or around their boats, beng afloat when making the passage or when engaged in whaling; and when driven to the shore by the ice or by stormy weather, or resorting thither to cook their food or sleep, the boats are hauled up and turned partially over for shelter, and tents are pitched with the sails. Fallen trees or drift wood furnish abundance of fuel, and by a rousing fire all sleep soundly when opportunity offers; but if whales are in abundance, the less sleep for the whalermen, in those high latitudes, where daylight lasts nearly the twenty-four hours of each day during the summer.

Tchantar Bay Whaling.

Arrived on the ground, whales being plenty, all surplus provisions and outfits are quickly landed, and the chase begins. Frequent spots in the air tell that the animals are all around. One of the number breaks the smooth surface of the water, between the land and ice, and is at once pursued, but before the boat can reach within darting or shooting distance, perhaps, the animal goes down. Then comes an impatient waiting for it to rise again. As the Bowhead is irregular in its course, when next seen it may be in another direction. Quickly the boat is headed for it, and before approaching near enough the whale goes down again. In this way the chase is frequently prolonged, sometimes abandoned and other whales pursued; or, it may be, when nearly within reach the animal glides under a floe of ice, and evades his pursuers; or, if hard-

* Capt. Roys is of the opinion that the Bowheads breed but slowly. Moreover his observations of many years in northern whaling goes to show that the young of this species seek but a short time compared with other cetaceous animals.

This opinion seems quite conclusive when we compare the immense head and long bal- leen of even the smallest individuals with those of other species, as though nature had provided them with immensely capacious mouths to gather insect food instead of drawing sustenance from the dam.

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pooned, it may run for the floe, and before being killed reaches it, and escapes with harpoons, lines, &c. If the pursuit proves successful, the captured whale is towed to the beach at high tide, and a scarf is cut through the blubber along the body, a tackle is made fast on shore and hooked to the blubber, then as the tide falls the animal is literally skinned of its oily hide, the carcass rolling down the bank as the process of skinning goes on. The bone is extracted from the mouth as the body rolls over, and presents the best opportunity. As soon as the blubber is taken off it is rafted,* and lies in the water till taken on board ship. The water being very cold, the blubber remains in its natural state for a long time, retaining the oil with but small loss. While the whaling is going on in this wise, the captain with the ship-keepers improves every opportunity to work the ship to the whales. If there is an opening seen between the ice and shore, the ship is at once worked through either by towing, kedging or sailing, and if meeting an adverse tide or wind the vessel is anchored with a very light anchor, so that if beset by ice unexpectedly in the night or during the dense fogs that prevail, the vessel will drift with the floe, thereby avoiding the dangers of being cut through. Heavy fogs prevail until the ice disappears, and the circumscribed clear water being crowded with ships and boats, much care and manoeuvring is exercised to prevent accidents. These fogs frequently are so dense that no object can be seen much more than a ship's length; consequently at such times cruising and whaling in the bays is full of excitement and anxiety. A ship may be laying quietly at anchor one moment, and the next she is surrounded by a field of ice, or the splashing of water under the bow of a passing vessel tells of her close proximity. Then comes the blowing of horns, the ringing of bells, the firing of guns, or pounding on empty casks, to indicate the vessel's position, in order to avoid collision.

Neither fog or drifting ice, however, prevents the whalers from vigorously prosecuting their work. In thick weather, when the spout of the whale or the animal itself cannot be seen, its hollow-sounding respiration can be heard a long distance. In such instances the boats approach as near as can be judged where the sound was heard, and if the animal is found and captured it is at the risk of the boats coming in contact with passing ships, ice or what not, and, too, not knowing with any degree of certainty what part of the bay they may be in, the first and main object being to capture the whale at all hazards. This being done it is taken in tow by the boats or is anchored. If taken in tow and not finding their own ship, but meeting with another, the custom is to go on board to eat or sleep, if necessary, and when recruited, or the fog lifts so as to find their own vessel, they are supplied with provisions, if needed, till they can reach her. If anchored, one boat always remains with the whale while the others go in search of the ship. As soon as found the master, learning of the capture, makes every effort to work his vessel to the dead animal; or, if that cannot be done, every favorable tide is improved to tow the whale to the ship, where it is cut in and tried out in the usual manner. As the season advances the ice disappears, leaving more room for cruising with the vessels, when the fleet becomes more scattered, and the feature of the whaling changes; the boats are kept more with the vessels, look-outs being stationed at the mastheads, and the whaling is principally done from the ship (as it is called); sometimes two boats are sent from a vessel to look for whales in an adjoining bay. Meanwhile the nights have become longer. Then comes the night whaling. The phosphorescent light caused by the whale's movements in the water show quite distinctly his whereabouts, and, the Bowhead whales being easy of capture compared with other kinds, night whaling has been pursued successfully.

We have spoken of the Bowheads as being comparatively easy of capture, but it must not be inferred that the pursuit is not often tedious or unsuccessful, or the attack made without risk of life and limb, as well as in other kinds of whaling.

* Tied together with ropes in a sort of raft.

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The Bowhead, compared with the other species of whales that are pursued, is considered very shy and timid.

After the ice leaves the bays, until the fall winds begin, much calm weather is experienced; and, although we have frequently seen large numbers of whale spouting among a large number of boats scattered over the water, not a single animal could be approached near enough to dart at with the hand harpoon, or to present a fair chance to shoot a bomb lance into it, notwithstanding the boats were rigg'd with extra large sails in order to take advantage of the light airs or winds that may prevail in midsummer. The use of oars or paddles would be quite sure to frighten the whales, and when there is not sufficient wind to sail on to them there is but little or no chance of getting fast. After the irons are firmly planted in the animal, or, as we frequently hear whalemen say, after the whale has been fastened to, good and solid, down the creature may go on to the bottom, and there rolls till either the irons are torn from its body or the line is wound about it, and the valuable prize may be lost.

The breeding places of the Bowheads seems to be a matter of conjecture among the most observing and experienced whaling masters. The only place known has already been mentioned, in the vicinity of Tchantar Bay, and a difference of opinion exists as to whether the Poggies before mentioned are calves or whether they are not a scrag species that have a corresponding relation to the full-grown Bowheads that the scrag Right Whale has to the larger grades of that species. Admitting, however, that they are the young ones, their numbers are comparatively few to the numerous progeny that is supposed to be brought forth by the cows during each season. Another singular fact is that no Bowhead of the Okhotsk Sea have ever been seen passing in or out the passage of the Kurile Islands, or from the Okhotsk to Behring Sea, or Arctic whales passing to the Okhotsk. According to statements of the most experienced whaling captains, a Bowhead with a calf never has been seen by any whaleers in the Arctic or Behring Strait, and where this species of cetacean resort to bring forth their young, or where the young remain till grown to a considerable degree of maturity, is not definitely known. The general opinion, however, is that an open Polar Sea must exist, where they resort, or some other open water not known to whalemen.

II. The Right Whale of the North-West Coast.

*Balena cullamach Chalm.*

Numerous species of whales frequent the coast of California at different seasons of the year, and both deep sea, bay and shore whaling has been prosecuted for many years. The shore and bay whaling, however, did not begin till about the time that Upper California became a part of U. S. Territory, and the shore whaling was not pursued to much extent till 1856. The first shore party was established at Monterey, 1852. The varieties of the larger Cetaceans found along the coast are known under the following names: California Gray, Humpback, Finback, Sulphur-bottom, Right Whale, Sperm Whale. The first five mentioned are of the Balena family, and their natural food is zoophytes, animalcules, "(brit)" mollusks, crustaceans, and small fish.

The Right Whales found on the coast are but few, compared with the numbers found on what is termed the Kodiak ground; the limits of which may be regarded as extending from Vancouver's Island, northward to the Aleutian Chain, and from the coast westward to longitude 150°. The small number frequenting the coast of California are supposed to be only a few stragglers from that region. They have been taken as far south as the Bay of St. Sebastian Viseiano, and off the north point of Cedros or Cerrros Island, both within the parallels of 27° and 29° N. The season of the year when seen was from February to April. This animal is thought to be a distinct species from the southern Right Whale, and is frequently called the North-West Whale, being larger, and in several particular points differing from the former. It has
ever been a matter of mysterious conjecture with the most philosophical whalemen where this species go to bring forth their young, and where they migrate during the winter months. That they do not go into the southern hemisphere is certain, and it is equally certain that but a few stragglers even reach within a number of degrees of the northern tropic in their wanderings. The same mystery hangs over the breeding place or winter resort of the species of Balena known as the Bowhead.

The Eskimo about the North Western shores of Behring's Sea speak about that species coming into the bays when the "small ice comes," and they look forward to that season as a time of plenty, and reap a kind of marine harvest by catching numbers of them, which yield an abundant supply of food for winter store; so it seems beyond question that this species is quite at home in the beginning of the arctic winter in that region, and the immense numbers of Bowheads and Right whales that would necessarily appear in the temperate latitudes if they migrated southward would be sure to arrest the attention of passing navigators, who frequently go far north, even in the winter season, to make their passages from China and Japan. Some have asserted that they probably congregate around the borders of the drifting or field ice, which joins the open water of the Pacific about the Kurile, and Aleutian Islands. All agree that they do not pass the tropics and reach the southern hemisphere. The southern Right Whales resort to the bays in that region to bring forth their young, and formerly were sought for in those inland waters, where many a ship has quickly completed her cargo by bay-whaling in high southern latitudes. But no bay has yet been discovered north of the equator in the Pacific where the North-West Right Whales go to calve; and, as before mentioned, nothing is definitely known of their winter resort. The last seen of them in high latitudes by whalemen is on their return from the Arctic Ocean, when they are found about St. Paul's Island, Behring's Sea, in the month of October, and those found then are usually very large. In the Okhotsk Sea the Right Whale is found toward the northern limits, in the early part of the season; later the ships cruise in the southern part, about the Kurile Islands.

For much of the information about the habits of the Right Whale, and for some of the measurements which have guided us in making our drawing, we are indebted to Capt. Poole, commanding the Bark N. S. Perkins, of San Francisco, and Capt. Baker, of Brig L. P. Foster, which sails from the same port, and Capt. J. M. Green, long known as an experienced whaling master.

The average length of this species may be calculated at sixty feet, the two sexes varying but little in size; average yield of oil 130 barrels, average thickness of blubber ten inches, which appears quite white; yield of bone about 1400 lbs. to a hundred barrels of oil.

The Right Whale is found singly, or in pairs; at times scattered about as far as the eye can reach from the mast head. The last of the season they are sometimes seen in large numbers, crowded together. These herds are called "gams," and they are regarded by experienced whalemen as an indication that the whales will soon leave the ground.

The general habit of this animal is to spout seven to nine times to a "rising," then turning flukes (elevating them six or eight feet out of the water) it goes down, and remains twelve to fifteen minutes. It is remarked, however, since they have been so generally pursued by whalemen, that their action in this respect has somewhat changed. When "gallied" by the close approach of a boat they have a trick of hollowing the back, which brings the blubber slack, preventing the harpoon from penetrating. Many whales have been "missed" by the boatsteerer's darting at this portion of the body. Having been chased every successive season for years, these animals have become very wild, and difficult to get near, especially in calm weather. The manner of propelling the boat at such times is by paddling, and when there is a breeze, by sailing, if practicable, using the oars only when it is not possible to use sails or paddles. Among Right Whalemen there is a difference of opinion 1869.]
PROCEEDINGS OF THE ACADEMY OF

about "going on to a whale," whether it is best to get out of or into its wake to avoid galloping it; and as regards safety, some prefer to have a good breeze, then, setting all practicable sail, run over the animal to leeward, at the same time that the harpoon is thrown. The whale, after being struck, often runs to windward, thrashing its flukes in every direction, and after going a short distance frequently stops, or "brings to," "sweeping," as it is said, from "eye to eye," and at the same time making a terrific noise through its spout holes, called bellowing; this sound is compared to that of a mammoth bull, and adds much to the excitement in its chase and capture; others will not stop until they are huunstrung, as it were, by "spading." The spading process is performed by hauling the boat near enough to cut the cords that connect the body and flukes, either on top or underneath, as the attitude of the fish may be; a large vein runs along the under side of the "small," terminating at the junction of the caudal fin, which, if cut, will give the animal its death wound. The instrument used for cutting is called a boat spade, which may be compared to a very wide chisel, with a handle six or eight feet long; sometimes the cords are so effectually severed that the flukes become entirely useless, and still the animal slackens its speed hardly perceptibly, showing evidently that its pectorals are its principal propellers. Another mode of stopping them is by throwing a number of harpoons (detached from the line) into its small, a kind of torture that would seem, if the bleeding victim could speak, it would entreat its tormenters to put an end to its misery. But when once "brought to" it will remain nearly stationary for a few minutes or roll from side to side, giving the officer of the boat a good opportunity to shoot a bomb lance, or use the hand lance with good effect, which soon dispatches it. But sometimes one of these huge animals, in spite of bomb guns, harpoons, and all the whaling craft combined, will, after being fastened to, make the best of its way to windward with the boat, taking it so far from the ship as to oblige the men to cut the line and give up the chase. Of late Greener's gun has been used to some extent in its capture. But before harpoon or bomb guns came into general use, the whaleman of the North-West coast made such havoc among these marine animals (which were regarded the most gigantic and vicious of their kind,) as to have nearly annihilated them or have driven them to some unknown feeding ground.

III. THE CALIFORNIA GREY WHALE.

Rhachianectes glaucus Cope.

Agaphelus glaucus Cope, Pr. A. N. Sci. Phil. 1868, 225.

The California Gray is unlike other species of Balana in its color, being of a mottled gray; some individuals, however, of both male and female, are nearly black. The jaw is curved downward from near the spout holes to the "nib end," or snout, and is not so wide as that of the other species in proportion to the size of body. The length of the female is from forty to forty-four feet, the fully grown varying but little in size; its greatest circumference twenty-eight to thirty feet, its "flukes" thirty inches in depth and ten feet broad. It has no dorsal fin. Its pectorals are six and a half feet in length and two and a half feet in width, tapering from near the middle toward the end, which is quite pointed. It has a succession of ridges, crosswise along the back, from opposite the vent to the flukes.

The coating of fat, or blubber, is six to ten inches in thickness, and of a reddish cast. The average yield of oil of the female is forty barrels. The whale-

81 Going on to a whale," is a whaleman's term for getting near enough to dart the harpoon.

82 Forty-four feet, however, would be regarded as large, although some individuals have been taken that were much larger, and yielding sixty or seventy barrels of oil.

83 The size of flukes and fins usually varies but little in proportion to the whale; the side view illustration is to represent the largest extreme of those parts of the animal.

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bone, or "baleen," of which the longest is fourteen to sixteen inches, is of a light brown color, the grain very coarse; the hair or fringe on the bone, likewise, is much coarser and not so even as that of the Right Whale or Humpback.

The male may average thirty-five feet in length, but varies more in size than the female, and the average quantity of oil it produces may be reckoned at twenty-five barrels.

The California Grey is only found in north latitude, and its migrations have never been known to extend lower than 20° north. It frequents the coast of California from November to May. During these months the "cows" enter the lagoons on the lower coast to calve, having one young at a birth; while the males remain outside, along the sea shore. Occasionally a male is seen in the lagoons with the cows the last of the season, and soon after both male and female, with their young, will be seen working their way northward, following the shore so near that they often pass through the kelp near the beach. It is seldom they are seen far from land.

Their habits are strikingly different from those of other species of Balaena, in resorting to shoal bays and lagoons to bring forth their young. In summer they congregate in the Arctic Ocean and Okhotsk Sea. It has been said that this species of whale is found on the coast of China, but this report needs confirmation. In October and November they appear off the coast of Oregon and Upper California, on their way back to their tropical haunts, making a quick, low spout at long intervals, showing themselves but little till they reach the smooth lagoons of the lower coast, where, if not disturbed, they congregate in large numbers, passing into and out of the estuary, or slowly raising their massive forms midway out of their element and falling over on their sides, dashing the water into foam and spray about them. At times in calm weather they are seen lying on the water quite motionless, keeping one position for an hour or more.

The first time we were in Scammon's Lagoons the boats were lowered several times for them, we thinking that the whales when in that position were dead or sleeping, but before the boat approached within darting or even shooting distance they were on the move again.

About the bar and shoals at the mouth of one of the lagoons, in 1860, we saw large numbers of California Grays; it was at the low stage of the tide, and the shoal places were plainly marked by the constantly foaming breakers. To our surprise, we saw numbers of these "Grays" going through the surf where there could barely have been depth to float them. We could see in many places, by the white sand coming to the surface, that they must be near to or touching the bottom. One in particular lay for a half hour in the breakers playing, as we have often seen seals in a heavy surf, turning from side to side with half extended fins, and moved apparently by the heavy ground swell which was breaking, at times making a playful spring with its bending flukes, throwing its body clear of the water, coming down with a heavy splash, then making two or three spouts, then settling under water, and perhaps the next moment his head would appear, and with the heavy swell the animal would roll over in a listless manner, to all appearance enjoying the sport intensely. We passed close to this playful fellow, and had only thirteen feet of water.

Hunt, Chase, and Capture—Dangers of Lagoon Whaling.

As the season approached for the whales to bring forth their young, which

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* Two or three calves have been seen with one whale, but these instances have only occurred in lagoons where there had been great slaughter among the cows, leaving their offspring motherless, which straggle about, sometimes following other whales, or congregating by themselves, a half a dozen together at times. We know of one instance when a whale was killed close to the ship which had a calf perhaps a month old. When the mother was taken to the ship to be cut in, the young one followed, and remained playing about for two weeks, but whether it lived to come to maturity is a matter of conjecture.

1869.]
is from December to March, they formerly collected at the most remote extremities of the lagoons, huddled together so thickly that it was difficult for a boat to cross the waters without coming in contact with them accidentally. Frequent instances have been known of their getting aground, and lying for three or four hours with but two or three feet of water around them, without apparent inconvenience or injury from lying heavily on the sandy bottom till the rising tide floated them again.

In February, 1856, we found two aground in Magdalena Bay. Each had a calf playing about; there being sufficient depth for the young ones, while the mothers lay hard on the bottom.

When attacked the smaller of the two old ones laid motionless, and the boat approached near enough to "set" the hand lance into her "life," dispatching her at a single dart. The other, however, when approached would raise head and flukes above the water, supporting herself on a small portion of the belly, turning easily, and heading towards the boat, which made it very difficult to capture her. It appears to be their nature to get into as shallow water as will float them when their calves are young. For this reason, the whaling vessels anchor a considerable distance, sometimes two or three miles, from where the crews go to hunt them. Several vessels are often in the same lagoons. The first streak of dawn is the signal for lowering the boats, all pulling for the head waters, where the whales with their calves are found. As soon as one is seen, the officer who first discovers it sets a waif in his boat, heads for the whale, and gives chase. Boats belonging to other vessels do not interfere, but go on in search of more whales. When the boats are in chase, great care is taken to keep behind and a short distance from the whale, till driven near the head of the lagoon or into shallow water; then the men in the boats nearest spring to their oars in the exciting pursuit. At such times the animal swims so close to the bottom as to impede its progress, thereby giving the boat a decided advantage; but occasionally the whale will suddenly change its course, or dodge, especially if she has a calf that is old enough to swim fast. Under such circumstances the chase will frequently last for hours, the boats cutting through the water at their utmost speed. At other times, when the calf is young and weak, the movement of the mother is very slow, keeping close to her young and giving it all the protection and assistance which her nature affords. It is an unusual occurrence for the mother to forsake her offspring when molested. When within "darting distance" (sixteen or eighteen feet), the boat steerer darts the "irons," and when the whale is struck it dashes about, lashing the water into foam, frequently even straying the boats. As soon as the boat is "fast" the officer goes into the head, and watches a favorable opportunity to shoot a bomb lance into it. If it enters a vital part and explodes, it kills instantly, but it is not often this good luck occurs; oftener two or three bombs are shot which paralyze the animal to some extent, then the boat is hauled near enough to use the hand lance. After repeated thrusts the whale becomes sluggish in its motions; then, going "close to," the lance is set into its "life," which completes the capture; the whale rolling over on its side, with fins extended, dies without a struggle, or will circle around in a small compass, or make a zigzag course, heaving its head and flukes above the water, and either roll over, fin out, or die under water and sink to the bottom.

My remarks thus far have been confined principally to the females as they are found in the lagoons. Mention has been made, however, of the general habit of both male and female, in making their passage between their northern and southern feeding grounds, of keeping near the shore. This fact becoming

* Whalmen call the forward part of a whaleboat the head, differing from merchantmen, who term it the bow; still the oar next to the forward one in a whaleboat is named the bow-oar; likewise when the boat is hauled close to the whale by heaving the line out of the "bow-chocks," and taking it to one side against a cleft placed a few feet aft of the extreme bow, it is called "bowing on."
generally known, and the bomb gun* coming into general use, has changed
the mode of capture along the coast.

Parties of whalemen have for several years established themselves along
the shore at the most favorable points where the thickest beds of kelp are
found, and there lay in wait watching for a good chance to shoot the animals
as they migrate to their southern breeding grounds and return again to the
north. This by whalemen is called "kelp-whaling." The first year or two
that this kind of whaling was pursued, many of them passed through or along
the edge of the kelp, giving the gunners an opportunity to choose their own
distance for a shot. This manner of capture, however, soon developed the
sagacity of these periodical visitors. At first the ordinary whale boat was
used, but the keen-eyed devil-fish soon found what would be the consequence
of getting too near the long dark-looking object, as it lay nearly motionless
in the kelp, only rising and falling with the rolling swell.

A very small boat, with one man to shoot and another to scull, was then
used instead of the whale boat and crew; this proved successful for a time,
but as season after season passed the whalemen worked more off shore, and at
the present time the boats anchored a little outside the kelp as a general rule.
The whale being seen approaching at a distance far enough for the experi-
enced gunner to judge pretty nearly where the animal will "break water,"
near to this place the boat is sculled to await the "rising." If the whale
"shows a good chance," it is frequently killed instantly and sinks to the bot-
tom, or receives its death-wound by the bursting of the bomb-lance. Conse-
quently the stationary position or slow movement of the animal enables the
whaler to get a harpoon into it before sinking. To the harpoon a line is at-
tached, with a buoy at the end, which indicates the place where it lies on the
bottom. Usually in the course of twenty-four hours, and often in much less
time, the whale rises to the surface, and is then towed to the shore, the blub-
ber taken off, and tried out in pots set for that purpose on the beach.

Another mode of capture along the coast is by the ships cruising a little
way off shore, sending the boats inshore, towards the line of kelp, and as the
whales pass to the southward, the boats being provided with extra large sails
and the whalemen taking advantage of the strong northerly winds which
prevail, run their boats before the wind, sailing near enough to dart the or-
dinary hand harpoon into the animal, getting fast this way. The whale is
killed in deep water, and if inclined to sink, it can usually be held up by two
boats, till the ship comes to them, when a large "fluke-rope" is made fast or
the "fin-chain" is fastened on its fins, the "cutting tackle" hooked, and the
whale "cut in" immediately. This manner of taking the whale is called
"sailing them down."

Still another way of catching them is with Gruner's Harpoon Gun, which
is similar to a small swivel gun. It is of one and a half inch bore, and three
feet long in the barrel, and when stocked and complete weighs seventy-five
pounds. The harpoon, four feet and a half long, is projected with consider-
able accuracy to any distance under eighty-four yards. It is mounted on the
bow of the boat, and was formerly fired by the boat steerer who pulls the
harpooner's oar. This was the old Scotch plan, the gun being first used by
the Scotch whalers; but at the present time it has been more successfully
managed by the officer in charge of the boat, who takes the boat steerer's
place for the time. A variety of manoeuvres are practised with the boat when
using the harpoon gun; at times lying at anchor as in deep whaling, at other

* The bomb gun is made of iron, stock and all. It is three feet long, the barrel of which
is twenty-three inches in length; diameter of bore, one and one-eighth of an inch;
weight, twenty-four pounds. It shoots a bomb lance twenty-one and a half inches long,
and of a size to fit the bore. It is pointed at the end, with sharpened edges, in order to
cut its way through the fibrous fat and flesh, and is guided by three elastic feathers,
which are attached along the fuse tube, folding around it when in the barrel. The gun is
fired from the shoulder, in the same way as a musket.

1869.]
times drifting about for a chance shot, or paddling quietly if in calm weather, and when a breeze comes sailing after the animal. When the whale is judged to be ten fathoms off, the gunner sights eighteen inches below its back; if fifteen fathoms, eight or ten inches below; if eighteen or twenty fathoms distant the gun is pointed at the top of the back. Twenty fathoms is considered a long range, as there is constantly more or less motion to the boat.

Gruner's gun, as a general thing, has not been brought into successful use among American whalmen, except for this peculiar species of whale, along this coast, where much of the time the water is quite smooth—during the winter months. It has been used of late with great success, the harpoon being so effective a weapon as often to give the whale a death-wound, and in some instances killing instantly.

Still another strategic plan has been practised with successful results, called "whaling along the breakers." Mention has been made of one prominent habit of these periodical visitors to the coast, evidently taking great delight in playing their uncouth gambols through or along the breakers that front the mouths of the lagoons. This the watchful eye of the whaler was quick to see could be turned to his advantage and to the destruction of this interesting marine animal, when exhibiting its natural habits. They will pass through the surf where there is scarcely water to float them, and frequently are seen along the edge of the breakers, and in making their passage north and south they follow along the outlying shoals as they once did along the kelp.

After years of pursuit by waylaying them around the beds of kelp, the wary animals learned to shun those points of death, and seemingly made a wide deviation in their course to enjoy the sport among the rollers of the lagoons' mouths, as they passed them either way. But the civilized whaler, their greatest enemy, ever ready to destroy for gain, anchors his boats as near the roaring surf as safety will permit, and the unwary "fish" that comes in reach of the deadly harpoon, or bomb, is very sure to pay the penalty with its life. If the whale comes within darting distance, he is harpooned, and as they almost invariably run "off shore" they are soon in clear deep water, where the pursuer makes his capture with comparative ease; or, if passing within range of the bomb gun, one of the explosive missiles is planted into its side. This usually so paralyzes the animal that the first boat's crew, who have been resting at anchor, taking to their oars, soon overtakes the wounded animal, which is fastened to and despatched in a summary manner.

The casualties occurring in connection with the coast and kelp whaling are nothing to be compared with the accidents that have been experienced by those engaged in taking them in the lagoons. Hardly a day passes but that there is upsetting or staving of boats, the crews receiving bruises, cuts, and in many instances having limbs broken, and repeated accidents have happened where men have been instantly killed or received mortal injury. The reasons of the increased dangers in lagoon-whaling are, first, the sandy bottom being continually stirred by the strong currents mixing with the water, making it difficult to see an object to any considerable depth; the quick and deviating movements of the animal, and its unusual sagacity. When a whale is struck at sea there is generally but little difficulty in keeping clear. When it is first irritated by the wound of the harpoon, it endeavors to escape by "running," or descends to the depths below, taking out more or less line in its course, the direction of which and the movements of the boat indicate the whereabouts of the animal. The clear water likewise renders an object visible a considerable distance below the surface, so that in any event the careful "boat-header" has comparatively but little difficulty in keeping clear of the whale when first struck.

But in a lagoon the object of pursuit is in narrow passages, where frequently there is a swift tide, and the turbid water precludes seeing far beneath the boat. Should the chase happen to be made with the current, if the
whale is struck, it often stops suddenly, and the speed of the boat, together with the influence of the running water, prevents it from being kept clear, notwithstanding the utmost caution and exertion to avoid accident, the boat shooting against or over the animal, when it is dashing the water in every direction. The whales that are given chase to have a calf with them, and the mother, in her endeavors to avoid the pursuit of herself and offspring, will sometimes lose sight of her calf in the thick water. Instantly she stops, "sweeping" around in search of the lost one, and at such times if the boat comes in contact with her, it is almost certain to be stow. Another great danger is in killing the calf. At times, when the harpoon is thrown or the lance darted at the mother, the calf, in its innocent gambols about the parent animal, will get in the way of the weapon, and receive the wound, killing it instead of the intended victim. In such cases the whale in her frenzy will chase the boats, and overtaking them will overturn them with her head or dash them in pieces with a stroke of her flukes. Sometimes the calf is fastened to instead of the cow. In such instances the mother may have been an old frequenter of the "ground," and before chased perhaps suffered from attack, consequently is more difficult to capture, staving the boats and escaping after repeatedly receiving wounds. One instance occurred in Magdalena Lagoon, in 1857, where, after several boats were stow, they being near the beach, the men in those remaining afloat managed to pick up their swimming comrades and in the meantime to run the line to the shore, hauling the calf into as shallow water as would float the "dam," she keeping near her troubled young one, giving the gunner a good chance for a shot with his bomb-gun from the beach. A similar instance occurred in Scammon's Lagoon in 1859.

The testimony of many officers of whaling vessels furnishes abundant proof that this species of whale is possessed of unusual sagacity, and their inordinate affection for their offspring is beyond question. Numerous contests with them prove that after the loss of their young the enraged animal has given chase to the boats, which only found security by pulling into shoal water or to shore. The many mishaps that have been experienced among a class of men that are fond of listening to tales of adventure or relating their own exploits have been the sources from which many a marvellous though truthful tale has sprung.

Indian Whalermen of the North-West Coast,—Indian Whaling Cance,—Indian Whaling Craft—Indian Whaling Disposition of the Whale after Captured.—Description of the Eskemo Whaleboat,—Eskemo Whaling Implements.—Division of the Captured Whale.—Closing Remarks.

After evading the civilized whaler and his instruments of destruction, or suffering from wounds received while in their southern haunts, these migratory animals of both sexes begin their northern journey. The mother with her young, grown to half the size of maturity, but wanting in strength, make the best of their way along the shores, avoiding the rough sea by passing between or near the rocky islets which stud the points and capes. But scarcely have they quitted their southern homes before they are surprised by the Indians about the Strait of Juan De Fuca, Vancouver's and Queen Charlotte's Island. Like enemies in ambush, they glide in canoes from island, bluff, or bay, rushing upon them with whoop and yell, launching their instruments of torture into them, like hounds worrying the last life-blood from their vitals, and then trains of canoes tow the captured ones to shore in triumph. The whalermen among the Indians of the north-west coast are those fond of the height of adventure, and likewise of becoming worthy of the greatest consideration among their fellows. The one among them that could boast of killing a whale formerly had the most exalted mark of honor conferred upon him by a cut across his nose.*

1869.]

*This custom is no longer practiced.
The whaling canoe is from thirty to thirty-five feet long; eight men invariably make the crew, each wielding a paddle five and a half feet long. The whaling craft consists of harpoons, lances, lines, and sealskin buoys, all of their own workmanship.

The harpoon is much the shape of the head of the common lance used by our whalers, adding two pieces of pointed bone projecting from one of the edged sides of the weapon. Its length is six and a half inches and its width two and a half inches. It is composed of sheet iron, bone, the fibers of cedar roots, or of the wild nettle, and gum. The iron forms the principal and cutting part, and is perforated from midway to the end that joins the line.

"Formerly the muscle-shell was used to make this blade." The horns of bone which extend from one edged side as before mentioned, are placed one on each flat side of the iron; the rope unaided and marked on with the pieces of bone, through the holes in the sheet iron blade, and the whole covered with a coating of gum. The rope, bones, and seizures, form a cavity, into which the pointed end of the harpoon pole or staff is inserted. This pole—made of yew—is eighteen feet long and weighs about nineteen pounds. It serves the double purpose of harpoon-staff and lance-pole.

The lance is of the same shape as the harpoon, without the bars or horns, and adding the socket for the lance-pole. The blade is made of a muscle-shell, and the socket is formed of cedar bark "wounded" or "served" with fibrous roots, the whole gummed in like manner as the harpoon. Its length is seven inches, and it is two and a half inches wide.

The line is made of cedar withes, twisted into a three-strand rope five-eighths of an inch in diameter, and looking very much like coir rope; the usual length of the line is fifty to sixty feet for the first harpoon, but the buoys attached to the harpoons subsequently thrown have only about five feet of line.

The buoys are prepared seal skins with flipper holes and mouth secured air tight; one flipper hole is fitted with a nozzle, for the purpose of blowing it up when required for use. These buoys are fancifully painted, according to the taste of the owner of the canoe to which they may belong, care being taken that each canoe's buoys are differently marked.

Their whaling grounds are limited, as the Indian whalers rarely venture seaward far out of sight of the smoke from their habitations by day, or beyond view of their bonfires at night.

The number of canoes engaged in the chase is from two to five, each one of the crew being from among the chosen men of the tribe, who can with silent stroke paddle the sharp, symmetrical caum* close to the rippling water along the sides of the animal. The bowman then, with sure aim, thrusts the harpoon into it, and heaves the line and buoys clear of the canoe. The whale diving deeply, sometimes takes the buoys out of sight, but from the long stretch of line, the pursuit being usually near the coast, on comparatively shoal soundings, there is but little time when the inflated seal-skins do not indicate the animal's whereabouts. The instant they are seen by the nearest canoe a buoy is elevated on a pole, and all dash with shout and grunt toward the object of pursuit. The chase then becomes one of great excitement, each boat being provided with implements alike; in order to entitle it to a full share of the prize when captured, its crew must get their harpoon into the animal with the buoys attached to the line. After the whale is struck, the strife that ensues to be the next to launch the prize-weapon, creates a scene of brawl and agility peculiar to these piscatory adventures. One canoe after another approaches, and its bowman hurls his missile deep into the side of the huge animal. At length the victim, becoming weakened by loss of blood and strength, slackens its speed. The canoe is then carefully paddled near, and the lance is used with unerring precision

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* Caum is the name for canoe among these tribes.
—the rude weapon being cautiously handled; to prevent accident to the craft by contact with the dashing flukes and fins of the whale. This careful manoeuvring subjects the bleeding animal to a system of torture character-

istic of the savage horde about it, and eventually, bleeding its last blood from a lacerated heart, it writhes in convulsions and expires. Immediately after the whale is dead, the whole fleet of canoes assist in towing it to the shore. As soon as the prize is brought to the beach a division is made, and all the inhabitants of the village gorge themselves upon its fat and flesh till their greedy appetites are satisfied. After the feast, what oil can be extracted from the remaining blubber is put in skins or bladders, and becomes an article of traffic with neighboring tribes, or the white traders that frequently visit them.

This whale of passage, when arrived among the scattered flos of the Arctic Ocean, is rarely pursued by the whaleship’s boats, consequently they rest in some degree of security; but even there, when a favorable opportunity offers, the watchful Eskimos steal upon them and with their rude weapons and torturing process, the whale pursued, at last yields to the combined enemies about it, and supplies food and substance for its captors.

The Eskimo whaling boat, although to all appearances simple in its con-

struction, will be found, after careful investigation, to be admirably adapted to the purpose, as well as for all other uses necessity demands. It is not only used to accomplish this the most important undertaking within their frozen imaginations, but in it they pursue the walrus, shoot game, and make their long summer voyage about the coast, up the deep bays and long rivers, for the purpose of traffic with coast and interior tribes.

When they prepare for whaling, the boat is cleared of all passengers and their effects, nothing being allowed in it but the whaling implements and boat gear. Eight picked men make the crew.* Their boats are twenty-five to thirty feet in length, flat on the bottom, with daring sides and tapering ends; there are four thwarts which are placed about midway between the bottom and the gunwales. The frame is of wood, and consists of fourteen or sixteen ribs, a center-piece along the bottom, stern and bow timbers and strips run along each side to receive the thwarts and give shape to the craft. The frame is lashed or served together, with the fibres of whalebone and thongs of walrus’ hide, the latter article being the covering or planking to the boat.

The whaling implements are one or more harpoons of their own make, four seal-skin buoys, a line made of walrus hide, one end of which is fastened to the harpoon, the other to one of the buoys, a boat mast that serves the triple purpose of spreading the sail, and furnishing the staff for harpoon and lance, a large knife or two, and eight paddles.

The harpoon is made out of the walrus tusk, with a piece of stone or iron fitted in the end for a point; it is nine inches long, three-fourths of an inch in average thickness; width one inch and three-eighths, tapering a little towards the pointed end. The socket end is of a diagonal shape, the better to catch the flesh; in the middle or nearer the socket end, a hole is made to receive the strap of walrus hide to which the line is fastened. The point end has a triangular-shaped piece of thin iron or stone inserted in it—as before mentioned—which completes the weapon. In the socket end of this harpoon the small end of the boat mast is fitted, and serves as the harpoon staff. A common butcher knife, the blade fourteen or sixteen inches long—which they purchase from whale ships or trading vessels—lashed to the boat mast constitutes the lance.

The boat being in readiness the chase begins. As soon as the whale is seen and its course ascertained, all get behind it; not a word is spoken, nor will they take notice of a passing ship or boat, when once excited in the chase.

* It is said by Capt. Norton, who commanded the ship “Citizen,” wrecked in the Arctic several years since, that the women engage in the chase.

1869.]
All is silent and motionless till the whole spouts, when with instant dash all paddle towards it. The moment the spouting is over, every paddle is raised from the water. Again the spout is seen, or in thick weather heard through the fog—again they spring to their paddles. In this manner the animal is approached near enough to dart the harpoon, when all shout at the top of their voices and make all the noise possible. This is said to have the effect of checking the animal's progress, till the harpoon is planted in its body with line and buoy attached. The chase is continued in like manner until a number of weapons are fastened, causing the whale much effort to get under water and still more to remain down; consequently it soon rises again, and is attacked with renewed vigor. In a short time it becomes so much exhausted that the boat can, without much risk, go close to it. It is an acknowledged right with them for the man that first harpoons the whale to take command of the whale party. Accordingly, as soon as the proper time arrives his "baidarrn" is paddled close to the whale, and with surprising quickness he cuts a piece of blubber from its side large enough to admit a knife and he boat mast to which it is lashed. Then the cutting and piercing begins, and is continued till the whale is in his death struggles. The capture being made and the whale towed to the shore, it is divided as follows: Each member of the party receives ten slabs of bone, and a like proportion of the blubber and entrails; the owners of the canoes take the remainder.

The choice pieces for a dainty repast with them are the flukes, lips and fins. The oil is a great article of trade with the interior tribes of reindeer men; it is sold in skins, containing about fifteen gallons each, a skin of oil being the price of a reindeer. The entrails are made into a kind of sauce by pickling them in a liquid extracted from a root that imparts an acrid taste. The preparation is a savory dish among them as well as a preventative of the scurvy. The lean flesh of the whale supplies food for their dogs, the whole canine horde of the village assembling where the carcass lies, fighting, feasting, growling and howling, as only Eskimo dogs can.

Many of the prominent habits of the California Gray are widely different from those of other species of Balena. It makes its regular migrations from the hot southern latitudes to beyond the Arctic circle, and in these passages between the antipodes of climate it follows the general trund of an irregular coast so near that it is exposed to attack from the savage tribes inhabiting the sea-shores, who pass much of their time in the canoe, and make the capture of this piebald animal a feat of the highest distinction. As it approaches the genial waters of the torrid zone it presents an opportunity to the civilized whalermen, at sea, along the shore, and in the lagoons, to practice their different modes of strategy, that hasten its annihiilation. It manifests inordinate affection for its young and seeks the quiet waters of the estuaries lying under a tropical sun, as if to warm its offspring into activity and promote comfort in their native element until grown to the degree that nature demands for their first northern visit. When the parent animals are attacked they show a degree of resistance and tenacity of life that distinguish them from all others of the great cetacean family.

Many expert whalermen have been made to suffer in the encounter, and, as before mentioned, there is lack of instances where the daring pursuer has either been killed or received serious injury. Once captured, however, they yield the coveted reward to their enemies. They furnish sustenance for the Eskimo whaler from such parts of the animal as are of little value to others. The oil extracted from their fatty covering is exchanged with remote tribes of reindeer men for their fur clad animals, of which the flesh affords the vendors a feast of the choicest food, and the skins form an indispensable article of clothing. The North-West Indians realize the same comparative benefit from the captured animals as do the Eskimo, and look forward to its periodical passage through their circumscribed whaling grounds as a season of exploits and profit.

[April,
The civilized whaler seeks the hunted animal farther seaward, as from year to year it learns to shun the fatal shore. No species of the whale tribe is so constantly and variously pursued as the one we have endeavored to describe, and the large bays and lagoons where once these animals congregated, brought forth and nurtured their young, are now nearly deserted. Their mammoth bones lie bleaching on the shores of those placid waters, and are strewn along the broken coasts from Eastern Siberia to the Gulf of California. Ere long the California Gray will be known only as one of the extinct species of Cetacea recorded in history.

IV. THE HUMPBACK.

Megalaptera versabilis Cope.


The Humpback is one of the species of Whale that roam through every ocean, generally preferring to feed and play its uncouth gambols near extensive coasts, or about the shores of islands, in all latitudes except the frozen polar regions.

It is irregular in its movements, seldom going a straight course for any considerable distance; at one time moving about in large numbers, scattered over the sea as far as the eye can discern from the masthead, at other times singly, seeming as much at home as if it were surrounded by hundreds of its kind; at will performing the varied actions of breaching, rolling, finning, lop-tailing, or scooping; or, if a calm sunny day, perhaps lying motionless on the molten-looking surface, as if life were extinct.

Its shape, compared with the symmetrical forms of the Finback, California Grey, or Sulphurbottom, is decidedly ugly, a short body with immense belly, and frequently diminutive "small," inordinately large pectorals and flukes.

A protuberance, of variable shape and size in different individuals, placed on the back about one-fourth the length from the flukes, is called the hump. All combined impress the observer with the idea of abnormal proportions. The top of its head is dotted with irregular rounded bunches, that project above the surface about a half inch, each covering about two inches of space.

The following measurements and memoranda were taken by Capt. F. S. Redfield, of the whaling and trading brig "Manuella," while cruising in Behring Sea, September 17th, 1866:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Ft.</th>
<th>In.</th>
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</thead>
<tbody>
<tr>
<td>Extreme length</td>
<td>49</td>
<td>7</td>
</tr>
<tr>
<td>Length of pectorals</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Breadth</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Distance from snout to pectorals</td>
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<td>0</td>
</tr>
<tr>
<td>&quot; corner of mouth to snout</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>&quot; eye to snout</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>&quot; spout holes to snout</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Breadth of flukes</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Depth</td>
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<td>4</td>
</tr>
<tr>
<td>Distance from arms to flukes</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>&quot; genital slit</td>
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</tr>
<tr>
<td>Length of folds on belly</td>
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<td>9</td>
</tr>
<tr>
<td>Whole breadth of folds on belly</td>
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</tr>
<tr>
<td>Distance from flukes to hump</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Length of hump along the back</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Height of hump</td>
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<td>6</td>
</tr>
<tr>
<td>Depth of small close to flukes</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Thickness of small close to flukes</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

1869.
Number of folds on the belly twenty-six, averaging in width from four to eight inches. Thickness of blubber five to ten inches. Color a yellowish white. Yield of oil forty barrels.*

Color of body black, under side of pectorals white. Frequently the under side of the flukes is white likewise, and sometimes the greater portion of the belly. The Humpback, as well as all other whales except the Bowhead or Arctic whale, are infested with parasitic crustaceans, which collect about the head, particularly near the spout holes, and if there are any scars or sores on the animal's body, this vermin is sure to find them.† They vary from as small as can be discerned with the naked eye to one inch in length, and are of a straw color, furnished with numerous legs, disposed in a row on each side of the body, and a mouth that at least gives a sharp bite to human flesh.

The Humpback has also growing on its body what are termed barnacles, which appear to collect most on the fins, flukes, and head. This barnacle is entirely different from that found on a vessel's bottom, timber, rocks, &c., being flat on the side that adheres to the skin, the edges forming a circle, the mouth or opening being in the centre and protected by a rounded, bony or flinty substance, the exterior of which is creased into a rough surface, and in color nearly white, or mottled with black. The size of the barnacle varies from half an inch to two and a half in diameter, and from one-fourth to three-fourths of an inch in thickness.

The peculiar undulating movement of the Humpback, its frequent roundings, turning flukes, and irregular course, are characteristic habits that the quick and practised eye of the whaler can distinguish at a long distance. Like all other whales it has two spout holes, and when it respires, the breath and vapor ejected through these apertures forms the "spout," which rises in two separate columns, joining in one as it ascends and expands. When its enormous lungs are brought into full force the spout rises twenty feet or more. When the whale is going to windward the influence of the breeze upon the vapor is such that a low "bushy" spout is all that can be seen. The number of "spoutings to a rising" is exceedingly varied, sometimes blowing only once, at another six, eight or ten, and from that up to fifteen or twenty times.

From observations made along the coasts of the North and South Pacific in regard to their times and places of resort for the purpose of bringing forth their young, we deduce the following:

In the year 1852—3 large numbers of Humpbacks resorted to the Gulf of Guayaquil, coast of Peru, to calve, and the height of the season was during the months of July and August. The same may be said of the gulfs and bays situated near the corresponding latitudes north of the equator; still, instances are not unfrequent when a cow with her young one is seen at all other seasons of the year about the same coast. In the Bay of Valle de Banderas, coast of Mexico, latitude 26° 30', in the month of December, we saw numbers of Humpbacks with calves but a few days old. In May, 1855, at Magdalena Bay, coast of Lower California, about lat. 24° 30', we found them in like numbers, and with very large calves.

Our belief is that the females of this species may resort in large numbers to favorite inland waters, connected with the ocean, to bring forth their young; but there are many exceptions to this rule, and on account of their roving

* The Humpback probably varies more in size and yield of oil than any others of the whale family; we having frequently taken those that made but eight or ten barrels, and from that up to seventy-five. Their length would vary from twenty-five to sixty-five feet. We have reliable account of one being taken in Monterey Bay, in 1858, which produced one hundred and forty-five barrels of oil.

† On the coast, in 1856, we took a whale that had many patches of vermin upon his body, several of them three or four feet in extent. It proved to be what is called a "dry skin," the blubber yielding no oil; and the lean condition of the animal was attributed to the unusual number of those troublesome creatures upon it.
habit they are found on different coasts in all latitudes between the freezing points, from the young one but a few days old to those of extreme maturity. They are captured with the common hand harpoon and lance, adding the use of the bomb-gun, and as they are very liable to sink when dead, every exertion is made to get the harpoons in before the gun is discharged. The best points for Humpback whaling on the coast have been Magdalena, Bal-le-nas, and Monterey Bays.

V. THE SULPHURBOTTOM.

Sibralides sulphureus Cope.

The largest whale found upon the coast, if not the largest known, is the Sulphurbottom. Never having had an opportunity of obtaining an accurate measurement of its proportions, I can only state them approximately.

Length seventy to ninety feet; the body is comparatively more slender than the California Gray; the pectoral and caudal fin may be regarded as being in like proportion to the body as those of the Finback and the "Gray." The color is somewhat lighter than in the former on its back and sides, but underneath it is of a yellowish cast, or sulphur color: hence the name Sulphurbottom is supposed to have been given. The dorsal fin is much smaller than that of the Finback, and is a little nearer the flukes, but the head, throat and bone in shape is similar to that species.

A Sulphurbottom is found in the Atlantic as well as in the Pacific. The Pacific species occurs at all seasons on the coasts of the Californias. During the months from May to September they are often found in large numbers close in with the shore, at times playing about ships at anchor in the open roadsteads, near islands or capes, but as a general rule they do not approach vessels with the degree of boldness that the Finback does.

The Sulphurbottom is considered the swiftest whale afloat, and for this reason is but seldom pursued and still more rarely taken. Capt. Thomas, of the bark Lagrange, in 1857, off St. Bartolme Bay, caught one by first shooting a bomb-lance into a vital part; and, although the whale ran a long distance before "turning up," they were enabled to keep trace of it among the large number around by its spouting blood. When the animal was nearly exhausted, the boats approached near enough to get fast, which was done and the capture completed. This one yielded about ninety barrels of oil, and measured eighty-five feet in length. The schooner "Page," of San Francisco, succeeded in taking several near Ascension Island, the vessel laying at anchor under the lee of it, the capture being made with the bomb-gun and lance. Notwithstanding that a large proportion of these whales sank as soon as dead, they were enabled to save them, the water being of moderate depth, in consequence of which the whales rose to the surface before decomposition was far advanced. The size and yield of those taken by the "Page" compared favorably with the one taken by the "Lagrange."

Several days' trial was made in the brig "Boston," in 1858, off Cenos Island, to capture these animals. It was the month of July, and the sea, as far as the eye could discern, was marked with their huge forms and towering spouts. Ten were bombed by the best shooters, who affirmed that they chose their "chance," but as soon as the gun was discharged the whale would disappear, and that was the last trace seen of it, except a patch of foam, sometimes mixed with blood. On the last day of pursuit, toward the evening, another vessel appeared in the offing and approached within a mile or less, when the last trial bomb was fired and the men in the boats looked eagerly to the rising of the wounded whale, but in vain. A signal was made from the approaching ship that they had seen it, as it "broke water" close to the vessel, and it soon rolled over and sank. The swiftness of this animal, under water, as demonstrated at this time, appeared to make it impracticable to pursue them.

1869.]
Doubtless several of those fired at received mortal wounds, or were killed outright, but their propensity to sink, and also to "run under water," baffled the skill of the whalers to secure them.

VI. THE FINBACK.

Balaenoptera velifera Cope.

Another species of the Whale tribe is known as the Finback.

One picked up by Capt. Poole, of the bark "Sarah Warren," of San Francisco, affords us the following memoranda: Length sixty-five feet. Thickness of blubber seven to nine inches. Yield of oil seventy-five barrels. Color of blubber a clear white. Top of head quite as flat and straight as that of the Humpback. Baleen, the longest two feet four inches, greatest width thirteen inches, its color a light lead streaked with black, and its surface presents a ridgy appearance crosswise; length of fringie to bone two to four inches, and in size this may be compared to a cambric needle.

Its side fins and flukes are in like proportion to the body as in the California Gray. Its throat and breast are marked with deep creases or folds, like the Humpback. Color of back and sides black or blackish-brown; belly a milky white. Its back fin is placed nearer to the caudal than the hump on the Humpback, and in shape approaches to a right-angled triangle, but rounded on the forward edge, curved on the opposite one, and the longest side joins the back in some individuals; in others the anterior edge is the longest.

The habits of the Finback in several points are peculiar. When it respires the breath passing through its spoutholes produces a sharp sound that is quite distinguishable from that of other whales of the same genus. It frequently gambols about vessels at sea, in mid ocean as well as close in with the coast, darting under them or shooting swiftly through the water on either side, at one moment upon the surface, belching forth its quick ringing spout, and the next instant submerged deep beneath the waves. In beginning the descent it assumes a variety of positions, sometimes rolling over nearly on its side, at other times rounding or perhaps heaving its flukes out and assuming nearly a perpendicular attitude. Frequently it remains on the surface, making a regular course and several uniform blows. Occasionally they congregate in schools of fifteen to twenty or less. In this situation we have usually observed them going quickly through the water, several spouting at the same instant. Their uncertain movements, however, often showing themselves twice or thrice, then disappearing, and their swiftness, make them very difficult to capture. The results of several attempts to catch them were as follows: One was shot from the ship with a bomb-gun, which did its work so effectually that, although the boat was in readiness for instant lowering, before it got within darting distance the animal, in its dying contortions, ran afoul of the ship, giving her a shock that was very sensibly felt by all on board, and likewise a momentary heel of about two streaks. We got quite a good look at the under side of the whale as it made several successive rolls before disappearing, and our observations agreed with those noted on board the "Sarah Warren" in relation to color of belly and the creases on throat and breast. The under side of fins was white also. At another time the whale died about ten fathoms under water, and after carefully hauling it up in sight, the "iron drawed and away the dead animal went to the depths beneath." Frequently we have "lowered" for single ones that were playing about the ship, but by the time the boats were in the water nothing more would be seen of them, or, if seen, they would be a long way off and then disappear.

An instance occurred in Monterey Bay, in 1865, of five being captured under the following circumstances: A "pod" of whales were seen in the offing, and the whalemen from their station on shore immediately embarked in their
boats and gave chase. On coming up with them they were found to be Finbacks. One was harpooned, and, although it received a mortal wound, they all “ran together” as before. One of the gunners, being an expert, managed to shoot the whole five, and they were all ultimately secured, yielding to the captors a merited prize. We have noticed more of these whales along the coast during the summer months, and they seem to be more together then; but, as the opportunities for observing their habits have been much greater at that season of the year, we may have been led into error in this particular point. On the northern coast the Finbacks, in many instances, have a much larger fin than those in warmer latitudes, and I am fully satisfied that these are a distinct species, confined to the northern waters.

We have had but little opportunity to observe the Finbacks that frequently rove about the Gulf of Georgia and Juan de Fuca Strait. Several have been seen, however, in May and June, on the coasts of California and Oregon, and in Fuca Strait in June and July of the present year; these observations satisfy me that the dorsal fin of this, the northern species referred to, is strikingly larger than in the more southern Finbacks.

Appended is a sketch of one individual of several seen in Queen Charlotte Sound in February, 1865, which is a fair representation of them all. Those I have noticed about Fuca Straits seem to have the back fin modified in size between the extremely small found on Lower California and the one here represented.

Further investigation, which I hope to have the opportunity of before very long, may settle this question.

VII. THE DOLPHIN FAMILY.

DELPHINIDÆ.

In addition to the Whales which have been described as frequenting the coast, many species of Cetacea of the Dolphin family are also found. Those coming under our observation are known as the Bottlenose, Grampus, Blackfish, Killer, Cowfish, Right-whale Porpoise, Finback or common Porpoise, and Bay Porpoise. All these species are covered with a coating of fat or blubber, varying in thickness from half an inch upwards, according to their size and degree of fatness.

THE BAY PORPOISE.

Phoœna vomerina Gill.


The habits of this animal differ from those of the other species found in the open sea or along the coast. Their home seems to be in the discolored waters between the limits of the pure ocean element and the fresh rivers. They are rarely seen on either side of these boundaries. Our observation proves that they are found as far south as the Valle de Banderas Bay, about the mouths of the river Piginto, on the coast of Mexico, which is in lat. 20° 30', and as far north as Columbia River, lat. 46° 10'. In the winter season they are seen off Astoria, and in Cathlamet Bay, twenty miles above; but during the spring and summer, when the river is fresh to its mouth, and in some instances for miles at sea, they leave the Columbia, following in the vein of mixed water. They are never found in schools, but occasionally six or eight may be seen scattered about, appearing on the surface alternately, singly or two or three at the same instant. They do not make those playful gambols and leaps that the other species do, their general habits being to make a quick turn as soon as appearing above water, apparently choosing the darkness below rather than the light above. It is not from shyness, however, for they are met with about roadsteads and harbors, among the shipping, and frequently play their odd turnings close about vessels under way or at their moorings. By night, when at anchor, we have known them to play about the vessel's rudder. 1869.]
Sometimes they are seen among the breakers on the bars which front harbor mouths, darting through or along the crest of the rollers as if excited into unusual action by the dashing waves surrounding them.

They feed on small fish, and are occasionally taken in the seines that are hauled about the shores of San Francisco Bay by the Italian fishermen.

**BOTTLENOSE GRAMPUS.**

The Bottlenose Grampus is probably the largest of the species of Cetaceans reckoned among the Dolphin or Porpoise family. Its color approaches nearer to brown than black. The fin on the back is comparatively small, angular in shape, with the longest side attached to the body, and placed much nearer the caudal fin than on other species. The name Bottlenose is said to have been given it by reason of the head resembling the upper portion and neck of a junk-bottle; if so, from our observation of them (which was many times, from the vessel's deck or masthead) in their different natural positions, the bottle must have been one with a very large but exceedingly short neck; still the comparison is not inappropriate. The Grampus has habits such as nearly preclude capture, and but little is known about its peculiarities. They are generally seen two or three together, "rounding" to "go down" as soon as coming to the top of the water and spouting, and when rising to the surface the next time may be beyond view. It is said they have been taken with a line upward of three hundred fathoms long.

The largest of the species are not less than twenty-five feet long, and otherwise of similar proportions with the Blackfish. The head appears to be intermediate between that of the Blackfish and Porpoise, having a short snout, or round-pointed beak.

I met with a related species on the coast of Lower California, in July and August.

An exception to this, however, occurred on the coast in July and August, 1853, between Cape St. Lucas and Cerros Island, at which time we saw large numbers of them going in schools, ten, twenty or thirty together, nearly all being of the largest growth, and their actions were a good imitation of a school of small sperm whales—spouting several times up, and only remaining down the usual time of sperm whales of their apparent size. Several fruitless trials were made to capture one. In two instances the harpoon was fastened effectually, and the consequence was that the animal immediately dived down with great velocity, each taking a line in its descent one hundred and fifty fathoms long almost before the boats' crews knew what they were about.

In March, 1853, off Panama Bay, on board the bark Rio Grande, we captured what was supposed to be two small Blackfish, but on making an examination concluded that they were a species of Grampus.

Our notes are as follow: Length of largest one, 10 feet. Fin on back in same place as the Blackfish. Shape of fin—upper end more pointed, and the whole fin taking nearer the form of the dorsal fin of the common Porpoise. Body less in circumference in proportion to length than the Blackfish.

Form of head somewhat pointed, approaching to a beak. Color a uniform black. Average thickness of blubber about an inch, and quite red; the oil when extracted retained the same cast, and appeared watery.

The jaws were narrower at the base, more elongated, but furnished with teeth like those of the Blackfish.

**FINBACK OR COMMON PORPOISE.**

The Finback or common Porpoise is ordinarily—feet long, and its body of similar proportions with the Right-whale and Bay Porpoise. Its dorsal fin is longer and more pointed in proportion to its size than that of the Bay Porpoise. Its color on back and sides blackish-brown. Belly white or yellow—
ish-white. We have observed this species to have a wider range, to congregate in larger numbers and exhibit more activity than others of the Dolphin family. They are seen in numbers varying from a dozen up to many hundreds, tumbling over the surface of the sea, or making arching leaps, plunging again on the same curve, or darting high and falling diagonally sidewise upon the water with a spiteful splash.

When a brisk breeze is blowing they frequently play about the bow of a ship going at her utmost speed, the animal cutting across the bow and shooting ahead, or circling around the vessel, apparently sporting at ease.

They are found in every ocean, and are often seen in considerable numbers about the large bays and lagoons along this coast, that have no fresh water running into them. They abound more along coasts where small fish are found than in mid ocean, as they prey upon the smaller finny tribes, and to obtain them shoot swiftly through the water, seizing the object of pursuit with the slightest effort. Occasionally a large school of them will get into a shoal of fish, frightening them so much that they will dart around in all directions, taking no regular course to escape their pursuers, and finally get so bewildered as to lose nearly all control over their movements. At such times the Porpoise is manifestly the "sea swine," filling itself to repletion.

In perfectly calm weather they are sometimes seen huddled together on the glaring surface, their heads slightly raised, or reclining a little on their sides, as if resting from their constant activity; but such instances are not frequent. Generally they are seen in large numbers rushing over and through the undulating sea, exhibiting their active habits and propensity to roam over an unlimited extent of ocean.

RIGHT-WHALE PORPOISE.

The Right-whale Porpoise in form and habit is nearly the same as the Finback, except it has no fin on its back, and is rather more slender in proportion to its length. They are not seen in as large numbers, and are seldom found in shallow bays and lagoons. We have met with animals of this genus from about Cape Horn as far north as Behring Sea, showing plainly that their feeding grounds embrace the whole coasts of North and South America on the Pacific side, if no more.

THE COW-FISH.

A species of Porpoise, larger than the Finback or Right-whale kind, is known under the name of Cow-fish. It is longer also in proportion to its greatest girth, but its head is not as long. Its teeth are larger, less in number, and it differs in its color, being of a dull black, lightened a little on the belly. This description is based upon two momentary observations—the first at St. Bartolome Bay, in 1853, and the other in Balene's Lagoon, in 1850. In its habits, likewise, as observed on the coasts of California, Mexico and Peru, it shows a striking difference. They are often remarked upon by whalemen as a "mongrel breed," of doubtful character, often seen in company with Black-fish, sometimes with Porpoises, and occasionally with Humpbacks, when the latter are found in large numbers on an abundant feeding ground. They are met with likewise in the lagoons along the coast, sometimes singly, or in pairs or fives and sixes—rarely a larger number together—straggling about in a vagrant manner through the winding estuaries, subsisting on the fish that abound in them. At times they are seen moving lazily along under the shade of the mangroves that fringe the shores in many places, at other times lying about in listless attitudes among the plentiful supplies of food surrounding them, consisting of many varieties of the finny herds that swarm in those waters.

THE KILLER.

**Orca rectipinna Cope.**

The Killer is a peculiar species of Cetacean, that is found wherever the Ba-
The average length is about twenty feet for the males and fifteen for the females, a long dorsal fin distinguishing them from all others of the Dolphin tribe, as well as the shape of their head, which is more pointed than that of the Blackfish, and with a still shorter beak than in the common Porpoise. Their color is black or black with streaks of white on the forward part of the sides from near the eye, extending as far as the end of the back fin in some cases. A greater portion of the belly is almost invariably white in the females. We never have seen but one of the species dead (a female, fifteen feet long, which answers to the above description). The back fin, on account of its extraordinary length, gives the fish a very singular appearance when moving along in its usual manner. It measures six feet or more with the larger males, who may always be known by the extremity of the fin turning over on one side as represented in the accompanying illustration. This protuberance vibrating in the air as the animal rolls to and fro or makes its tumbles over the waves, appears as though it was a great burden and required much effort for the animal to keep right side up. But from what we have observed in different latitudes we are inclined to the opinion that there must be more than one species of Killer on the Pacific coast. Those about the shores of California to all appearance are rather slender animals, with a long dorsal fin of dagger shape projecting from the back about one third of the distance between the extreme end of the head and the "flukes." The covering of fat on the one that was taken did not exceed three-fourths of an inch in average thickness, and was very white. The yield of oil was one and a half barrels, and nearly as clear as spring water.

Although diminutive in size compared with the different species of whales, they prey upon them all, except the Cachalot, the lips and tongues of the animals often affording them a bountiful repast. These Killers may be not improperly styled the cannibals among the whale kind, being the only species that destroys individuals of their own race to afford them food. It is a most surprising sight to witness three or four Killers about a whale. The sight of them before making any attack seems to nearly paralyze the huge monster, who frequently remains nearly stationary, submitting to the attacks of its enemies on either hand, and making little if any resistance.

The mode of attack is to keep about the whale's head, seizing it by the lips, hauling it under water, and it is said to eat out the tongue. We once saw the attack made by three of these voracious animals on a "cow and calf," in a lagoon on the coast of Lower California. The whale was of the species known as the California Gray, and her young one was grown to three times the bulk of the largest Killer. The three made the attack, which lasted for an hour or more, alternately on the old whale and her offspring, finally killing the calf, which sunk to the bottom where there were about five fathoms depth. During the melee the mother became nearly exhausted, having received several wounds about the lips. As soon as the prey was on the bottom the Killers descended, bringing up large pieces of the flesh, anddevoured it after coming to the surface. While gorging themselves in this manner the old whale made her escape. The scene took place within about two hundred yards of the vessel, our observations being made from the deck, and during the time the whales and killers kept nearly a stationary position. Instances have been known where Killers have attacked whales that had been killed by whalemen, and were being towed to the ship, in so determined a manner that, notwithstanding they were frequently lanced, or cut with a bow spade, they took the animal from its human captors and hauled it under water out of sight. But the Killer does not always live on whales. For several seasons we had noticed them about the seal islands along the coast, and came to the conclusion that they subsisted on the fish found around the edge of the kelp. By chance,
however, we were so fortunate as to take one of them, as before mentioned, and on examining, to satisfy our curiosity about the character of its food, found that it consisted of young seals. At the time it was the sealing season, and the beaches about the island were covered with innumerable herds, and, although there were scaling parties about the shores from early dawn till dark, no one ever saw these savage animals molest the seals that were continually swimming about in large numbers.

Compared with other species of the Dolphin family, the Killers are not numerous. Their mating season, or time of gestation, is a matter of conjecture; probably in this respect they are similar to the Sperm Whale. We have met with them in mid winter about the Gulf of Georgia, and along the northern coast as far as Sitka, as often as at any other season of the year, showing plainly that they are not confined to warm latitudes, nor migrate from the colder climates during the rigorous months, and, in whatever region found, they seem to be always prowling for prey.

THE SHORT-FINNED KILLER.

Orca ater Cope.

The Killers I have noticed in the Gulf of Georgia, about the northern end of Vancouver Island, and as far north as the Aleutian Islands, appear to have more white on the sides and are of a dull black on the back, the dorsal fin shorter and much wider at the base. Their habits, however, are the same, being almost invariably seen going along, with an undulating movement, three, four, six, or eight together. They are generally irregular in their course, and are much more of the time below than upon the surface of the water.

November 7th, 1868, we saw, in the Strait of Juan de Fuca, off Port Angeles, a number of Killers moving rapidly up the strait. We noticed one of the number peculiarly marked on the side with a white spot of shape as shown in the sketch. They were marked on the back also, with a brown spot approaching a crescent shape, just behind the dorsal fin; but we did not see them long enough to ascertain the shape with any degree of accuracy. The pectorals of the Killers seem to be farther from the head in proportion to their length of body than any others of the Dolphin family. This seems to be a provision of nature to facilitate their attacks on the whales, as when inserting the head between the lips of the Balæna, to eat out its tongue, these side fins of the former are not in the way.

I am fully convinced that there are at least two species of Killers on the coast between the latitudes of 20° and 60° north: one with a dorsal fin excessively long, narrow at the base, standing very erect; the other species with a shorter fin, somewhat curved, much broader and slanting backward.

THE WHITEFISH.

Beluga sp.?

My opportunities for observing the habits of the Whitefish, as termed by the American whalemen, have been as follows: In the Okhotsk Sea, along the coast of Eastern Siberia, during the summer of 1862; in Plover Bay, lat. 64° 26' N. long. 173° 07' W., September, 1863, and in the same place and month of 1866; in Norton Sound Sept., 1865.

Their habits are similar to those of the Blackfish in many respects, being seen in schools of various but usually less numbers than the former. When pursued they appear to be wild and to avoid the boats. One striking peculiarity I observed was their going along one after the other in a sort of train, coming to the surface and spouting irregularly, showing but little of the body above water. It was unusual to see more than two or three abreast, undulating through the water, at the same time. They often make a noise when coming to the surface that may be compared to the faint low of an ox, but the 1869.]
strain not so prolonged. Sometimes they gambol about vessels as do por-
poises. We know of only one instance, however, which was in Tchantar Bay,
during calm weather, in August, 1862. All our efforts to capture one proved
fruitless. We learned from the natives that they were less shy about the
mouths of rivers, where they resort frequently during the warm season, and
even ascend into fresh water where the depths permit. Only one chance of
getting a view of the animal was in the water close alongside the ship, and it
answered to the description of those found in the Arctic Ocean, the head and
neck appearing much smaller in proportion than that of any other species of
the Dolphin family. Their length may average ten feet, color white or yellow-
fish white.

THE BLACKFISH.

Globicephalus scannonii Cope.

The Blackfish is found wherever sperm whales are, but in many instances
they congregate in much larger numbers, and are nearer to the coast than the
regular feeding grounds of the latter.

Although subsisting almost entirely on the same kind of food, the “squid,”
still, at times, when they visit bays or lagoons, they prey upon small fish found
there. In Magdalena Bay we have seen them in small schools, appearing as
much as at home miles from sea as the Porpoise or Cowfish.

They are seen in schools of from ten or twenty to hundreds, going along
with less of the rising and falling movement than the Porpoise, and usually
spouting eight or ten times before “going down.” If moving quickly much of
the head and body is exposed. When seen by whalemen in this wise they call
it going “eye out.” In low latitudes, during perfectly calm weather, it is not
unfrequent to find them lying quite still, buddled together promiscuously, mak-
ing no spout, and seemingly taking a rest.

The 14th December, 1862, on the coast of Lower California, in lat. 31°, land
ten miles off, a school of Blackfish were “raised.” We lowered the boats and
gave chase; three were taken. The largest was measured accurately, and the
dimensions were as follows:

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<tr>
<td><strong>Length</strong></td>
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<td><strong>Depth of body</strong></td>
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<td><strong>Circumference of body</strong></td>
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<tr>
<td><strong>Breadth of flukes</strong></td>
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<td><strong>Depth of flukes</strong></td>
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<td><strong>Distance from end of head to spouthisholes</strong></td>
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<td><strong>“</strong> “ eye <strong>”</strong></td>
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<td><strong>“” “ dorsal fin”</strong></td>
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<td><strong>Length of pectorals</strong></td>
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<td><strong>Distance from end of head to pectorals</strong></td>
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<td>9</td>
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<tr>
<td><strong>Extreme width of pectorals</strong></td>
<td>1</td>
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<td><strong>Length of mouth</strong></td>
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<td>“ dorsal fin along the back”</td>
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<td><strong>Extreme length of dorsal fin, upper edge</strong></td>
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<tr>
<td><strong>Distance from flukes to arms</strong></td>
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<td>“ abdomen” <strong>”</strong></td>
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<tr>
<td><strong>Length of spouthishole across the head</strong></td>
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The accompanying sketch exhibits the proportions of the animal. Its
color is black. The profile of head shows its shape laterally, and the spout-
hole, which is of a half circular shape, opening like a valve when the spout
ascends, closing as it escapes. The jet is not visible above two or three feet,
and rises perpendicularly when not affected by the wind. The number of teeth
on each side of the upper jaw varies from ten to twelve, in the lower jaw from
eight to ten; the exposed parts one-fourth to three-fourths of an inch long.

[April,
The breadth of the head where cut from the body—just forward of the side fins—was twenty-two inches. From all we can learn of their breeding habits, they bring forth their young at any time, or in any part of the ocean, as necessity may require. Off the Gulf of Dulce, coast of Guatemala, in February, 1855, a calf taken from one was three feet long, the mother measuring thirteen feet. In the same school it was taken from we saw several young ones apparently about the same size as that above named, hence doubtless this fact has, if not been disturbed, would have soon played in its native element.

The Blackfish is taken for its oil, which is however much inferior to sperm, and the yield small compared with its size, which may be calculated as varying from ten to twenty-five feet in length, and the production of oil from half a barrel to ten, the coating of fat or blubber varying in thickness from one to three inches, and nearly white.

The flesh is like coarse beef, and after being exposed to the air for a few days, then properly cooked, is by no means unsavory food, and is often used by whalers as a substitute for the fresh meat of land animals. The same may be said of the different species of Porpoises.

Formerly Blackfish were found in large numbers on the coast of Lower California, particularly about Cape St. Lucas and up the Gulf, but, probably from the same cause as made mention concerning Sperm Whales, these grounds are now but little frequented by them.

The Pursuit and Killing.

Although the Blackfish is taken for its oil, it is not an object of pursuit by the whaler, as is the Baleena and Cachalot. Sperm whales do not lower their boats for Blackfish when on Sperm Whale ground, unless the day is far spent or there is little prospect of "seeing whales."

The northern or polar whaleships pay but little attention to them, except it may be when passing the time "between seasons," cruising within or about the tropics. Occasionally a small vessel is fitted out for blackfishing and sperm whaling, carrying a proportionately limited crew, thereby making blackfishing profitable.

When a ship's boats are lowered for blackfish the chase begins as for other whales, although the masters of many ships have their boats all ready, and run just ahead of or into the school with the ship before lowering, by which means they are generally so much frightened or "gallied" that they "bring to," that is, stop for a short time, or move but slowly in all directions, giving the boats, which are instantly lowered, a good chance to "get fast." The harpoon frequently kills the fish; if not, a few darts with the hand lance dispatches it. As soon as dead they almost invariably sink; therefore, if the ship is close to, the fish is towed to the vessel at once; but if a considerable distance off it is either made fast to the loggerhead at the stern of the boat, or a buoy is tied to it and left, the boats continuing the chase. In this way quite a number are captured from one school.

Their favorite resorts along the coasts of North and South America, on the Pacific side, are off Guatemala, Equador and Peru.

VIII. PHYSETERIDÆ.

THE SPERM WHALE.

Physeter macrocephalus Linn.

The Sperm Whale in form and habits is in many respects the opposite of the Baleena. Its color is a dull black, and in some individuals, particularly the old males, approaches nearer to gray.

Its principal food is "squid," the flesh of which is tender, destitute of bones, and as white as that of the sun-fish. "The upper portion of the head embraces a large cavity, separated and covered by cartilages, and filled with an 1869."

NATURAL SCIENCES OF PHILADELPHIA.
oil which becomes fixed as it cools, and is known under the name of spermaceti. The body yields sperm oil. The substance known under the name of ambergris is a concretion found in the intestines of Sperm Whales."

The Sperm Whale is found usually in the deep open sea, or, as whalmen term it, "off soundings," but many instances are known of their being seen in large numbers, and captures have been made on soundings. This has been the case to our knowledge off St. Bartolome Bay and Ballenas Bay, on the Lower California coast, the depth of water at these places varying from forty to eighty fathoms.

Many have the impression that the Sperm Whale is found but rarely out of the limits of tropical or temperate waters, but we have known of the larger class being often taken as far south as 56° of latitude, both in the Pacific and Atlantic, and as far north in the Pacific as Cape Osmany, which is in latitude 56° 12'.

The Sperm Whale is usually found in schools numbering from fifteen up to hundreds, females with their young predominating; sometimes the large males are found alone, at other times in schools, either alone or in company. The sperm whale is very regular in its spoutings, the volume of vapor being ejected forward in one column at nearly a right angle with the body, and the time it remains under water after it has made its habitual number of blows is marked with great uniformity also. The spout-hole is situated at a point formed by the superior and anterior surfaces of its head, a few inches on the left side.

The one referred to as being taken off the Galapagos Islands in 1853, spouted (or blewed) fifty-five times while on the surface (ten minutes), and when he desceded to the depths below, turned his flukes a few feet out of water and was not visible again for fifty-five minutes; at the expiration of which time he was seen as before, and when his spoutings were out, which occurred at regular intervals, he again disappeared in the same manner. This whale was pursued from eleven o'clock A. M. to four P. M., during which time he did not deviate in his course, and the number of respirations at each rising and the time of remaining under water after turning flukes were alike.

The smaller and younger whales spout a less number of times, remain under water a shorter period, and are not quite so regular in their habits. This class of them usually remain above water one-fourth or one-fifth of the time, making from thirty to forty spouts at each rising, and remain under water about twenty minutes.

But when the Cachalot becomes alarmed, or is sporting on the ocean, it exhibits widely different actions, sometimes thrashing the water with its flukes (i. e. "loptailing,") at times descending below the surface, then giving itself a shoot out of the water at an angle of about forty-five degrees, falls on its side, raising the water into a pile of foam that may be seen from the masthead in clear weather fifteen miles. This singular antic is accounted for by its pursuers, that it is to rid itself of "suck fish" and "crab-lice," but after examining these marine vermin, the reason appears to be an improbable one. The Sperm Whale is seen not unfrequently in a perpendicular posture with the head above water; it has a habit likewise of rolling over many times in succession; this it does occasionally after being harpooned, winding the line around its body; when "gallied"* it frequently "sweeps" around to ascertain whether there is any object within reach; this "sweeping" is performed by moving its tail from side to side. When feeding it is said to move through the water with its under jaw hanging down perpendicular to its body, and when any substance comes in contact with it the jaw is instantly shut; but when on the surface, if the animal attacks a large object like a boat, it turns over on its back to bite.

Its time of gestation is not known, but is supposed to be ten months, and it

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*Frightened.

[April,
IX. PINNIPEDIA.—THE SEA-ELEPHANT.

Macrorhinus angustirostris, Gill.

Proceedings of the Essex Institute v, 1866.

A species of seal was in former years found along the coast from Cape St. Lazarus to Point Reyes, herding on sandy or shingled beaches in great numbers, and were known as the sea elephant. This animal, in form, resembles the common seals, only materially differing in its mammoth proportions. Frequently those unacquainted have mistaken “rookeries” of sea-lions for elephants.

The extreme length of the oldest males will average fourteen or fifteen feet; the longest we have ever seen measured twenty-two feet from tip to tip, but frequently individuals have been met with that gave seventeen to eighteen feet from extreme end of trunk to that of posterior flippers. Its color is a light brown, when the hair is grown to full length; but immediately after “shedding” it becomes of a leaden color, similar to the land elephant. The hair on the body is very short and thin; about the under side of the neck in the oldest males, the animal appears to undergo a change with age, the hair falls off, the skin thickens and becomes wrinkled, the furrows crossing each other, producing a checkered surface, and sometimes the throat is more or less marked with white spots. Its proboscis extends from opposite the angle of the mouth forward (in the large males) about fifteen inches when the animal is in a state of quietude, and the upper surface appears ridgy; but when it makes an excited expiration the trunk becomes more elongated and the ridges nearly disappear. The average thickness of the skin that covers the body is fully equal to that of the largest bullock. The mouth is furnished with teeth similar to those of the Sea-Lion, the lower and largest canines being from four to five inches long, the exterior portion conical, and presenting a smooth surface, the part imbedded in the jaw slightly curved and ridgy; the whole tooth is nearly solid, a small cavity only appearing at the lower end. The females average ten feet between extremities and are destitute of the proboscis, the nose being like the seals, except that it projects considerably more over the mouth. The canine teeth are shorter, smoother below the sockets, larger at the base and hollow nearly to the upper point. The sailors on one voyage not having a supply of pipes, made them of cow-elephants teeth, and the quills or leg-bones of the pelican; the former furnishing the bowls and the latter the stems.

Our observations on the Sea-elephant show that they were found in much larger numbers from February to June than during the other months of the year: but more or less were on shore at all seasons upon their favorite beaches, which were about Santa Barbara, Cerros, Guadalupe, St. Bonites, Natividad, St. Roque and Ascension islands, and a few of the most inaccessible points on the main land between Ascension and Cerros. The first seen of them would be coming up out of the water near the beach, then crawling up 1860.]
by degrees, frequently reclining as if to sleep, then again moving up or along the shore, appearing not content with their last resting place. In this manner they would ascend ravines or low intervals half a mile or more. They are not so active on shore as the seals, but when excited to inordinate exertion their motions are quick, the whole body quivers in their semi-vaulting, crawling gait, and the animal at such times manifests great fatigue; notwithstanding its unwieldiness we have sometimes found them on broken and elevated ground fifty or sixty feet above the sea. The principal seasons of their coming to shore are when they are about to shed their coats, and the females to bring forth their young (which is one at a time, rarely two), and the mating season. These seasons for "hauling up," as it is termed, are more marked in southern latitudes, as I have learned from shipmasters who have taken seals about Kerguelen's Land, the Crozetts and Hurd's Islands. The different periods were known as the pupping cow season, the brown cow, bulls and cows, and march bull seasons. But in the species of our coast, either from the influence of climate, or some other cause, we have noticed young pups with their mothers at quite the opposite seasons. The time of gestation is supposed to be three-fourths of the year. The continual hunting of these animals may have possibly driven them to irregularities. The most marked season, however, that we could discover was that of the matured males, which shed their coats later than the younger ones, and the females; still among the largest herd of these gregarious creatures taken on St. Barbara Island, in June 1852, were several cows* with pups apparently not a few days old. When they come on shore for the purpose of "shedding," if not disturbed, they remain out of the water till the old hair falls off; by the time this change comes about, the animals are supposed to lose at least half their fat. In the stomach of the Sea-elephant a few pebbles are found, which has given rise to the saying that "they take in ballast before going down" (returning to the sea). On warm sunny days we have watched them come up singly on a smooth beach and burrow in the dry sand, throwing the loose particles that collected about the fore limbs over their backs, nearly covering themselves from view. The largest number we ever found in one herd was one hundred and sixty-five, which lay promiscuously along the beach or up the ravine near by. The mode adopted to capture them is to land in front of the "rookery," getting between them and the water, with clubs and lances in hand, then raising a loud noise and moving slowly toward them, they retreat back, appearing in a great state of alarm. Occasionally an overgrown male will give battle, or attempt to escape, but a ball from a musket through his brain dispatches him, or some one with a lance checks his progress by thrusting it into the roof of his mouth, which causes the animal to throw back its head and settle on its haunches; meanwhile two men with heavy oaken clubs give it repeated blows about the head until it is stunned or killed. After dispatching those that are disposed to show resistance the party rush on to the main body, and the onslaught creates so complete a panic among these harmless creatures, that losing all control of their actions they will climb, tumble or roll over each other, when prevented from further retreat by the projecting cliffs. One instance occurred where a rookery of sixty-five were captured, and several were found that had neither been clubbed or lanced, but were smothered by numbers of their kind piled upon them. The whole flock when attacked manifest alarm by uttering their peculiar roar, the sound of which among the large males is nearly as loud as the lowing of an ox, but more prolonged in one strain, hoarser, and accompanied with much rattling in the throat. The quality of blood in this species is supposed to be double that contained in a neat animal in proportion to its bulk. After the capture the flay-

* The term "cow and calf" are whalemen's names for mother and offspring of those animals. Sealers apply the term clapmatch to the female seals, and to the young, pup. Between whalers and sealers has originated cow for the female sea-elephant, while her offspring is called a "pup."

[April,
ing begins. First, with a large knife the skin is ripped on the upper side of the body its whole length, then skinned down as far as practicable without rolling it over. The coating of fat that lies between the skin and the flesh, being from one to seven inches in thickness, according to the size and condition of the animal, is cut off into "horse pieces" about eight inches wide by twelve to fifteen long, and a puncture made in each piece large enough to pass a rope through. After fressing the upper side the animal is rolled over and cut all around as above described. Then the horse pieces are strung on a raft-rope,* which is taken to the edge of the surf and a long line made fast to it, the end being thrown to a boat that lies just outside of the rollers. They are thus hauled through the breakers and towed to the vessel, where they are tried out on board.

The oil produced is superior to whale oil for lubricating purposes. The individual yield may be less than a barrel with the smaller males and females, but the larger males make from three to seven. Owing to the continual pursuit of these animals they have become nearly, if not quite, extinct, or have fled to some isolated, unknown points for security. The latter conjecture, however, seems hardly probable, for the Sea-elephant, it is said, has never been found in the north Pacific, except on the coasts of the Californias.

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Notice of some extinct VERTEBRATES from Wyoming and Dakota.

BY JOSEPH LEIDY, M. D.

1. Omomyx Carteri.

On several occasions, Mr. J. Van A. Carter, of Fort Bridger, Wyoming, sent to me a number of fossils consisting of small blackened fragments of bones, together with casts of fresh water shells, obtained from a tertiary formation. In one of his letters, Mr. Carter remarks that the country in his vicinity is covered with buttes, composed mostly of a gray sandstone, easily worn by the weather, wind and snow. Particular strata of a greenish gray cast contain the fossils.

Portions of rock accompanying the fossils consist of a crumbly, greenish gray, granular material, with few imbedded fragments of soft and more homogeneous rock. Some of the specimens contain multitudes of minute whitish concretions having a concentric arrangement. The fossil shell casts for the most part consist of what appear to be a species of Melania and of Planorbis. The bone fragments consist of remains of teleost fishes but mainly of reptiles, generally too imperfect for specific identification. The reptilia remains, mostly of turtles, indicate several species of Trionyx, Emys, etc.; a Crocodylian is also represented.

Among the fossil bones from the same formation, Mr. Carter sent me a portion of the cranium of a small mammal reduced to indeterminate fragments except a few pieces, which indicated apparently the skull of a carnivorous animal about the size and general form of that of the Mink. Fragments of the parietals and contiguous bones adherent to a portion of matrix, exhibit a long, low sagittal crest separating a capacious pair of temporal fossæ with surfaces almost as convex as in the Mink. A portion of the supra-occipital and condyles, adherent to another portion of matrix, enclose a foramen four lines in transverse diameter.

As Dr. Carter informed me that he had obtained the fossil cranium from its position in the rock, at my solicitation he examined the locality for other portions of the skull, and had the good luck to discover the greater part of the right ramus of the lower jaw, apparently of the same animal. This specimen indicates an insectivorous mammal, probably belonging to the family of the hedge-hogs. Among living insectivora, described and figured by DeBlainville,

1869.]  

*A rope three fathoms long, with an eye spliced in one end.
Gervais, Peters, Mivart, and others, the jaw fragment approaches most nearly in size and form the corresponding portion in the representations of *Tupaiia ferruginea*, of Java and neighboring isles. It likewise nearly resembles in size and form the corresponding portion of a fossil jaw, found in a miocene formation of Sansan, France, and referred to an insectivorous animal with the name of *Galerix vieroides*. The extremities of the ramus are lost, and the remaining portion contains four molar teeth. The depth of the jaw below the position of the latter measures about two lines and is nearly uniform. The base is but slightly convex fore and aft, below the position of the teeth. Back of these to the broken end of the specimen it is slightly concave. The mental foramen is below the position of the second premolar, and the symphysial articulation reached as far back as the third. The masseteric impression is well marked, and well defined about two lines back of the position of the second true molar.

Seven molar teeth, in an unbroken series, appear to have occupied the side of the jaw. Four appear to have been double-fanged premolars with laterally compressed conical crowns. Only the third and fourth of the latter are preserved. The alveoli of the second are retained, and also the inner side of what appears to be a pair for the first premolar.

The last true molar, which has lost its crown in the specimen, appears to have been a double fanged tooth, constructed like those in advance.

The teeth in the specimen from the third premolar to the second true molar successively, and after the former, gradually decline in height or prominence.

The third and fourth premolars nearly resemble in general form and proportions the second and third premolars of the Opossums. The true molars are constructed on the same general pattern as those of the genera Sorex, Erinaceus, Gymnura, Potomogale, Galeopithecus, and the Opossums. All the teeth are provided externally with a basal cingulum or ridge, nowhere elevated into points or cusps.

The crown of the third premolar, more prominent than in any other tooth, is triangular, longer than broad, pointed, and thicker posteriorly. Its anterior border is acute and slightly convex in the length; the posterior outline, formed by the back part of the outer convex surface, is slightly concave. The inner surface, narrower than the outer, presents at its fore part below, a narrow ledge feebly continuous forward as an element of the basal cingulum. This is best developed as a talon at the back of the crown, and least externally and postero-internally. The outer surface of the crown, convex transversely, is continuous posteriorly.

The fourth premolar has nearly the same form as the preceding tooth, but its crown is lower and wider. The basal cingulum is rather better developed externally and less so antero-internally. The inner surface is sensibly concave, and the ridge defining it from the postero-external surface exhibits a feeble tendency to form an accessory point.

The crowns of the two succeeding true molars, retained in the specimen, are nearly alike in size and form, though the first is in a trifling degree wider and higher. They are bounded by a well marked basal cingulum externally, nearly half their depth, reaching across the median valley and also anteriorly, but ceasing and becoming obsolete behind.

Two cusps or lobes project at the outer part of the crown of the true molars, and three smaller ones internally. Of the outer cusps the anterior is the higher and narrower. Of the inner ones the posterior two are nearly equal and the anterior is the smallest; most so in the second molar. They are all three-sided pyramids, each with one face directed inwardly and two outwardly. Their height is not greater than their width, nor are they very sharply pointed. The borders defining the inner surface of the antero-external cusps conjoin the antero-internal two cusps, including a small depression. Of the borders defining the inner concave surface of the postero-external cusp, the front one joins the posterior surface of the antero-external cusp, while the back one joins the postero-internal cusp.
The space occupied by the molar series was about 6\(\frac{1}{2}\) lines. The length of the crown of the third premolar is one and one-fifth lines; the breadth 1 line. Length of crown of second premolar five-sixths of a line, breadth one and one-fifth lines. Breadth of first true molars 1\(\frac{1}{2}\) lines.

Unlike the corresponding part of any other insectivorous animal known to me, I have referred the jaw fragment to a new genus, and have dedicated the species to its discoverer, with the name of *Omomys Carteri*.

2. *Nanohyus porcinus*.

In the expedition of Dr. F. V. Hayden, in the summer of 1866, to the Man-vaisses Terres of White River, Dakota, among the fossil vertebrate remains previously noticed or described, he discovered a fragment of the left ramus of the lower jaw of a small mammal, supposed to be nearly allied, if not belonging to the suiline family.

The teeth in the fragment consist of the last temporary molar; the succeeding two permanent molars in functional position, and the anterior portion of the third molar partially protruded. The interior of the jaw beneath the temporary molar is occupied by the crown of the last premolar, which, judging from the appearance of the exposed outer part, has the same form and size as the molars behind.

The temporary molar is inserted by a pair of widely separated fangs, and its crown presents the usual greater breadth than in the succeeding pair of those of the teeth behind, as in pachyderms generally. The crown is trilobate externally and internally, and this condition probably corresponds with three constituent pairs of lobes, the distinction of which is for the most part obliterated by wearing. The median division of the crown is largest, and that in advance is the smallest. The abraded summit of the former presents an irregularly transverse quadrate surface of exposed dentine continuous with a smaller subreniform tract upon the anterior division. The posterior division of the crown still exhibits the distinction of a transverse pair of lobes, of which the outer one is much the larger. This presents on its abraded summit a crescentoid surface of exposed dentine, and the inner one a minute circular islet of the same substance, and both are considerably below the level of the worn surfaces of the divisions of the crown in front.

The two permanent true molars preserved in the specimen are alike in form and size, and the anterior portion of the last molar agrees in character with the corresponding portion of the teeth in advance.

The crown of the first and second true molars is composed of two transverse pairs of conical lobes of which the anterior are about a third higher than the posterior, and are separated from them by a deep transverse valley. The inner and outer lobes are separated by a valley almost half the depth of the former, closed at the fore and back part of the crown by a small tubercle. The front tubercle is most conspicuous, and receives a feeble offset or ridge from the antero-external lobe. A similar offset from the postero-external lobe ends in the middle of the transverse valley of the crown. A basal ridge exists nowhere except at the fore part of the crown, where it is most conspicuous externally and is there associated with the tubercle closing the front of the fore and aft valley of the tooth.

A minute circular islet of exposed dentine occupies the summits of the anterior lobes of the crown of the first true molar. The breadth of the crown of the last temporary molar is 2\(\frac{1}{2}\) lines. The breadth of the crown of the second unworn permanent true molar is 1\(\frac{1}{2}\) lines, and its height at the anterior division is the same.

The depth of the jaw fragment below the first permanent true molar is one fourth of an inch. The base is moderately convex fore and aft.

Though I have found it difficult to ascertain, by comparison with figures, how far the fossil described differs from the corresponding portion of other known animals, it nevertheless appears to me to do so sufficiently to refer it to a distinct genus and species, for which I have proposed the name of *Nanohyus porcinus*.

1869.]
3. _Trionyx guttatus._

Remains apparently of the same species of _Trionyx_ as that indicated by the small fragments above mentioned, were discovered by Dr. F. V. Hayden in a Tertiary deposit at Church Buttes, near Fort Bridger, Wyoming. The most characteristic specimen obtained by Dr. Hayden, during a geological survey on account of the Commissioners of the General Land Office at Washington, belongs to the Geological Cabinet of that Office, and has been submitted to my inspection by its Secretary, Dr. A. R. Roessler.

The specimen consists of the portion of a carapace adherent to a homogeneous, greenish gray, argillaceous rock. It retains the third to the seventh vertebral plates inclusively entire, with part of the second one; and the 6th and 7th right costal plates, together with parts of those of the second to the fifth inclusively of the same side, and smaller portions of several of the same plates of the left side.

The plates are for the most part marked by distinct or separate circular pittings, which only run into one another more or less at the outer third of the costal plates.

The carapace appears to have been longer than broad, and has approximately about 14 inches in length by about a foot in breadth. The fourth and fifth costal plates appear to have been unusually expanded or widened outwardly. The sixth costal plates conjoin in the median line, though their inner angles are separated by the sixth and seventh vertebral plates. The breadth of the last costal plate is within half an inch of its length.

The third vertebral plate is six-sided or coffin-shaped in outline. It measures 23 lines long, 5 lines wide at the fore part, gradually widening to a little over an inch, and then rapidly narrowing to 8 lines at its back part.

The second vertebral plate appears to have had the same form and a somewhat greater size.

The fourth vertebral plate in the specimen is rather irregular at the sides, and the right posterior angle is twice as long as on the left side. Its length is 20 | lines; its width where greatest posteriorly is 10 | lines.

The fifth vertebral plate is smaller than the former and has its lateral borders approaching in a curve at the hinder extremity. Its length is 19 | lines; its anterior border is 7 lines wide, and its greatest breadth is 8 | lines.

The sixth vertebral plate is cordiform or five-sided in outline, and is almost 10 lines in length and breadth.

The seventh vertebral plate is lozenge-shaped and occupies the interval between the approximate angles of the 6th and 7th pairs of costal plates. It is 53 lines long and 5 lines wide.

The last costal plates include a deep wide em margination behind, and each exhibits a deeper and more abrupt notch at the outer extremity. The length of the plate from the back angle of the last vertebral plate to its outer end, is a straight line is 25 lines; its breadth is 19 lines.

The length of the sixth costal plate along the middle is 41 lines. It is narrowest at the middle, where it measures 16 lines. At the inner extremity it is 19 | lines wide; at the outer end 18 lines.

The length of the fifth costal plate along the middle is 57 lines; its breadth internally 22 lines; externally 40 lines. The species may be distinguished by the name of _Trionyx guttatus._

4. _Emys Wyomingensis._

An episternal bone, among the specimens, obtained by Mr. Carter near Fort Bridger, Wyoming, indicates a species of _Emys_ about as large as the living _Emys (Trachemys) scabra_ or _E. (Pyxehemys) riggsi_, but it possessed a proportionately thicker shell than in either of these species. The bone is remarkably like the corresponding one of _Emys petrolei_ (Pr. A. N. S. 1868, 176) from Harden Co., Texas, but is shorter along the median suture, proportionately broader and rather less produced at its fore part.

The portion of the bone impressed by the gular scutes projects abruptly for-
ward about a fourth of an inch, and ends in a transverse truncate border, which in the entire sternum would measure two inches in width. The position of the ento-sternal plate, of the usual form, at the suture of the episternal and hyo-sternal plates would measure 22 lines in breadth. The depth of the episternal to the ento-sternal is 11 lines; the breadth at the posterior suture 14 lines. In the specimen near the median suture there exists a groove, apparently indicating a long narrow scute intervening between the gular scutes, but not reaching the anterior border of the sternum within four lines. This last mark may perhaps be an anomalous one.

5. Crocodilus apterus.

Dr. A. R. Roessler, in charge of the Geological Cabinet of the General Land Office, Washington, has submitted to my inspection a specimen from the collection consisting of a cervical vertebra of a Crocodile. The specimen was found by Col. John H. Knight, U. S. A., near South Bitter Creek, where it crosses the stage route about 70 miles west of the summit of the Rocky Mountains, in western Wyoming. It is thoroughly petrified, and the bone appears to have been of mature age. It has lost the greater part of the neural arch with the dependent processes, but is otherwise perfect. It belonged to an animal about the size of the Mississipp Alligator, and the bone bears a near resemblance with the corresponding sixth or seventh cervical vertebra of that species. The hypapophysis has the same character, projecting obliquely from the fore part of the centrum, but the latter is less carinated back of the process.

Length of centrum in its axis 16 lines; height and breadth in front 14 lines. Length of hypapophysis below the anterior articular concavity of the centrum 5 lines. Probably the vertebra may belong to the same species as less characteristic fragments of bone, found by Mr. Carter, near Fort Bridger, in the same territory.

Descriptions of new CRINOIDEA and ECHINOIDEA, from the Carboniferous rocks of the Western States, with a note on the Genus ONYCHASTER.

BY F. B. MECK AND A. H. WORTHEN,
Of the Illinois State Geological Survey.

Genus SYNBRATHOCRINUS, Phillips, 1836.

SYNBATHOCRINUS WACHSMUTH, M. and W.

Body below the top of the first radial pieces nearly semi-globose, or approaching semi-oval, being about twice as wide as high, and rounding to the column below. Base forming one-third to nearly one-half the height, somewhat basin shaped, and obscurely pentagonal in outline as seen from below; basal pieces, with the two larger divisions wider than high, and hexagonal in outline, and the smaller about as wide as high, and pentagonal in form. First radial pieces two-thirds to three-fourths as high as wide, with a general quadrangular outline, but two of those on the anal side, have each one of the superior lateral angles slightly truncated to form a notch for the reception of the first anal piece, so as to give each an additional angle. Second radial pieces of nearly the same size as the first, but not tapering upward as much as the first do downward, quadrangular in outline, and generally about three-fourths as long as wide. First anal piece about half as wide as long, pentagonal in form and equaling the length of the second radial pieces; second anal piece nearly half as long as the first, on the truncated upper end of which it rests; trigonal in outline, the upper angle being acute.

Arms very long and very gradually tapering, angular along the middle of the dorsal side, and each composed of more than thirty quadrangular pieces, 1869.]
that are somewhat wider than long, and provided with a very deep ambulacral furrow within. Minute ambulacral pieces extending up the furrows of the arms, from five to seven to each arm-piece, in each row, the two rows arching over the deep furrow. Proboscidiiform ventral tube very long, slender, cylindrical, and composed of apparently not more than two or three vertical ranges of oblong curved pieces, about half as long as those of the arms.

Column comparatively rather stout, rounded, and composed near the base of more or less irregular pieces, gradually becoming thicker farther down, and all pierced by a small rounded or subpentagonal central canal.

Surface, when well preserved, showing under a strong magnifier minute granulations, with a tendency to run together into a kind of vermicular style of marking.

Height of body of a medium sized specimen, to the top of the first radial pieces, 0-16 inch; breadth 0-28 inch; height to top of second radial pieces, 0-30 inch. Length of arms, about 3 inches; breadth of same at the base, 0-15 inch. Thickness of column, 0-10 inch.

This species will be at once distinguished from all the others known to us, by having its body obtusely rounding under to the column below, instead of expanding upward from the same, with straight or concave sides. By this character alone of its body, exclusive of the second radials, when found detached, it can be readily distinguished from S. dentatus, Owen and Shumard, as well as from S. Wortheni and S. papillatus, Hall.

We have elsewhere noticed the occurrence of a long pipe-stem-like ventral tube in this genus, and a double series of minute ambulacral pieces extending up, and apparently arching over, the ambulacral furrow of each arm. These characters were first observed in this species, in which the ventral tube seems to be nearly as long as the arms. We have also seen indications of the same characters in S. Wortheni, and fragments of other undetermined species, and hence have little doubt that they occur in all the species of the genus, when well preserved. There is perhaps scarcely any other type of all the various genera of Crinoids, in which one would less expect to find such an elongated ventral tube, than in this.


SYNTRACHINUS BREVIS, M. and W.

Body small, expanding rather rapidly, with nearly straight sides from the base to the top of the first radial pieces, thence contracting very slightly to the top of the second radials. Form and arrangement of the body pieces very nearly as in the last. Arms comparatively short, and tapering rather rapidly at the extremities, angular or subcarinated along the middle of the dorsal side, the carina being interrupted, or obsolete near the sutures between the arm-pieces, so as to present, as seen in outline, a subcrenate appearance; arm-pieces eighteen to each arm; excepting the first one, slightly wider than long. Column slender, round and composed of alternately thinner and thicker pieces near the base; some of those 0-25 in. farther down, however, being as long as wide, all marked with strong radiating striae on their articulating surfaces, and pierced by a small, apparently round, central canal. Surface finely granular.

Height of body to the top of the first radial pieces, 0-15 inch, to top of second do., 0-20 inch; breadth, 0-21 inch; length of arms, 1-35 inches.

This species will be readily distinguished from S. Wortheni, S. dentatus and S. papillatus, by its much shorter arms, which have scarcely two-thirds as many pieces as in those species. Its body is also rather less spreading, and slightly
more inclined to round in to the column below, but not near so much so as in the last described species, from which it also differs in having much shorter arms.


Genus DICHOCRINUS, Münster, 1839.

DICHOCRINUS LINEATUS, M. and W.

Body ovoid-subglobose, about as wide as long, not rounded below, but abruptly tapering to the column; widest near the middle, and but slightly contracted above. Base forming very nearly half the height, and expanding rapidly, so as nearly to equal, at the top, the greatest breadth of the body; margins faintly sinuous for the reception of the next range of pieces; sutures a little furrowed, but anchylosed. Radial pieces quadrangular, generally nearly, or quite as wide as long; sinuses above, for the reception of the second radials, shallow, rounded, and equaling about half the breadth of the upper margin, marked with fine radiating striae at the outer margin. Anal piece as wide below as the first radials, but narrower above, and slightly shorter; sub-pentagonal in form, being but very obtusely angular in the middle below. (Succeeding parts unknown.)

Surface ornamented with numerous sharply elevated lines, slightly less than the furrows between. Of these lines, on the base, a part near each lateral margin run parallel to the same; while other series farther from the margins, although parallel with each other, on each side of the middle, run obliquely so as to connect with the lateral ones, and with each other, along the middle, in such a manner as to form three divericating series on each piece; near the upper margins there are also traces of a few very fine crowded striae running parallel to the same. On the first radial and anal plates there are also a few fine transverse striae, near and parallel to the lower margins; while on a triangular central space, with its most acute angle terminating near the middle of the top, there are vertical or slightly converging striae of the same size as the divericating series on the base; and on each upper latter space, on each side, another series runs up and down, parallel to the lateral margins. Column rather small, round, and provided with a very minute central perforation.

Height of body to top of first radials, 0.65 inch; breadth, 0.65 inch; height of base about 0.30 inch.

This species seems to be somewhat intermediate in its characters between D. ovatus and D. striatus, of Owen and Shumard. From the first it differs in having distinct, sharply defined, continuous lines on the body plates, instead of merely rows of depressed granules; and these lines also run differently on the basal pieces from the rows of granules on that part of D. ovatus, which are described as forming a series of hexagons, one within the other, instead of forming three series of triangles, as the lines on our species show a tendency to do. The lines are also as well defined on the radial and anal pieces of our species as on the base, while the surface of these parts of D. ovatus is described as being merely "corrugated."

In having continuous, well defined, raised lines, it agrees more nearly with D. striatus, of Owen and Shumard; but it is easily distinguished from that species by having these lines very much finer and more crowded, as well as greatly more numerous; there being about ten of them in the space of 0.20 inch, which only includes four or five of those on D. striatus.


DICHOCRINUS PISUM, M. and W.

Body small, somewhat cup-shaped, approaching sub-globose, rather depressed or flattened below, and from one-fourth to one-third longer than wide, 1869.]
slightly contracted at the top. Base nearly flat, or presenting a shallow dish-shape, sub-circular outline; facet for attachment of the column very small. First radial plates generally slightly longer than wide, and nearly quadrangular in form, comparatively moderately thick; sinuses in the upper margin of each, for the reception of the second radials, very shallow, and about half as wide as the upper margin. Anal plate wider below than any of the first radials, but narrowing upward; provided with a very obscure angle at the middle of the under side, so as to present a sub-pentagonal outline. (Arms and vault unknown.)

Surface ornamented with comparatively strong, rounded costae, wider than the furrows between. On the base these are arranged in three diverging series, the lateral costae being parallel to the lateral margins, and the divergence upward. On the radial and anal plates there are 7 or 8 of these costae which run nearly vertically and parallel, the lateral ones, however, converging above, so as to leave small triangular spaces on the superior lateral corners, on which there are a few short costae not properly connected with the others. Height of body, 0·30 inch; breadth, 0·37 inch. Costae on radial plates, six or seven in the space of 0·20 inch.

In the coarseness of its costae this species is nearest like D. striatus, of Owen and Shumard, but it differs in having its costae rather smaller, more rounded and separated by furrows, distinctly smaller than the costae themselves, which are also without the numerous little asperities seen on those of D. striatus. It is also a smaller, shorter species, with a much more depressed or nearly flat base.

Locality and Position. Upper division of the Burlington group at Burlington, Iowa. Mr. Wachsmuth's collection.


This genus was originally proposed by us for the reception of two very similar forms, one of which, from the upper part of the Coal-Measures of Illinois, we called E. typus, and the other, from the same horizon in Nebraska, we called E. Nebrascensis. The specimens then known consisted only of the body up to the summit of the first radials. This part of these forms is sub-hemispherical in outline, being rounded below, and evenly truncated above, with five minute, or very small basal pieces, surrounded by, and alternating with, somewhat larger subradials, which in their turn alternate with, and support, five larger, thick first radials, with articulating facets occupying their entire breadth above for the reception of the next range of radials. These radials being in contact with each other all around, leave no spaces for anal or interradial pieces. All the specimens then known had lost the arms, but those of other species now before us are seen to be simple from their origin on the second radial pieces, and each composed of a single series of transversely oblong pieces.

Subsequently another species was found in the same beds in Illinois, presenting an obconic form of body, with a protuberant base, and we were so much impressed with its resemblance to an East Indian Carboniferous type described by Dr. de Koninck, under the name Philocrinus, in 1863, that we were led to think our genus not distinct, and his name having priority of date we referred the two forms we had first described to it.* In doing this, how-

* Our later comparisons of other specimens have led to the conclusion that these are only varieties of one species. Good specimens of a form described by us in the Proceedings for Aug. 1865, from a number of detached plates, under the name Euberecrinus, also show that it does not belong to this genus, as it has a large oblong subanal, and a true anal piece, resting on the upper truncated edge of one of the subradials. Hence, although it agrees exactly in all its other known parts with Erisocrinus, it cannot properly be retained in that genus, but would belong to Cysthoecrinus, giving that group the limits generally admitted. It is not a typical Cysthoecrinus, however, but nearer the group Largocrinus, and yet differs from the typical forms of that group, in having its second radials as wide as the first, and articulating by broad transversely furrowed facets, instead of merely resting in comparatively small sinuses in the upper edge of the latter.
ever, we thought it desirable to change the specific name of our species typus, it not being the type of the genus Philocrinus.

We were led to regard our species as not being generally distinct from Philocrinus, because they agree exactly in all their known generic characters, unless the lower range of pieces shown in the figure of Philocrinus really are the basal pieces, which would make that genus without subradial pieces. As the typical specimen, however, seems, from the figure, to be a little defective at the lower extremity, and the lowest range of pieces represented, if really prolonged to the bottom of the body, would have to present a very remarkably elongate cuneiform outline, we were strongly impressed with the probability of there being another smaller series of true basal pieces below the lowest range represented (but not visible in consequence of the condition of the specimen), especially as these forms appear to agree so nearly in other respects. If so, there would be no generic differences between Philocrinus and Erisocrinus, and the American species would have to stand under the former name. If Philocrinus, however, really has no subradial pieces, then, of course, Erisocrinus must be an entirely distinct genus. Until all doubts on this point, however, can be removed, we finally concluded to retain our name Erisocrinus.

The close similarity of the body of some species of this genus, and that of another allied form, found in the upper members of the Coal-Measures of Nebraska, to the corresponding parts of the genus Encrinus, and their wide difference from all the then known Lower Carboniferous Crinoids of America, have been appealed to as facts sustaining an opinion, maintained by some, that these Nebraska beds belong to the age of the Permian of Europe, instead of to the Coal Measures. The fact, however, that we now have the species of this genus described in this paper, from the lower part of the lower Carboniferous or Mountain Limestone at Burlington, ought, we should think, to be sufficient evidence that no such conclusions can be properly based on this type of fossils.

**Erisocrinus antiquus, M. and W.**

Body small, much depressed, somewhat basin shaped, or very rapidly expanding from the base to the summit of the first radial pieces, at the connections of which it is very faintly sinuous around the margins, as seen from below. Base small, subpentagonal, almost entirely covered by the round, flat facet for the attachment of the column; basal pieces exposing very small pentagonal surfaces, three or four times as wide as long. Subradial pieces each about one-half to two-thirds as large as the whole base, all uniformly pentagonal (there being no visible angle at the middle of the base), and with the upper sloping sides each about twice the length of the lateral margins. First radial pieces about twice as large as the subradials, half as long as wide, and all equally pentagonal, with the lateral and inferior sloping edges of nearly equal length, and the straight, upper truncated side equaling the entire breadth; articulating upper edge very thick, deeply notched at the middle on the inner edge, and provided with the usual transverse ridge and furrows. Second radial pieces as wide as the first, and about three-fourths as long as wide, angular in the middle on the dorsal side, and constricted on each lateral margin; pentagonal in form, and supporting on their superior sloping sides the first arm pieces, which are quadrangular, slightly constricted on each side, and a little wider than long; arms beyond these simple (as far as they can be traced in the specimen), two to each ray, or ten in the whole series, and composed of somewhat shorter quadrangular pieces, provided with a well defined ambulacral furrow within. Surface merely finely granular.

Height of body to the top of the first radials, 0.12 in.; breadth, 0.23 in.

This little species will be readily distinguished from those already known from the coal measures, by its much more depressed, rapidly expanding body, as well as by its proportionally longer and constricted second radial pieces.

1869.]

Erisocrinus Whitei, M. and W.

Body of moderate size, very much depressed, or almost dish-shape, below the top of the first radials, being about three times as wide as high. Base very small, and entirely hidden by the slender, round column, when it is attached. Subradials small, forming together a nearly flat pentagonal disc. First radials comparatively large, thick and presenting a general quadrangular outline, there being scarcely any visible angle at the middle of the under side, which is distinctly shorter than the straight transverse upper edge, and about as long as the diverging lateral margins. Second radial pieces as large as the first, which they equal in breadth; broadly rounded on the outer or dorsal side, pentagonal in form, and each supporting on its superior sloping sides two arms, thus making ten to the whole series. Arms simple from their origin, flat on the outside, and composed of quadrangular pieces, the first of which is nearly as long as wide, and the others about half as long as wide, with scarcely any tendency to assume a wedge shape. Surface merely finely granular.

Height of body to the top of first radial pieces, measuring to their inner edges, 0:14 inch; breadth, 0:40 inch; breadth of column, 0:98 inch.

This species will be distinguished from the last by its more depressed body, which has its under side between the top of the first radial pieces and the column, slightly convex in outline, instead of concave, which results from the greater prominence of the basal and subradial pieces of the latter. The species under consideration likewise has its radial pieces proportionally wider, particularly the second radials, which also differ in being broadly rounded instead of angular on the dorsal side, and not constricted on their lateral margins. Its arm pieces are also flat, instead of convex, on their outer side.

Owing to the fact that the column entirely hides the very small base of this species, and the sutures between the subradials, or first range of pieces around the summit of the column, are rather obscure, and really looking as if there were only three instead of five of these pieces, we were led to suspect that these might be the basal pieces, which would remove the species entirely from the genus Erisocrinus. On removing the column, however, we have been able to see what we believe to be five minute basal pieces within the first series surrounding the end of the column, which would necessarily have to be succeeded by five pieces in the next range. Hence, we think we can scarcely be mistaken in supposing the appearance of only three suture lines between the plates we regard as the subradials, as merely an abnormal condition, resulting from two of the suture lines being anchylosed, or accidentally obliterated. This supposition is also strengthened by the near specific relations between this and the last described species, in which all the basal, subradial and other plates are clearly and distinctly seen.

In case our genus Erisocrinus is not distinct from Philocrinus, with which we have already suggested it may be identical, then the names of the species here described will have to be written Philocrinus antiquus and P. Whitei.

The specific name of this species is given in honor of Dr. C. A. White, the able State Geologist of Iowa.

Locality and position. Upper division of the Burlington Group, at Burlington, Iowa, Lower Carboniferous. Mr. Wachsmuth's collection.

Genus CALCEOCRINUS, Hall.


[April,
Dr. Shumard has suggested, in his Catalogue of North American Palæozoic *Echinodermata* (Trans. Acad. Sci. St. Louis, ii, p. 358, 1866), that the curious genus of Crinoids described by Prof. Hall, in the Report of the Regents, cited above, under the name *Cheirocrinus*, may be the same type for which Prof. Hall had previously proposed the name *Calceocrinus*, in the second volume of the Palæontology of N. Y. The name *Calceocrinus* was proposed by him for some subtrigonal pieces of a Crinoid, which, judging from his figures and description, certainly resemble very closely the basal piece of the subsequently proposed genus *Cheirocrinus*—so closely indeed, that we are much inclined to adopt Dr. Shumard's suggestion that they may belong to the same type. Still it seems very improbable that Prof. Hall, with the original typical specimens of his *Calceocrinus* (of which he says many specimens, all agreeing in form, have been found) at hand for comparison, should have been less liable to understand their true relations to his subsequently described type than others, with only his figures and description of *Calceocrinus* accessible for comparison, and consequently proceeded to redescribe the same genus under another name, that he had previously called *Calceocrinus*.

The synonymy is also unfortunately still farther complicated, by the fact that Prof. Hall happened to select for one of the above mentioned genera, proposed by him, the name *Cheirocrinus*, which had been used by Eichwald in 1856 for a genus of Cystidians. Eichwald's proposed genus seems to be nearly related, as he has stated, to *Echino-encriniles*, though it is very probably distinct. If so, then the name *Cheirocrinus* would have to stand for his type, and could not be retained for that described by Prof. Hall, even if distinct from his *Calceocrinus*. In that case, to avoid confusion, the form here under consideration might be called *Eucheirocrinus*.

Until these questions of synonymy can be cleared up, however, we prefer to describe our species, provisionally, under the name *Calceocrinus*; although, if the type of that genus is distinct from *Cheirocrinus*, and the latter name can stand, they would have to be ranged under it, as they are clearly congeneric with the types for which it was proposed.

It is evident that this remarkable genus differs so widely from all the other known types, that it must be regarded as belonging to an entirely distinct and unnamed family, which might be called *Calceocrinidae*, as it is almost a certainty that *Calceocrinus*, even if generically distinct from the forms here under consideration, would at least belong to the same family, and if they are generically identical, *Calceocrinus* being the older name, would have to stand for the typical genus.

*Calceocrinus?* Bradley, M. and W.

Body exclusive of the base subquadrangular, with the upper lateral angles obliquely truncated, and the sides rather deeply sinuous, or constricted above the middle; compressed antero-posteriorly, and rather distinctly concave in the central region of the dorsal side below the middle. Lower dorsal plate triangular, and more than twice as wide as high. Dorso-lateral pieces twice as high as wide, presenting an irregular pentagonal outline, with sloping sides above diverging at an angle of about 90 degrees. Upper dorsal plate about half the size of the lower, subtrangular, or nearly semicircular, slightly more than half as long as wide, and scarcely more than filling the notch between the inner sloping sides of the dorso-lateral pieces. Dorsal arm slender, rounded, and composed first of five pieces, the lower of which is expanded below so as to be nearly three-fourths as large as the upper dorsal piece; while the succeeding pieces are narrow and slightly longer than wide, excepting the fifth one, which is a little wider than the others, pentagonal in form, and supports upon its superior sloping sides two equal divisions, which are slender, rounded simple, and composed of pieces about twice as long as wide. Lateral divisions of the rays (or perhaps, more properly, supports of lateral arms) composed of pieces that are wider than long, and rapidly dimin-

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lishing in size from the first to the terminal one; of these, three can be counted on one side, but there may have been one or two more; each supporting an erect arm, more slender than the dorsal one, and dividing first on the third piece, the inner division being smaller than the other and remaining simple, while the larger one bifurcates again on the fourth piece, the subdivisions being equal and of the same size as the inner branch at the first bifurcation. All the axillary pieces are expanded and more protuberant at the upper end than any of the others, though all of the other pieces are slightly projecting at the upper end. (Ventral side unknown.)

Column comparatively stout, or slightly thicker than the dorsal arm below its bifurcation; composed, two or three inches from the body, of round, nearly equal, moderately thick pieces, but near the body showing a slight tendency to become pentagonal, and apparently composed of more irregular, somewhat roughened pieces. Surface rather distinctly granular, particularly on the dorsal side of the body.

Length of body exclusive of the basal piece, 0.48 inch; breadth, 0.47 inch; length of dorsal arm to the first bifurcation, 0.62 inch; entire length about 1.86 inch; breadth of do., near the middle, 0.10 inch. Length of upper dorsal plate, 0.15 inch; breadth of do., 0.20 inch.

Compared with Prof. Hall's figure of the body of his C. tunicatus, and with specimens we have identified with that species, this form differs in having the body not narrowing upward, being as wide across, just above the constriction, as at the base of the dorsal-lateral pieces; the constriction of its sides is also distinctly above, instead of at the middle; while the outer sloping sides of its dorso-lateral pieces are proportionally shorter, and directed more obliquely outward. Its dorsal side, instead of being "flattened," is also distinctly concave below the middle. Again its upper dorsal plate is proportionally smaller, being considerably less, instead of more, than half the breadth of the body above the middle, and only just large enough to fill the depression in which it rests, without projecting above; while its lower sloping margins are rounded, so as to give it a semicircular outline, instead of being straight.

Compared with C. nodosus, Hall, the only other described species from this horizon, it will be at once distinguished by the nodose character of the latter. It likewise differs in the details of its structure from the various other species described by Prof. Hall from other horizons.

The specific name is given in honor of Prof. Frank H. Bradley, of Hanover College, late of the Illinois Geological Survey, who discovered the typical specimens, and numerous other fossils, at the same locality.


Calceocrinus? Wachsmuth, M. and W.

Body small, compressed antero-posteriorly; above the base approaching an oblong outline, being longer than wide, a little concave in the middle of the dorsal side, and with the lateral margins of the dorso-lateral pieces constricted in the middle, and rounded and curving inward or forward, so as to form a part of the ventral side. Basal piece subtrigonal, about twice as wide as high, truncated its entire breadth above, for connection with the succeeding piece by a widely gaping suture, evidently constructed so as to permit it to be opened out on a line with the body, though in the specimens seen, it is always folded close in against the ventral side; facet for the attachment of the column truncating the lower end, concave and equaling about half the breadth. Column comparatively rather stout, composed near the base of alternately thicker and thinner pieces; becoming more slender, and composed of longer and more uniform pieces farther down; central cavity pentagonal. Body plates closely ancylosed; lower dorsal plate triangular, about one third as large in the middle as the dorso-lateral pieces, which are between three and
four times as long on the outer side, as wide. Upper dorsal plate subtrigonal, with the lateral angles a little truncated obliquely outward, about twice as wide as high, and truncated about three-fourths its breadth above, for the reception of the middle or dorsal arm; more than filling the broad triangular notch between the upper ends of the dorso-lateral pieces.

Dorsal arm simple, and composed, above the first piece, of oblong pieces, that are rounded on the outer side, and about one third longer than wide. Lateral divisions of the rays supported on the superior latter sloping side of each dorso-lateral piece, composed each of (as far as can be seen) five pieces in a direct range, extending out laterally and curving around toward the ventral side; of these pieces the first is very short and does not support an arm, while each of the other bears an erect arm above. Each of these lateral arms, as far as can be seen, gives off a small division on the dorsal side of the third piece above the base, while the main division of each bifurcates again on the fourth piece above, the bifurcating pieces being a little tumid. All the arms have a deep ambulacral furrow within.

Pieces of the ventral side unknown.

Length of base, 0.10 inch; length of body exclusive of base 0.35 inch: breadth do., 0.27 inch; length of arms 1 inch.

This species is related to C. doactylus, Hall, but differs in having its dorsal arm simple, instead of bifurcating; and its lateral arms bifurcating first on the third, instead of the fourth piece. From C. ventricosus, llall, it also differs in having the dorsal arm simple, instead of bifurcating, while its upper dorsal piece is distinctly shorter in proportion to breadth than in that species.

If farther comparisons should show these forms to be generically distinct from Calcocorinus, and Cheirocorinus is found to be tenable, this and the preceding species would have to be called Cheirocorinus Wachsmuthi and C. Bradleyi.

The specific name is given in honor of Mr. Charles Wachsmuth of Burlington, Iowa, to whom we are indebted for the use of the specimens from which the description was made out.

Locality and position. Upper Burlington beds of Lower Carboniferous, at Burlington, Iowa. Mr. Wachsmuth's collection.

Genus GILBERTSOCRINUS, Phillips.

Subgenus GONIASTEROIDOCRINUS, Lyon and Casseday, 1859.

Syn. Trematocrinus, Hall, 1860.

GONIASTEROIDOCRINUS TENUIRADIATUS, M. and W.

The only specimen of this species we have seen is too much crushed to admit of a detailed description of the structure of its body. It evidently attained a medium size, however, and has unusually long, slender, pseudo-brachial appendages, or false arms; while its subradial pieces are produced into short pointed spines. Its false arms are each composed, near the body, of a double series of alternating semi-elliptic pieces, which are joined together by their straight sides, and each pierced by a small central canal. At a distance of about three or four pairs of these pieces from the body, each series of pieces diverges from the other at an angle of about fifty degrees, thus forming two very long, slender, rounded, gradually tapering branches, composed each of a single series of round pieces, generally less than twice as wide as long, with a small central canal. These pieces have their articulating surfaces radiately striated, and could not be in any way distinguished from the joints of the columns of many crinoids, if found detached.

From Prof. Hall's species typus* (which also belongs to the section of the genus

*As this species is neither the type of the genus Gilbertsocrinus, nor of the subgenus Goniasteroidocrinus, the name typus can only serve to confuse and mislead the student in regard to the history and synonymy of the genus, and hence ought to be changed.

1869.]
with the pseudo-brachial appendages composed, near the body, of a double alternating series of pieces, and bifurcating farther out into two rounded branches, composed each of a single range of pieces pierced by a small central canal; the species under consideration will be readily distinguished by its much longer and more slender pseudo-brachial appendages, which have their pieces merely rounded and finely granular, instead of being each provided with a row of small tubercles around the middle. From *G. tuberculatus*, Hall, (sp.), which, if correctly identified among the specimens before us, has its pseudo-brachial appendages constructed, at the base at least, in the same way, it will be distinguished by having its subradial pieces produced into short pointed spines, instead of being merely tuberculiform. The same character, as well as its larger size, and more robust appearance, will also distinguish it from our *G. fiscellus* and *G. reticulatus*, Hall (sp.).

The specimen is too much crushed to afford measurements of the body, but the false arms measure 0·60 inch from the body out to the point of bifurcation, and 0·35 inch in breadth. Each of the branches near the point of bifurcation measures only 0·18 inch in thickness, while one of them can be traced to a length of 2 inches, where it is broken off, and measures 0·13 inches in thickness, the whole length of each branch being probably not less than three inches.

**Locality and Position.** Lower division of the Burlington group, Burlington Iowa. Lower Carboniferous. No. 308 of Mr. Wachsmuth's collection.

*Goniasteroidocrinus obovatus*, M. and W.

Body rather large, truncato-obovate, being narrow below, with convex sides, and truncated above; height a little greater than the breadth. Base small, and very deeply concave; basal pieces entirely within the concavity of the under sides, and hidden by the column, when it is attached; apparently completely inverted by the pushing in, as it where, of the column, around which they are folded down with their outer sides inward, while their edges that join to the subradials are turned downward. Subradials of moderate size, very tumid or tuberculiform, but not pointed; curving into the concavity below and upward at the outer ends, while their tumid central part forms the base upon which the body stands when placed upon a plane surface; all heptagonal in form, if we count an obtuse angle at the middle of the base of each. First radial pieces about as large as the subradials, tumid, and of nearly equal length and breadth; all heptagonal in outline. Second radial pieces generally smaller than the first, and proportionally a little narrower, rather tumid, and all hexagonal in form. Third radial pieces of about the same size as the second, or sometimes slightly larger, equally convex, pentagonal or hexagonal in outline, and each supporting on their superior sloping sides, convex secondary radials, the second of which is sinuous above, so as to form the under side of the openings to which the pendent true arms connect, while on their outer sloping sides they connect with a series of small pieces, which unite with others coming in the same way from the adjacent ray, so as to form the under side of the base of the false arms over each interradial and anal space.

Anal and interradial areas of an oval outline, and scarcely distinguishable from each other, each occupied by twelve to fourteen more or less convex, or tumid pieces, the first of which is hexagonal, about as large as the second radials, and rests as usual on the upper truncated side of a subradial; above these there are usually three arching ranges of three each, and three or four other pieces still farther up, more or less irregularly arranged.

Vault flat, not quite equaling the greater breadth of the body below, and composed of irregular tumid pieces, generally of rather small but unequal sizes, with a more or less marked depression opposite each false arm; opening apparently nearly central. False arms composed at their bases of four rows of small pieces above and two below, arranged so as to inclose two distinct canals which do not pierce any of the pieces themselves.

[April,
Surface very finely granular. *Impressions at the corners of the plates also sometimes cause the appearance of a tendency to form a short obtuse radiating rib at each side of some of the plates, but this character is too faintly marked to attract attention.*

Height of body about 1-70 inch, breadth, 1-60 inch.

The most marked feature of this species is its rather obovate form, produced by the narrowness of its lower part and its convex sides, and slight contraction near the top. The narrowness of its lower part results from the small size of its basal, subradial, and first radial pieces. The deeply sunken character of its base also contributes to the same result, as it is not near so wide as it would be if its pieces extended out horizontally from the column, instead of being folded down with their backs against it. It seems to resemble *G. tuberculatus*, Hall (sp.), more nearly in general appearance than any other species known to us, but will be readily distinguished, not only by its different form, but by the proportionally smaller size of its basal, subradial, and first radial pieces, but more particularly by the structure of its false arms, which are each composed at the base of six ranges of pieces, instead of only two.


Genus *LEPIDOCENTRUS*, Müller (?). 1856.

Entire form unknown. Interambulacral plates rather thin, very irregular in size and form, all strongly imbricating apparently from below, and toward the lateral margins of the areas; arranged in five or more rows, only the outer two of which seem to be continued to the extremities of the areas, all occupied with generally obscure secondary granules, and most of those on the lower (?) side of the body also provided with large primary central tubercles and spines; primary tubercles sometimes showing a small pit in the top, surrounded by two smooth rings, separated by an annular furrow, and all without any ring, depression or prominence around the base; on the upper (?) side of the body, only the marginal rows provided with primary tubercles. Ambulacral areas wide, and occupied by six or more irregular rows of unequal, irregular pieces, some of which are as large as the smaller interambulacral plates, and all strongly imbricating in the opposite direction from the interambulacral series; each pierced by two pores, and the larger ones usually marked with one or two additional pits, which, with the pores, are surrounded by a large circular impression, while some of them sometimes show a tubercle intermediate in size between the primary and secondary series. Apical disc unknown, but a single rather large plate believed to belong to it is seen to have six or seven pores circling around near its outer margin, and a small tubercle in the middle.

This type is related to several of the other paleozoic genera, but cannot be properly referred to any of them. In the great irregularity of its interambulacral plates, both in size and form, as well as in the absence of primary spines, excepting on the marginal rows (at least on the upper (?) side of the body) it seems to be very similar to *Perischodomus* of McCoy. It differs, however, clearly from that group in the much greater breadth of its ambulacral areas, the greater number of ranges of ambulacral pieces and their greater irregularity, as well as in the much larger sizes of some of them, and their peculiar circular impression around the two pores. If *Perischodomus* has its plates not imbricating, that would also be another important difference, but although that character is not mentioned in the description, we suspect it may really exist, because we find it to occur in all the analogous types in this country.

From *Lepidechinus* it is also readily distinguished, by the much greater breadth of its ambulacral areas, and its more numerous rows of ambulacral pieces and pores, as well as by the larger size and the other peculiarities of these species.

In the breadth of its ambulacral areas, and the number of rows of pieces occupying the same, it is more nearly related to our *Lepidastes*; but it differs 1869.]
in the great irregularity of these pieces, both in size and form, as well as in the curious circular impressions of the same: also in the possession of large primary tubercles and spines on some of the interambulacral pieces.

It is probably more nearly related to the form referred in this paper, doubtfully to Eocidaris, but it differs materially in the much greater breadth of its ambulacral areas, more numerous ranges of ambulacral plates, and the larger sizes, and other peculiarities of these species; as well as in not having primary spines and tubercles on all of its interambulacral plates.

Note.—After preparing the foregoing description, with the view of proposing a new genus for the reception of this fossil, our attention was called by Prof. Alexander Agassiz to a very similar type, that was published by Müller under the name Lepidocentrus, in 1856, from the Eifel Limestone (Aus den Abhandlungen der Königl. Akad. der Wissenschaften zu Berlin, p. 258, taf. iii); but which has been entirely overlooked by subsequent authors. After comparing our specimens with the figures and description in Müller's paper (a copy of which Prof. Agassiz was kind enough to loan us), we find our type agrees so nearly with his genus, in all the parts known to him, that we have concluded to refer it provisionally to the same. Müller, however, knew nothing of the nature of the ambulacral pieces of his type, and we have therefore no means of comparing these important parts. As it is already known that there are various genera of these older types, agreeing in some characters and differing in others, it is quite probable our fossil may belong to a distinct genus. If so, we would propose to call it Pholidocidaris.

Lepidocentrus irregularis, M. and W.

The specimens of this fossil that we have had an opportunity to study are too much crushed and broken to give a clear idea of its general form, or to admit of being systematically described. It seems to have attained a rather large size, however, and if of a depressed subglobose form, may even have measured as much as three and a half to four inches in its transverse diameter. Some specimens show from five to six ranges of interambulacral plates lying together, so as to indicate that there were at least that many ranges between the ambulacra at that point. These six ranges, as they lie flattened by pressure, measure about two inches across.

All of these interambulacral plates are thin and sharp at the edges, and of only moderate thickness in the central region, while they present such a variety of forms that it would scarcely be possible to give a correct idea of their outlines, without describing each individual plate. They are generally a little longer than wide, however, and on what appears to be a part of the body below the middle, most of them have the primary tubercles more or less distinctly developed, though on some they are obsolete, or not easily distinguished from the obscure secondary ones.

On what appears to be the upper side of the body, no traces of any but the small secondary tubercles covering the surface of all of these plates are visible, excepting, as already stated, on those of the marginal rows. These marginal plates on this side, are generally each as large as three or four of those adjoining them, and in some instances measure 1 inch in length, and about 0.60 inch in breadth, being of an elliptic form. The primary tubercle of each is placed about midway of the length, and between the middle and the ambulacral side. In many instances these tubercles are rounded off, as if the spines had been dropped during the life of the animal, and the tubercles partly absorbed away.

The ambulacral plates are apparently even more irregular in size and form than those of the interambulacral series. In one crushed specimen, showing a part of the fossil composing apparently the under side, extending an inch or more away from the supposed oral opening, portions of three of the ambulacral and two of the interambulacral series of plates are seen, apparently
nearly in their relative positions, excepting that they are all spread almost on a plane, and more or less displaced and broken by accidental pressure. Here, near the ends of the areas, there are apparently only two rows of interambulacral plates in each series, the two ranges measuring together only about 0.40 inch in breadth; soon, however, they pass into three or four ranges. The ambulacral areas, at about one inch from the apparent position of the oral orifice, measure nearly an inch in breadth, and, as near as can be counted, there appear to be there six or more ranges of ambulacral plates. These plates appear to increase in size and decrease in number toward the end of the areas, so that some of them are there nearly as large as the adjacent interambulacral plates. They are generally wider than long, and as they lie together present more or less rhombic faces, arranged somewhat like the scars on the surface of some species of Lepidodendron. This similarity is also increased by the pores, and some little pits in the central region, surrounded by the circular depression. Some of the larger of these plates have the pores near one end, and a tubercle occupying the middle, nearly as large as the primary tubercles on the adjacent interradials. These probably belong to the middle ranges.

The larger primary spines attained a length of about one inch, and a thickness of 0.10 inch at the head, which is a little swollen; above this they taper rather gradually, are rounded, nearly straight, and marked by minute, crowded, longitudinal striae. Among the ambulacral plates there are also seen lying scattered about a number of other spines, from one-fourth to one third the size of those described, and of very nearly the same form. These seem to belong to the ambulacral plates, on most of which we see a tubercle larger than the secondary tubercles of the interambulacral plates. Many much smaller spines than the latter are likewise seen, that probably belong to the secondary, or perhaps, more properly, tertiary series.

*Locality and position.* Hamilton and near Nauvoo, Illinois; in the Keokuk division of the Lower Carboniferous Series.

**Eocidaris? squamosa,** M. and W.

Body attaining a large size, apparently depressed-subglobose in general form. Interambulacral plates rather thick, in eight or more longitudinal rows near the middle of each area,* but apparently only the two outer rows continued to the oral aperture; all presenting the usual hexagonal form, excepting the pentagonal marginal rows, and distinctly imbricating apparently from the lower side upward,† as well as inward toward the central row, excepting the two outer rows on each side, the lateral imbrication of which is outward, that is, the outer row laps the edge of the ambulacral series, and the next range laps the edge of the outer row, while its inner edge laps that of the next row within, and so on to the middle row, which is lapped on both sides; each with a comparatively large, smooth, saucer-shaped depression, occupying the central region, from the edges of which the surface is distinctly beveled off in every direction to the margins, the beveled edges that pass under the edges of the adjacent plates, however, being distinctly wider than those lapping the adjacent pieces, these lapping edges being as if ground off obliquely under, or in other words, beveled on the inner side; tubercles for the support of the primary spines smooth, prominent, rather large, and rising in the middle of the saucer-shaped central depression, narrowing upward to near the top, where there is a circular depression surrounding a very narrow, prominent, perforated, central process, for the immediate articulation of the primary spines; most convex part of each plate surrounding the smooth, saucer-shaped depres-

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* Eight rows are seen in the specimen at the widest part, but we are not sure this is the middle of the area, owing to the imperfection of the specimen.
† This imbricating character, as well as several others mentioned in the above description, may be of more than specific value, and they are mentioned here, along with specific characters, because we are in doubt in regard to the generic relations of the fossil.

[1869]
sion, ornamented with a few very small pustules, upon which small secondary spines probably articulated. Primary spines, apparently one inch or more in length, rounded, slender and nearly or quite straight, with the articulating end perforated and a little enlarged, so as to form an undefined ring; surface ornamented with minute, crowded, longitudinal strie, only visible by the aid of a good magnifier.

Ambulacra narrow, or only about equaling the breadth of the marginal rows of interambulacral plates on each side, slightly convex. Ambulacral pieces slightly imbricating in the opposite direction from the interambulacral series, of very unequal size and form, and irregularly arranged, most of those starting from the mesial zigzag suture, extending out so as to connect with the crenated lapping margins of the outer ranges of interambulacral plates, while many of those starting from the latter inward, wedge out more or less abruptly between the others, at various distances before reaching the mesial suture, so as to present the appearance of a strong tendency to run into two rows of pieces on each side of the mesial suture; each pierced by two pores, which, owing to the irregular arrangement of the plates, present the appearance of forming two double rows along near each lateral margin of each ambulacrum, or four rows to each of these areas. They might, however, with probably almost as much propriety, be counted as one double, strongly zigzag row on each side.

Near what appears to be the position of the oral opening, there is adhering to the specimen one half of a stout jaw, 0·69 inch in length. On its outer side it is conical form, a little arched, and provided with a broad, longitudinal, excentric furrow; its lateral margins are smooth, and near 0·30 inch in breadth at the base, and converge to a sharp edge within. We have now tolerable good evidence that all the different genera of the Perischoechinidae are provided with strong jaws.

The specimen is too imperfect to give a good idea of its general form or size. As it shows one of the interambulacral areas, however, to be near two inches broad, it is probable the entire fossil was not less than four and a half inches in its transverse diameter. The largest interambulacral plates measure about 0·25 inch in length and breadth, while those of the outer rows next the ambulacra are proportionally narrower. The primary spines seem to be about one inch or more in length, though we have seen none entire. The longest fragments we have seen, are about half an inch long, 0·10 inch in thickness at the articulating end, and 0·06 inch in diameter a little above, but without any taper toward the broken end. The ambulacral areas are only about 0·26 inch in breadth at the widest place, near the middle, and about four to six of their pieces fit into the crenulations of each of the marginal interambulacral plates.

We have been somewhat puzzled in regard to the generic characters of this species. Its interambulacral plates are each provided with the large central tubercle and spine, characterizing Archwoechidaris and Eoecidaris, though these tubercles agree with those of Eoecidaris in having no ring or slight projection around the base, as in Archwoechidaris. At first we were inclined to believe it related to Prof. Hall's genus Lepidechinus, on account of the decidedly imbricating character of its plates; but judging from the brief published description of the type of that group (which has not yet been figured), it would seem to belong even to a different family, or sub-family, as nothing is said in the description of that type in regard to a large central tubercle for the articulation of a larger spine, on each of the interambulacral plates, the surface being, on the contrary, merely described as crowded with "irregular granules." In addition to this Prof. Hall places his group as a sub-genus under Paloechinus, one of the distinguishing features of which is the presence of numerous small imperforate tubercles covering all the plates, without any larger central perforated tubercle.

It is worthy of note, however, that Prof. Hall has since figured and described another species (L. rarispinus, Twentieth Rep. Regents Univ. N. Y. on State [April,
EXPLANATION OF THE CUTS AND OF THE LITHOGRAPH.

Fig. 1. Beluga rhinodon Cope cranium, from above; from Upernavik.
Fig. 1a. Beluga rhinodon teeth.
Fig. 2. Beluga declivis Cope scapula.
Fig. 3. Beluga angustata Cope scapula.
Fig. 4. Balena callamach Chamisso; from north west coast; proportions approximate. (Capt. Scammon does not represent the recurved rictus figured by Chamisso.)
Fig. 5. Megaptera versabilis Cope; from California coast; drawn to a scale of ·25 inch to a foot. This and all the remaining cuts reduced to two-thirds of the proportions given.
Fig. 6. Megaptera versabilis, from below.
Fig. 7. Rhachianectes glaucus; from the Californian coast; scale ·25 inch to a foot.
Fig. 8. Rhachianectes glaucus Cope, from below.
Fig. 9. Balanoptera velifera Cope, approximate proportions; from coast of California.
Fig. 10. Balanoptera velifera, approximate proportions; from Queen Charlotte Sound, February, 1865.
Fig. 11. Sibbaldius sulfurcus Cope, approximate proportions; from California coast.
Fig. 12. Globicephalus scammonii Cope; coast of California; about ·5 inch to the foot.
Fig. 13. Same, from below.
Fig. 14. "Bottle-nose Grampus;" California coast; scale near ·5 inch to the foot.
Fig. 15. Orca rectipinnna Cope, male; approximate proportions; California coast.
Fig. 16. Orca rectipinnna Cope, female; same scale and locality.
Fig. 17. Orca ater Cope; Juan de Fuca Straits, 1868.
Plate I. Hyreraodon from the shore of Narragansett Bay, near Tiverton, Rhode Island; from photographs obtained by Samuel Powell, formerly Secretary of the Academy, at Newport, Rhode Island.
Cab. N. H.) in which some of the interambulacral plates are provided with a large central tubercle, while others apparently have none. We are not informed whether these larger tubercles are perforated at the end, as in Archocidaris and Eocidaris, or whether they are without such perforation, as in Paleochinus; but if it belongs to the same family as that including Paleochinus, of which Lepidechinus is supposed to be a sub-genus, it is almost certain that its tubercles are not perforated.

At any rate, our fossil differs from L. rarispinis in the following characters, that seem to be of more than specific importance. In the first place, it differs materially in the very irregular nature of its ambulacral pieces, which show a strong tendency to pass into, and in fact do, at some places, actually pass into two rows on each side of the mesial zigzag suture, instead of having clearly but a single row on each side, with each piece extending entirely across from the mesial suture to the lateral margins. Again, it differs in having a large central tubercle and spine on each one of all the plate of the entire interambulacral series. The lateral imbrication of the plates, in our type, is also different, the direction of the imbrication being inward, excepting in the two outer rows on each side, instead of outward in the whole series, the middle row being clearly lapped on each side, instead of lapping those on each side of it.

The strongly imbricating character, especially of the interambulacral plates in our type, is a very marked feature throughout; the lapping edges being sometimes at least one-fourth the entire breadth of these pieces, and yet, owing to the accuracy with which they are beveled, they lie so evenly together that this peculiarity is scarcely apparent where the plates have not been displaced. We are not aware whether this imbricating character of the plates has been observed in any of the European types on which the genera Eocidaris and Archocidaris were founded.* It is certainly more or less marked, however, in several of the American forms now before us that have been referred to the latter genus. For instance, it is clearly seen in the typical specimens of A. Agassizi, of Hall, and less distinctly in his A. Shumardi. We can also see indications of it in A. Worthyi, of Hall, though owing to the thinness of its plates, the beveling of their edges is less apparent. All these species have the peculiar ring or prominence around the base of the tubercles supporting the primary spines, seen in the true Archocidaris, and distinguishing it from Eocidaris. It seems therefore probable that this character may be more or less marked in both Archocidaris and Eocidaris, but most apparent in species which, like that we have here described, are provided with plates of more than the usual thickness.†

So far as we are aware no European species of Eocidaris showing the structure and arrangement of the ambulacral series of pieces has been discovered; at least we have seen no figures or descriptions of such. Prof. Hall, however, has described a species from the Chemung group of New York (Twenty-first Report Regent's Univ. p. 298), to which Vanuxem had given the name Echinus Drydenensis, but which is said to be an Eocidaris. In this the ambulacral plates are described as being in two ranges without any intercalated pieces, if we understand the description correctly.

From all that is therefore known in regard to the several types mentioned, we are much inclined to believe that our fossil will be found to belong either to a distinct subgenus under Eocidaris, or to an allied new genus. In either case we would propose for the group the name of Lepidocidaris.

Locality and position.—Lower beds of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 404 of Mr. Wachsmuth's collection.

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* Some of Prof. Desor's figures of the plates of Eocidaris appear to show indications of marginal beveling, while others do not.
† Since this was written we have been led to believe this imbricating character of the plates is more or less defined in all the Archocidaridae as well as in some of the older types, apparently not belonging to that family.
Palechinus gracilis, M. and W.

Body small, and apparently oval or subglobose. Interambulacral areas a little convex. Interambulacral plates in seven rows at the middle, but apparently only the marginal rows of pentagonal pieces are continued to the upper and lower extremities of the areas, the intermediate hexagonal pieces running out at various distances between the middle and the ends of the areas; thickness of each about half the breadth of the largest; all ornamented with closely set granules, of which 25 to 30 may be counted on each of the larger pieces. Ambulacral areas slightly convex, and equaling in breadth the first and second rows of interambulacral plates on each side; composed of very short pieces, which are a little thinner than the interambulacral plates, and about three times as wide as long, the widest part of every alternate one being at the outer end, which is received into a little sinus in the adjacent marginal interambulacral plate (there being generally three of these little sinuses to each of these plates), while the intermediate pieces usually wedge out rather abruptly before quite reaching the lateral margins; the two pores at the outer end of each piece arranged so as to form two zigzag undulating rows along the lateral margins of each ambulacral area; surface of the whole series occupied by granules of the same size as those of the interambulacral plates.

Entire dimensions unknown; greatest breadth of interambulacral areas 0.76 inch; do. of ambulae, 0.22 inch; number of ambulacral pieces in 0.10 inch, on each side of the mesial suture, ten.

This species will be readily distinguished from our P. Burlingtonensis by the proportionally greater breadth of the ambulae, and the smaller size, and greater number of its interambulacral pieces, there being seven rows of the latter pieces at the widest part of the area, at a point equaling the breadth of these areas in P. Burlingtonensis, where there are only four or five rows of these pieces. Again its ambulacral areas are equal in breadth to the first and second rows of interambulacral plates on each side, taken together; while those of P. Burlingtonensis are scarcely wider than the single marginal row on each side.

Locality and position.—Upper division of the Burlington group, Burlington Iowa. Lower Carboniferous. No. 407 of Mr. Wachsmuth's collection.

Note on the Genus ONYCHASTER, M. and W.

The borrowed specimens from which we made out the outline cuts and description of this type, published in the third volume of the Illinois Geological Report, p. 526, had been, to a great extent, denuded of their outer covering in cutting away the rather hard, firmly adhering matrix, before coming into our hands. Since preparing these cuts and descriptions we have had an opportunity to examine other specimens of this fossil, in part belonging to Mr. Wachsmuth's collection, and others among the collections at Springfield, all from the original locality. From these it is evident that, in well preserved examples of this type, the granular outer covering seen on the arms, or free rays of some of the specimens first examined, actually covers the dorsal side of the small body also. We likewise observe the presence of a layer of thin small imbricating scales under the scattering granules on the dorsal side of the body; while some specimens certainly show clearly such scales under the granules on the arms. The fact that this granular covering, and this layer of thin imbricating scales, overspread the dorsal side of the body, would certainly show that the appearance of a large central, dorsal opening, which we had marked as an "anal?" aperture, could not be such. The appearance of pores in some of the pieces around the central opening is also deceptive, and due rather to deep pits than to actual perforations passing through these pieces.

From the specimens we have since had an opportunity to examine, we are led to think it almost certain that the parts seen around the central opening
in the specimen illustrated by us are the oral and adjacent pieces accidently pushed upward, and seen from the upper or inner side after the removal of the dorsal side or covering; and that the central opening is the oral aperture. At any rate we know of no other way to account for the very different appearances presented by these fossils, when examined in different conditions.

Since we have had some specimens of this type at hand which we have felt at liberty to grind and cut into, so as to reveal more clearly their structure, we find that the arm-pieces, which in the denuded specimen first examined by us presented the appearance of becoming isolated, deeply furrowed lanceolate pieces, at a little distance from the body, and of very little thickness or depth, really appear, when ground off, to extend nearly all the way down from the dorsal to the ventral sides of the arms, and to be connected and articulated together, like those nearer the body by little processes and sockets; the comparatively thin furrowed dorsal edges becoming thicker farther in.

Sometimes these arm-pieces appear as if consisting of two rows joined in pairs at their inner ends along the middle of the dorsal side, there being a rather large pore (or possibly only a deep pit) at the junction of the two pieces forming each pair. In other instances, as seen detached, these pairs of pieces are found to be firmly ankylosed so as to form single pieces, extending across the whole breadth of the arms, without, however, obliterating the appearance of a rather large mesial dorsal pore.

We have not yet had an opportunity to see the under side of the body or arms in any of the Crawfordsville specimens, but Mr. Wachsmuth has a specimen from the Burlington division of the Lower Carboniferous beds of Burlington, which would seem to belong to this genus, though specifically distinct.*

This is the form Prof. Hail has described in some preliminary notices of fossils (issued at Albany, N. Y., in 1861), under the name Protaster? Barrisi. This fossil has, so far as we have been able to see, essentially the same structure, and shows along the under side of the arms a broad shallow depression in the arm-pieces, somewhat like an ambulacral furrow. None of the specimens of either species we have seen show any indications of any proper extended disc, the body being comparatively small. It also evidently differs in several points of structure from Protaster.

So far as its structure is yet known, it seems to be a true Ophiurian. We only know the species, Onyxaster flexibilis.

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Remarks on the BLASTOIDEA, with Descriptions of New Species.

BY F. B. MEEK AND A. H. WORTHEN,
Of the Illinois State Geological Survey.

In regard to the nature of the functions for the performance of which the openings in the summit of this group of fossils, as the specimens are usually found, were designed, authors do not entirely agree. The central opening has been most generally regarded as the mouth, and the others surrounding this (excepting one that is always larger than the others) as ovarian apertures; while the larger one is usually supposed to be the anal aperture, with, in some types, two of the supposed ovarian apertures opening into it, one on each side.†

*We have not yet, however, seen any of the little articulating knobs on the scales of this Burlington species. These impart the granular appearance to the surface of our typical species, in which each scale has one of these little knobs articulated in its middle.
† In the genus Pentacrinus, as specimens are usually found, there are five of these openings of the summit, surrounding a central pentagonal aperture. Of these five surrounding openings, four are known to be divided within into two each, and the fifth one into three, the middle one of these three being generally supposed to be the anal opening, 1869.]
Dr. F. Roemer, who in 1852 published a beautiful and valuable monograph of most of the species of this group then known, giving accurate illustrations of almost the entire anatomy of the genus Pentremites, including the arms or pinules, and other parts not previously illustrated, regarded the summit openings in that genus as stated above. He noticed, however, that in Nucocorinum (= Elwcrinus, Roemer) the central opening is covered in by a series of small plates, and that in Codaster, the openings corresponding to the so-called ovarian apertures of Pentremites seem to be absent.* At that time Dr. R. was apparently not aware of the fact that Owen and Shumard had, in 1850, announced that all of the summit openings in Pentremites Godoni are, in perfect specimens, covered by minute plates,† as had been shown by himself to be the case with the central opening in Nucocorinum, since he seems to have regarded this character as one of the distinctions between the latter genus and Pentremites.

Dr. Shumard has also shown that this character is not as rare as other true Pentremites, such as P. conoides, P. subellipticus,‡ etc., but that at least the central hiatus in several species of the genus Granatoecrinus (= Pentremites, section Elipitic, of Roemer), such as G. Sayi, G. melo and G. Norwoodii, is also known to be covered in the same way, in perfectly preserved specimens.

Dr. C. A. White, the present able State Geologist of Iowa, also announced, in a very interesting paper on the summit structure of the Blastoidae, published in 1863, that in well preserved specimens of Pentremites stelliformis the central and anal openings are both covered by small pieces. He likewise stated in the same paper that he had seen specimens of Granatoecrinus Norwoodii with the central hiatus covered by small pieces, and that from this covering a double series of minute alternating pieces could be seen extending out the mesial furrow of each pseudo-ambulacral area for some distance.[[1]]

We have also seen specimens of Pentremites stelliformis, Granatoecrinus melo, G. Norwoodii and G. Sayi (most of them belonging to Mr. Wachsmuth's collection), showing the central opening covered by small pieces, and continuing out from and the other two, one on each side of this, like those of other lateral openings, are most generally viewed as ovarian apertures. In some species of Granatoecrinus, however, the openings corresponding to the four in Pentremites, divided into two each within, actually appear at the surface as four pairs of distinct openings; while in other types, such as Nucocorinus, and some species apparently allied to Codaster (more properly Codonaster), the supposed ovarian apertures appear as five pairs of separate openings, all distinct from each other, as well as from the anal opening.

Thus, as first illustrated by Dr. Roemer, these so-called ovarian pores are known to connect with a series of compressed tubes within the cavity of the body, extending down along the inner side of each pseudo-ambulacrum so as to connect with the numerous minute pores passing through the lateral margins of these areas. Of these tubes we have ascertained that, in Granatoecrinus melo, G. Norwoodii, and a new species described in this paper (which are all of this genus in which we have seen them), there are two pairs to each pseudo-ambulacral area; while in Pentremites Godoni, P. performis and P. Rhetenorcriniti there seem to be eight tubes to each field, and in the so-called Pentremites stelliformis twelve to each field. We are therefore inclined to think the number of these tubes may be found constant, or nearly so, in each genus, since the area occupied by the twelve tubes in Pentremites stelliformis is not so wide as that occupied by eight in some Pentremites proper.

* We have not had an opportunity, recently, to examine good specimens of any of the typical forms of Codaster, but it has frequently occurred to us that possibly the deep linear furrows seen on the upper surface of these fossils, running parallel to the pseudo-ambulacra, and which Prof. McCoy and others seem to have supposed to be punctured at the inner ends, may connect, by these punctures, with the tubes within, and thus represent the so-called ovarian openings in the other Blastoids. The fact that these openings certainly are represented in Pentremites stelliformis of Owen and Shumard, by linear slits, seems to favor this conclusion. But as there is only a single one of these slits on each side of each of the pseudo-ambulacra in the last-mentioned type, instead of four to six, and they exist in the anal, as well as the inter-ambulacral areas, it is evident that these and other differences are of sufficient importance to warrant the separation of this species from Codaster, to which it has sometimes been referred. And as it differs from Pentremites, in having the so-called ovarian pores represented by ten distinct slit-like openings, and in other characters, we would propose to establish for its reception a new genus, with the name Codonastes.

‡ Memoirs, St. Louis Acad. Sci. vol i, p. 245, pl. 9, fig. 4, 1863.
these, a double series of minute alternating pieces a short distance along the mesial furrows of each pseudo-ambulacral area, as Dr. White mentions seeing in *Granatoecrinus Norwoodii*. These little pieces do not fill the linear furrows, however, but cover them over, so as to leave a small canal passing along under them, and under the little vault covering the central opening, in such a manner as to communicate through the latter with the visceral cavity within the body.

From all that is therefore now known, we think there is little room for doubting that at least the little central opening seen in these fossils, in the condition in which the specimens are usually found, is really, in perfect examples, always covered by small pieces in all the different genera. We also regard this little covering of minute pieces as corresponding to the ventral disc, or vault, of the typical Crinoids, this part being here reduced, as it were, to its minimum size by the closing in of the surrounding parts. Hence we incline to concur with Dr. White in the opinion that the pieces composing this disc, at least in *Nucleocrinus*, *Granatoecrinus* and *Pentremites stelliformis*, if not indeed in all the Blastoids, were not constructed or arranged for being opened and closed at will, to admit food into the mouth, whatever may have been the nature of those covering the other openings.†

In 1862 M. M. Dujardin and Hupé, who were not aware that any of the openings in the summits of these fossils, excepting the central one in *Nucleocrinus*, were ever covered by small pieces, expressed the opinion, in their valuable work on the *Echinodermata*, that the so-called ovarian apertures in the Blastoids are not such, but that they and the internal tubes with which they connect, along with the pseudo-ambulacral pores, constitute the respiratory apparatus of these animals, while the aperture usually regarded as the anal opening they consider the ovarian orifice. From the fact that they seem to believe that the typical palæozoic Crinoids were probably nourished by surface absorption, or through the agency of the column, rather than by food taken into a digestive apparatus through a mouth, we infer that they suppose the Blastoids had neither anal nor oral aperture.

In regard to the existence in the palæozoic Crinoids of a well developed digestive sack, however, analogous to that seen in the existing Crinoids, the discoveries made in this country certainly seem to leave little room for doubts, while it appears to us more in accordance with all that is now known in regard to the general anatomical structure, and the arrangement of the reproductive organs of the living types of the Crinoidea, to suppose that the opening usually regarded as the anus in the Blastoids was really such, or as Dr. White and Mr. Billings maintain, both mouth and vent, than that it was an ovarian aperture. The fact, too, that there certainly seems to have been no direct passage or communication whatever, so far as we have been able to see, between the interior of the internal tubes under the pseudo-ambulacra and the general visceral cavity, would also appear to be an objection to the conclusion that they and the external openings with which they connect were really respiratory organs.

* These minute pieces we believe extended all the way down the ambulacral furrows in some, if not all types of the *Hilatoidae*, and we even suspect that another series covered the little transverse furrows extending across to the bases of the pinnules, and possibly up the ambulacral furrows of the latter, as we have seen in the pinnule of *Helicocrinus Christyi*.

† In *Pentremites concinclus*, as figured by Dr. Shumard, the small pieces covering the central opening have, as suggested by him, in their regularity of form and arrangement, much the appearance of the pieces closing the so-called ovarian aperture of the *Cyphoderus*; from which it might be inferred that in this genus these pieces might possibly have been movable, so that they could have opened and closed, as valves. We doubt, however, very much that they could have formed so striking an apparent exception to the corresponding parts of other types of the group. We think it probable that small openings exist under this little group of plates, at the upper terminations of the ambulacral furrows. This seems the more probable because Dr. S. describes these little pieces as being very differently arranged in *Pentremites sulcatus*.

†† These are generally more properly folds of a thin calcareous plate, but in the so-called *Pentremites stelliformis*, and other types, each separate fold connects with the inner wall all the way down, excepting at the upper end, so as to form a distinct compressed tube.

1869.]*
Dr. White has made the ingenious suggestion (See Bost. Proceedings already cited, that these internal tubes and the openings and pores passing into them may have been for the purpose of drawing in water and injecting it into the pinnule, in order to elevate and move them at will, without the agency of a complex muscular system, apparently so inconsistent with the structure of a being so low in the scale of animal life. It is true the inelastic, rigid nature of these little calcareous tubes would seem to be an objection to this view, bu this objection would doubtless apply with equal force against the opinion that they were respiratory organs. Possibly, however, this apparent difficulty may have been obviated by the presence of thin membranaceous sacks within these tubes, susceptible of contraction and expansion to the extent of their internal cavities.

Our own observations, both of the typical Crinoids and of the Blastoids, have, as already stated, led us to believe that the series of small pieces, probably always originally covering the small central opening seen in imperfect specimens of the latter group, represents the vault, or ventral disc, of the typical Crinoids. We likewise agree with Dr. White and others who reject the opinion that any of the other openings in these fossils were ovarian apertures.

In all the types of the Blastoidia yet known, these little mesial furrows of the pseudo-ambulacra are distinctly seen leading to the central opening, precisely as the ambulacral furrows on the disc of Comatula lead to the mouth; and in the few types we have yet seen with this little central opening covered by minute vault pieces these furrows could be distinctly traced, as already stated, under the covering, into the central opening. Now, from the exact analogy of these furrows to those we have seen passing inward from the arm bases, under the small vault pieces covering the central opening in Cyathocrinus, and as distinct apparently tubular canals, made up of minute interlocking pieces, converging upward from the arm openings in Actinocrinus proboscidealis, to connect with the upper extremity of the convoluted digestive sack, nearly under the middle of the vault, we think the furrows alluded to in the Blastoids may be properly called ambulacral furrows.

In the true Pentremites, with wide lancet pieces, the numerous little transverse furrows seen passing outward from these mesial longitudinal furrows, and along the pore pieces to the bases of the slender pinnulae, are merely lateral branches of the central ambulacral furrow. In a specimen now before us, supposed to be Pentremites elegans, of Lyon and Casseday, the little pinnule, some of which are more than twice as long as the body, are each composed of a double series of alternately arranged pieces and provided with a distinct longitudinal furrow along the inner side, exactly corresponding to the ambulacral furrows in the arms and pinnulae of the typical Crinoids. It is therefore probable, as suggested by Dr. White, that these furrows, in at least a portion of the pinnule, were provided with receptacles for the ova as in the true Crinoids.

As widely different as the Blastoids appear to be from the typical Crinoids, it is easy to see that they really possess essentially the same elements of structure; though in several respects they seem to be more nearly allied to the types composing the section Cystoidea than to the typical Crinoids. In trying to trace out the relations of their several parts to those of the Crinoids proper, we have sometimes thought that the lancet pieces might be modified second radials, deeply inserted in the profound sinuses of the first radials. It seems nearly as probable, however, that they may belong to the vault series. In a conversation with Mr. Wachsmuth respecting the structure of these fossils, he

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* We have not seen positive evidence that the pseudo-ambulacral pores pass into the internal tubes, but we can scarcely doubt that they do.
† Currents of water, however, might have passed into them, by means of the action of cilia.
‡ We use the term "lancet pieces," instead of "lanceolate pieces," often applied to these parts, because they are by no means always lanceolate in form, but often linear, hence it would be an awkward expression to describe "the lanceolate pieces" as being "linear in form."

[April,
suggested an idea that had sometimes occurred to us, that probably the pore pieces of the pseudo-ambulacral areas correspond to the recumbent arms in the Cystoidea.* This certainly seems very probable, as it may be seen that the ranges of these pieces merely lap, as it were, down the sides upon the lancet pieces, and really form no part of the body, properly speaking. If this view is correct, each of the ranges of pore pieces of each pseudo-ambulacral area must, in the true Pentremites with wide lancet pieces, represent half an arm, the two halves being, as it were, split apart by the wide lancet pieces coming to the surface between. In Granatocrinus, Nucleorinus, and some other groups with merely linear lancet pieces, however, the two ranges of pore pieces meet along the mesial furrow of each pseudo-ambulacrum, and alternately interlock, just like the arm pieces in Actinocrinus, and other types in which the arms are composed of double rows of pieces. If these suggestions are correct, the little delicate free appendages often regarded as arms, would correspond to the pinnae, sometimes called tentacles in descriptions of fossil Crinoids proper, and Cystoids. The fact that these little appendages are themselves, at least in some types, composed each of a double series of minute pieces, would be no objection to this view, because this is exactly the structure of the pinnae in most of the Cystoidea with recumbent arms. The next question, then, would be in regard to supplementary pore pieces. These, if the so-called pore pieces† can be viewed as arm pieces, may be merely the first pieces of the pinnae modified to adapt them to the peculiar structure of the other parts.

Supplementary Note to the foregoing remarks.

A few days before receiving the proof-sheets of this paper from the printer, we were provided, through the politeness of Mr. Billings, with an advance copy of a very interesting and important paper of his on the Structure of the Crinoidea, Cystoidea and Blastoidea, to appear in the July number of the American Journal of Science and Arts. We cannot state here in detail the various points in which he agrees with or differs from us, but we will mention a few of the latter. In the first place, he does not concur in a suggestion made by us, in our paper read before the Academy in December, 1868, that certain facts seemed to indicate that in the paleozoic Crinoids the ambulacral canals might have been organized so that, in addition to their reproductive and other functions, they could have conveyed microscopic objects through the arm-openings, under the vault, to the digestive sack. He also thinks the convoluted internal organ and canals radiating from the summit of the same to the arm-openings, belong to the respiratory, and not to the digestive system.

With respect to the first suggestion, we would merely state that we are not disposed to insist upon it, as it was not stated by us as a demonstrated fact, but we rather intended to state facts that seemed to us to point to that conclusion. We were led to do so, in part, by the statements of Bronn, and Du-Jardin and Hupé, that the food of the recent Crinoids was probably conveyed along the ambulacral canals, by the action of cilia, to the mouth; and partly by the fact that in the paleozoic types, there seems to be no opening whatever in the vault, at the point to which the ambulacra converge, and where, from all analogy among recent Echinoderms, the mouth ought to be situated.

We are aware, however, that there are some strong and perhaps insuperable objections to such a conclusion. And yet, there seems to be others of nearly or quite as much weight, against the conclusion that the single opening seen in the vault of these older Crinoids, always performed the double function of mouth and vent. Amongst these may be mentioned the fact that this opening

*Since this was written we learn that Mr. Billings had arrived at the same conclusion in regard to the corresponding pieces in Cystoidea.
†The term pore pieces could not, of course, be applied to any of the pieces of the pseudo-ambulacra in the same sense that we would call the ambulacral pieces of an Echinoid pore pieces, because the pores in the Blastoidea do not pierce these little pieces as they do in the Echinoids, but merely pass in between them.

1869.]
is never situated at the point of convergence of the ambulacral canals, where the mouth ought to be, but more or less removed from it, so that if it performed both the offices of mouth and vent, it would be, as it were, the anal opening that did so, instead of the mouth, as in all of those cases among the existing Echinodermata with but one opening to perform both functions. In addition to this, we have, as we believe, demonstrative evidence that species of Platyceeras and Gonasteroidocrinus could, and did live, in some way, with the only opening (excepting the arm-openings) covered by a Platyceeras that grew there, and sometimes not only so as to cover the opening, but in the case of the Gonasteroidocrinus, so as to cover nearly the whole vault. That these shells did not merely grow upon dead Crinoids lying at the bottom of the sea, is evident from the fact that these Crinoids thus found in such numbers, with a Platyceeras attached, at Crawfordsville, always have the arms and most delicate pinnulae perfectly preserved; and in some other instances where the Platyceeras is attached to the top of the vault, the arms of the Crinoid are found folded over the shell, as they would naturally fold together by the contraction of the muscles at death. Had these Crinoids remained uncouved by sediment at the bottom of the sea long enough after death for the Platyceeras to grow upon them, their arms and pinnulae would have fallen to pieces. If the only opening in the vault of these Crinoids was the vent only, we could readily understand how the excrementitious matter might have escaped under the foot of the Platyceeras; but if it was both mouth and vent it is difficult to understand how, in such a case, food could have passed in.

Again, in many of the Actinocrinida, the only opening in the vault (except the arm-openings) is situated at the extremity of a long, slender, straight tube, rising from near the centre of the vault, though never from directly over the point of convergence of the ambulacral canals. And it is a remarkable fact, that of the hundreds of specimens we have seen with more or less of this tube preserved, we have never yet seen one that had its extremity unbroken. In several instances we have seen it from one to three inches in length, and so attenuated in the latter cases, that the internal cavity was not more than 0.05 inch in diameter, even in large specimens; and in others we have seen it scarcely more than one hundredth of an inch in diameter, and still the end of the tube in all cases broken. How small this canal must be at the end of an unbroken tube, we cannot say, but it must evidently be very small. If this little pore-like opening, situated at the extreme end of this long, straight, rigid tube, performed the functions of both mouth and vent, it would certainly seem to be a very unnatural and inconvenient structure.

In regard to the internal convoluted organ seen in so many of the Actinocridae belonging to the respiratory instead of the digestive system, we would remark that its large size seems to us a strong objection to such a conclusion. In many instances it so nearly fills the whole internal cavity that there would appear to be entirely inadequate space left for an organ like a digestive sack, outside of it, while the solutions within would preclude the presence of an independent digestive sack there. In addition to this, the entire absence, so far as we can ascertain, of any analogous, internal respiratory organ in the whole range of the recent Echinodermata, including the existing Crinoids, would appear to be against the conclusion that this is such, unless we adopt the conclusion of Dujardin and Hupé, that the Palæozoic Crinoids had no internal digestive organs, and were nourished by absorption over the whole surface. We should certainly think it far more probable that this spiral organ is the digestive sack, than a part of a respiratory apparatus.

**Genus GRANATOCRINUS, Troost.**

**Granatocrinus melonoides, M. and W.**

Body rather under medium size, globose in form. Base very small, nearly even with the prominent lower extremities of the pseudo-ambulacral areas.

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Radial pieces nearly equaling the entire length of the body, and divided almost to their base by the pseudo-ambulacral areas, each with a broad deep sulcus extending up on each side of the pseudo-ambulacral areas, the entire length; while between this sulcus and each lateral margin, the surface swells out into a broad rounded ridge, widest near the middle of the body and narrowing upward and downward, these ridges on each two contiguous pieces being separated by a deeply sulcated suture. Interradial and anal pieces very small, subtriangular or cuneate-quadrangular, only about one-sixth the length of the body, measuring over the curve of the sides. Pseudo ambulacral areas very narrow or sublinear, with sides parallel, equaling the entire length of the body, slightly impressed above, but quite as prominent as the immediate margins of the radial pieces on each side below, if not wider; pore pieces about fifty on each side of the mesial furrow; supplementary pore pieces unknown; lancet pieces apparently not exposed externally. Openings of the summit small, but not clearly seen in the specimen.

Body of the typical specimen 0.45 inch in height; breadth, 0.5 inch.

The surface of the typical specimen of this species is not well enough preserved to show fine markings, but another individual of apparently the same species shows the lower half of the radial pieces to be ornamented with rather fine granules, so arranged as to look like fine transverse striae under a magnifier, while a few stronger longitudinal striae are also seen on this part of the body. In this specimen, however, the surface of the radial pieces is less convex between their lateral margins and the broad sulcus on each side of the pseudo-ambulacra, than in the typical form.

In form and the narrowness of its pseudo-ambulacra this species reminds one of G. Sayi, of Shumard, but it is at once distinguished by the very much larger anal and interradial and shorter radial pieces of that species, as well as by the canaliculate character of the sutures between the latter, with a rounded ridge on each side of this suture. In the comparative size of its radial and interradial pieces, as well as in the canaliculated sutures between its radial pieces, it agrees more nearly with G. melo, of O. and S., but is not only distinguished from that species by its subglobose form (a little wider than long) and merely even instead of concave base, but by its much more prominent pseudo-ambulacral areas below the middle of the body, and deep broad rounded sulci immediately on each side of these, and swollen surface between these sulci and the canaliculated suture separating the radial pieces. It moreover comes from the upper division of the Burlington group, while the vastly more common G. melo is only found in the lower beds.

**Locality and position.**—Upper beds of Burlington group, Burlington Iowa. Lower Carboniferous. No. 398 of Mr. Wachsmuth's collection.

**Granatochinae pisum, M. and W.**

Body small, oval—subglobose, being slightly longer than wide. Base very small, rather deeply concave, and distinctly pentagonal in outline. Radial pieces long, truncato-subelliptical in general outline, with the lower end narrow, forming a nearly flat surface across between the pseudo-ambulacral fields, excepting below the middle, where these surfaces are concave; all divided nearly to their very bases by the pseudo-ambulacra, and without even the faintest trace of a furrow along up the sutures between their lateral margins. Interradial and anal pieces strongly incurved above, cuneate-subtrigonal in form and longer than wide, the length being about one fourth that of the whole body, measuring over the curve of the sides. Pseudo-ambulacra narrow, or sublinear, with very nearly parallel sides, there being a slight taper from above downward; all quite as convex as the slightly raised linear margins of the radial pieces on each side; pore pieces about twenty-six on each side of the distinct mesial furrow, along which their inner ends are minutely crenate, comparatively rather large, and ranging obliquely outward and downward; 1869.]
supplementary pore pieces unknown; lanceet pieces apparently not visible externally, unless it is along the bottom of the mesial furrow.

Summit, when the minute pieces that doubtless closed the central region are removed, with a pentagonal opening of about the size of the anal aperture; so-called ovarian pores very small, and situated one on each side of each interradial piece, and two others doubtless as usual opening into the anal aperture, which is nearly circular and much larger than the pores.

Surface finely granular, the granules being smaller and more crowded on a lanceolate area, extending up the radial pieces between the pseudo-ambulacra, and terminating just before reaching the interradials, and on each side, and above this space.

Height of body, 0-30 inch; breadth, 0-28 inch.

This little species might be mistaken for a small specimen of *G. melo*, by a hasty observer. It may be readily distinguished, however, by its longer interradial pieces, less numerous and proportionally larger pore pieces, much more prominent pseudo-ambulacra, and particularly by not having even a trace of a linear furrow along up the sutures separating the radial pieces, and these pieces flat instead of convex across between the pseudo-ambulacra. The little projecting points at the bases of its pseudo-ambulacra are also directed more downward.

**Locality and position.** Upper part of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 397 of Mr. Wachsmuth’s collection.

**Granatocrinus neglectus, M. and W.**

Body small, varying from oval to subglobose. Base slightly projecting, pentagonal in outline. Radial pieces scarcely equaling two-thirds the entire length, and deeply divided by the pseudo-ambulacral areas. Interradial pieces more than one-third the length of the body, cuneate-subtrigonal in form. Anal piece of about the same size as the interradials, but its upper extremity is erect and distinctly projecting, so as to form around the anal opening protuberant margins. Pseudo-ambulacral areas narrow, with nearly parallel sides, almost equaling the entire length of the body, nearly as prominent as the slightly raised margins of the radial pieces on each side; pore pieces twenty-five to thirty on each side of the mesial furrow; supplementary pore pieces unknown; lanceet pieces apparently not visible externally.

Mesial opening of the summit very small; so-called ovarian apertures minute and situated one on each side of the interradial pieces; anal opening comparatively large, with very prominent margins.

Surface of the radial plates between the pseudo-ambulacral areas longitudinally granulo-striate, while that of the interradial and anal pieces is marked in the same way transversely with a downward curvature.

Length of one of the oval specimens, 0-36 inch; breadth, about 0-28 inch; breadth of pseudo ambulacra 0-05 inch. Length of a smaller, proportionately shorter specimen, 0-28 inch; breadth, 0-25 inch.

This is another species having much the general appearance of *G. melo*, from which, however, it is at once distinguished by its comparatively much larger interradial and anal pieces, flat spaces between the pseudo-ambulacra, without any furrow along the mesial suture, and its more protuberant base and anal pieces.

It is more nearly allied, however, to the last described species in several of these characters, though sufficiently distinct to be readily separated on comparrison. For instance, its anal and interradial pieces are nearly twice as large in that species. Again, its base is proportionally two or three times as large, and so protuberant as to be seen in a side view, instead of being concave; while its pseudo-ambulacral areas do not extend so far down, and the little projections of the radial pieces at the lower extremities of these areas point out horizontally, instead of being directed nearly downward, like five little
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legs, upon which the body stands when placed an an even surface, as in the last.

We have seen five specimens, all of which agree in the characters given.

Locality and position.—Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 39 of Mr. Wachsmuth's collection.

Granatocrinus glaber, M. and W.

Body very small, pentagonal-subglobose, being somewhat wider than long and rather broadly truncated below, with the spaces between the rather prominent pseudo-ambulacral areas almost flat near the middle, and more or less concave below. Base about even with the most prominent part of the lower ends of the radial pieces, nearly flat, and very distinctly pentagonal, or almost pentapetalous in outline. Radial pieces forming about three-fourths the actual height of the body, abruptly incurved below to connect with the base, and all divided quite to the lower side of the body by the pseudo-ambulacral areas. Interradial pieces of moderate size, or about one-third as long as the body, measuring over the curve of the sides from their upper ends to the base; triangular in form and nearly as wide as long, all strongly incurved above; anal piece shorter than the interradials below the anal opening. Pseudo-ambulacral areas rather narrow, tapering slightly from above, and nearly as convex as the margins of the radials on each side. Pore pieces about twenty-five to thirty on each side of the mesial furrow of each area; supplementary pore pieces unknown; lancet pieces apparently not showing externally. Summit depressed in the middle; central and anal openings comparatively rather large; so-called ovarian pores of moderate size, situated one on each side of the inner end of each interradial piece, and of course two others as usual opening into the anal aperture.

Surface apparently quite smooth, even as seen under a magnifier, but probably when entirely unworn, marked by microscopic longitudinal striae.

Height of one of the largest specimens, 0·21 inch; breadth, 0·23 inch; breadth pseudo-ambulacral areas, 0·04 inch; do. of spaces between the same, at the widest part, 0·13 inch.

This little species is so very clearly distinct from all others known to us, that it is unnecessary to compare it with any of those yet described. Its most characteristic features are its small size, smooth surface, flat space between the pseudo-ambulacral areas, and nearly even pentapetalous base.

We have before us nine specimens, of various sizes, all agreeing in the characters given excepting one, which, from abnormal development, has only four pseudo-ambulacral areas. As this agrees with the others, however, exactly, in all its specific characters, it is evidently a monstrosity of the same species, produced by the non-development of one of the radial pieces, by which means two of the pseudo-ambulacral fields are, as it were, welded together, to form one larger than any of the other three.

Locality and position.—Saint Louis division of the Lower Carboniferous series, in Hardin County, Illinois.

May 4th.

Jos. Jeanes in the Chair.

Twenty-seven members present.

The following paper was presented for publication:

"A review of the species of Plethodontidae and Desmognathidae."

By E. D. Cope.

Mr. J. H. Redfield stated that on the 22d of April, in company with Mr. C. F. Parker, he had visited Cedar Bridge, Ocean Co., N. J., in search of Corema Conradii. This plant occurs in Newfoundland, on islands near Bath, Maine, 1869."
at Plymouth, Cape Cod, and near Islip, Long Island, and was first discovered at
Cedar Bridge by Prof. S. W. Conrad. This locality was visited by Dr. Torrey,
83—so that there was no difficulty in finding the precise points mentioned; but
Mr. R. was sorry that no trace of the plant could now be found there, and it
has doubtless been eradicated by animals or by unscrupulous collectors, or
has been otherwise unable to maintain its foothold in "the struggle for exis-
tence." The vicinity was also carefully examined, but without success. The
plant is said to have once existed near Pemberton Mills, N. J., but as that
neighborhood is now entirely under cultivation, there is no evidence that the
Corena Conradii now exists south of Long Island. If it is again to be dis-
covered in New Jersey, it will probably be in the wide sandy waste a few miles
west of Cedar Bridge, near the boundary between Burlington and Ocean coun-
ties, where a succession of elevated ancient ocean beaches offer conditions
similar to those of Cape Cod.

Prof. Cope exhibited bones and teeth of the large extinct Chinchilla of the
island of Anguilla, W. I., Amblyrhiza i n u n d a n a, and with them teeth of
a second and new species, which he called Loxomylus 1 o n g i d e n s. It was
also allied to the Chinchillas, and of large size. They were accompanied by
a shell implement of human manufacture, which was, so far as discovery in
an earthy matrix, and the color, etc., were evidence, of the same age as the
Rodents.

May 11th.

DR. RUSCHENBERGER, Vice-President, in the Chair.

Twenty-eight members present.
The following papers were presented for publication:
"Further notes on Microscopic Crystals." By Isaac Lea, L.L. D.
"Sexual Law in the Conifera." By Thos. Meehan.

May 18th.

DR. RUSCHENBERGER, Vice-President, in the Chair.

Twenty-five members present.
The following paper was presented for publication:
"An attempt to ascertain the average weight of the Brain in the
different races of Mankind." By Joseph Barnard Davis.

May 25th.

PROF. FRAZER in the Chair.

Twenty-seven members present.
The new By-Laws were called up for a third reading, and, on mo-
tion to that effect, were adopted as the laws governing the Academy.
The following deaths were announced:
Frederick Cailliaud, Herman von Meyer and George J. Durham.
The following gentlemen were elected members:
Rev. Dr. Wm. Rudder and Persifor Frazer, Jr. Wm. H. Dall,
of Washington, D. C., was elected a correspondent.
The Committee on paper entitled "An attempt to ascertain the
average weight of the Brain in different races of Mankind," by Jos. Barnard Davis, reported in favor of its publication in the Journal.

On favorable report of the Committees, the following papers were ordered to be published:

**A Review of the species of the PLETHODONTIDÆ and DESMOGNATHIDÆ.**

**BY E. D. COPE, A. M.**

Family PLETHODONTIDÆ.


No anterior axil bone; palatines not prolonged over parasphenoid; bearing teeth on the posterior portion. No postorbital arch.

Dentigerous plates on the parasphenoid.

Carpus and tarsus cartilaginous.

Vertebræ amphicoelian.

Occipital condyles sessile.

Prefrontals present, pterygoids wanting.

Prefrontals not prolonged or embracing frontals; parietals slightly embracing.

Orbitosphenoids separated by membrane from proötic.

Vestibule, inner wall osseous.

The preceding diagnosis includes the characters assigned to the family by the writer in 1866, excepting one, i.e. the presence of the premaxillary fontanel, which I find to be wanting in the genus Stereochila.

In the characters of the scapular and pelvic arches this family does not differ from the Amblystomidae and Salamandridæ. The foramen which separates the coracoid from the procoracoid is well marked and intermarginal; in the Amblystomida it is smaller, and in the Salamandridæ marginal. The femur always presents a strong trochanter; it is weak in Stereochila marginata. In Hemisalamandra and Diemyctylus it is quite weak, but in Salamandra, strong.

In most of the genera of this family the enamel does not cover the entire crown of the tooth. In Spelerpes rubra, longicauda and bellii, and Plethodon glutinosus and cinereus, the external part of the crown terminates in a transverse cutting edge, while the inner extremity is more prolonged, leaving a transverse depression between the two. In Sp. bellii, the inner apex is transverse and prolonged a little beyond the external, while in the other Spelerpes and the Plethodon glutinosus the inner crown is more prolonged and incurved conic. In P. erythronotus it is a little more obtuse. In Desmognathus and the Amblystomidae the two apices are of equal height, and are both transverse cutting edges, the outer narrowed in the former. In the larva of Plethodontidae that I have examined, the crowns are more simple. The teeth of Anaides are more like those of the Coecilia or of Hylonomus of the coal measures, and distinguish the genus from other Plethodontidae.*

This family is more remote in its skeletal characters from the Salamandridæ and Plenurodelidae, than is the Amblystomidae. Thus the absence of parasphenoid brushes, the ossification of the tarsus and carpus, and the persistence of the pterygoid bones are characters common to the two latter, and wanting in

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the present family. On the other hand, the non-prolongation posteriorly of the vomers, and the amphicodial vertebrae, belong to this family and the Ambly stomi dæ only. The position of the latter family is therefore between the Plethodontidae and the Salamandridæ. The Amblystemidæ and Plethodonti dæ may be thus compared with reference to the developmental character of the features which distinguish them.

**Amblystemidæ.**

Superior.

- Carpus and tarsus osseous.
- Premaxillary fontanelle closed.
- O. pterygoideum persistent.

Plethodontidæ.

Inferior.

- Carpus and tarsus cartilaginous.
- Premaxillary fontanelle open.
- Superior.
- O. pterygoideum obliterated.

The inferiority of some Plethodontidæ is seen in the non-distinction of the digits (Geotriton), the thinness of the ossification of the parietal membrane bones (Batrachocephs), and in Opheobatrachus l i n e o l u s m, from Vera Cruz, the persistence of the membranous cranium by the limitation of the parietal bones to two small lateral scales, and the wide divarication of the posterior extremities of the frontals.

Most characters of this family are those of low development, and approximations to the larval condition, except the loss of the pterygoid; two of the species exhibit a subocular cirrhus, which occurs in some of the Gymnophidia (Ucèllia) and Dactylethra among Anura. It is probably the persistence of that long subocular tentacle characteristic of the early larval stage of Salamandridæ and Pleurodelidæ (e. g., Salamandra Notophthalmus), and of a later larval stage of Dactylethra (vid. Wyman and Gray), where they resemble the appendages of the Siluridæ. They have been called crochets by Rusconi, and homologized with the cylindric cephalic processes of the larval Rana, with what correctness remains to be proven by observations on other types.

Eschscholtz correctly represents Batrachocephs a t t e n n a t u s as without prefrontals. An elongate process of the frontal occupies only part of its place, forming no suture with the maxillary; this is quite different from Desmognathus, where the orbit is completed by the union of frontal and maxillary. In Batrachocephs q u a d r i d i g i t a t u s the prefrontal occupies this depression as an elongate vertical scale.

In Spelerpes r u b r a the quadratum presents a small internal anterior ala, which has a superficial resemblance to a pterygoid. In this species there is apparently an azygus bone behind the premaxillaries; this is, however, only the exposed extremity of their united spines, which are nearly or quite isolated by the approximation of the anterior parts of the nasals. It does not occur in the Gymnophillus s a l m o n e u s.

The genera embraced in this family appear to be as follows:

**Section I.** The tongue attached from the central or posterior pedicle to the anterior margin in narrower or wider band. (Plethodontæ).

A. Two premaxillary bones.

- Digits 4—5; maxillary bone regular, with numerous small teeth; parietals fully ossified. .......................... Plethodon. ..........................

- Digits 4—4; maxillary as above, parietals fully ossified. .......................... Hemidactylium.

A.A. One premaxillary.


Maxillary edentulous posteriorly, decurved, forming a cutting edge; teeth few, large, knife-shaped; a premaxillary fontanelle. .......................... Anaides. ..........................
Section II. The tongue free all around, attached by its central pedicel only. (Spelerpes).

A. Two premaxillary bones (with fontanelle).

Digits 4—5, closely united by a broad palmar membrane. .......... Geotrion.

Digits 4—5, entirely free........................................... Gyrinophilus.

AA. One premaxillary bone (with fontanelle).


Digits free, parietal and palatine bones well ossified................. Manculus.

aa. Digits 4—5.

Digits little distinct; parietal cartilages not ossified; two patches on para-
sphenoid teeth...................................................... .......... Theobatrachus.

Digits entirely confounded as an undivided palm or sole; cranial bones
well ossified............................................................ Edipus.

Digits all free, cranial bones well ossified................................ Spelerpes.

The generic relationships of the above named groups are exceedingly sim-
ple, and the ease with which the animals can be analysed, renders the case clear
from the doubts which constantly arise in discussions of generic relationships
as to the probable omission of characters from the argument. Here it can be
safely asserted that, as far as the skeletons are concerned, there exist no
other generic distinctions than those given above. If now any principles can
be derived from consideration of the osseous system, that which of all others
presents us with by far the greatest number of minute modifications of struc-
ture, the same may be with considerable probability inferred for the other
systems.

The primary groups are distinguished by the different degrees of attach-
ment of the tongue. That form which is most attached, represents, and is
identical with, an immature stage of the species of Sect. second, where it is
more extensively free, as any one may satisfy himself by the examination of a
larva of Spelerpes at a certain period. The tongue will be found to be that
of Plethodon.

The secondary groups are distinguished by the separation or confluen-
to the premaxillary bones. Those presenting the latter type exhibit separate
premaxillaries during the early portion of larval life, though the union often
takes place very early. The number of digits distinguishes groups of genera
of less value; in some the hind limb has five digits, in others four. In an
early larval stage all possess but four digits, and in some of those with five
the inner consists of one phalange only, even at maturity, (Spelerpes bir ro p-
ter us, et aff.), not having as complete a series of larvae of Spelerpes and
Plethodon, as of Amblystoma punctatum, the development of the digits in the
latter will indicate the meaning of variations in the same at maturity. At a
length of 1·2 mm. the fore limb only is projected, and bears two digits only,
as in the genus Proteus. At 1·5 mm. sometimes the posterior limbs are de-
veloped, sometimes not; and from this size to 2·5 mm. the number of digits
bears little relation to the size of the animal, an additional digit sometimes
appearing earlier, sometimes later. Their numbers are then at first 2—0; then
always 3—0; with the hind foot divided, they are 3—2, and then 3—3. Some-
times the anterior digits are complete in number before the hind limb appears,
and we have combinations of numbers from 4—0 to 4—3, 4—4, and the full
number 4—5, which is found in all specimens of 2·5 mm. and upwards.

Genera which exhibit reduced digits are in all other respects Spelerpes (i. e.
Manculus) or Plethodon (Hemidactylium) or Hemidactylium with unossified
parietal bones and consolidated premaxillaries (Batrachocephal). Applying the
case of Amblystoma to these, we could not assert that Hemidactylum, for in-
stance, is identical with the undeveloped stage of Plethodon, since when Am-
blystoma exhibits digits 4—4, it is branchiiferous. But making the more
1869.]
legitimate comparison with Plethodon itself, I find that the complete number of posterior digits appears much later in life than in Amblystoma, that development in this regard is retarded, while in respect to the gills it is accelerated. Thus in Plethodon erythrornotus the exterior digit is longer than the interior; in specimens of 2-4 mm. the outer digit is the shorter; in those of 1-8 mm. which are without gills, it is a very minute tubercle on the outer metatarsus. In a little earlier stage it cannot but be wanting, though this I have not seen, and I have little doubt that it is then a Hemidactylium, unless indeed the parietal bones be not ossified.

Another foetal condition rendered permanent is seen in the generic character of the genus Oedipus, which differs from Spelerpes solely in the foetal non-separation of the digits. In the larva of Sp. rubra, the digits are early entirely distinct, so that so far as this species is concerned Oedipus presents an inexact parallelism, but they are also more distinct than in the mature Spelerpes bellii, where, as might be supposed, the foetal union is delayed to maturity in other respects, as in a specimen from Orizava, Mex., of 16-51, in length. Here the union is about as extensive as in Oedipus morio. In the young of Thorus pennatus the digits are not distinguished in specimens of 6-66, the full size, and otherwise entirely mature. In the adult they are distinct for half their length. The digits in the young larva of Gymnophius salmoneus are as distinct as in those of Spelerpes rubra; in one example I find the simple foot of earlier stages retained, resembling exactly that of Oedipus, excepting that there are emarginations for but three toes, instead of five. Genera which have no premaxillary fontanelle at maturity have it in the larval stage. Finally closely allied genera, which only differ in the degrees of ossification of the parietal and palatine bones, represent simply the relation between undeveloped and developed conditions of the same form.

The relations of the genera may be expressed as follows: Those of the first or Plethodontine section are related to those of the second or Spelerpine, by an inexact parallelism, excepting Anaides, whose peculiarities exclude it from the comparison. Those in each section differing in the union or separation of the premaxillary bones, are related in the same way to each other. The nearly allied genera in the Plethodontine group are Hemidactylium and Plethodon, and Batrachoseps and Stereochilus. In the first case we have only inexact parallelism, because while Plethodon has the four digits of Hemidactylium, its parietal bones are unossified, though an acceleration of development in this respect would render the relation one of exact parallelism. This is apparently the relation between Batrachoseps and Stereochilus, for with the foetal digits of the latter, the former preserves also its foetal cranium. It only remains to ascertain whether Stereochilus loses its branchiae before or after acquiring the normal number of digits. From the very small size of one at least of these, the former case seems probable, but I have not yet been able to prove it by direct observation. Should it be so, we would have a case of exact parallelism.

In the Spelerpine group the relation between Geotriton and Gymnophius is again one of inexact parallelism, since when the digits of the latter are only separated at the extremities, as in the former, the animal is still branchiiferous and possesses the larval tongue, etc. The same occurs in Spelerpes when certain of its species present but four hind toes as in Manculus; therefore the relation of these two is also of inexact parallelism. The relation of Ophiodontodes is, however, one of exact parallelism, for its characters are all found in some young Spelerpes at an immature age, subsequent to the absorption of the branchiae. With Oedipus, if the condition be not that of exact parallelism with some species of Spelerpes, the approach to it is close, as above observed. It is chiefly prevented by the fact that the ossification of the parietal bones in most species of the latter takes place after the extremities are fully developed. It is to be observed in this connection that, as has been above pointed out, the separation of the digits takes place at very different periods in the history of the different
species of the same genus. Thus in Spelerpes rubra they are entirely distinct at a very early period of larval life, while in S. cephalicus and S. bellii, which much more nearly resemble the species of OEdipus in the disposition of the vomerine teeth and cylindric form of the tail, this separation is much retarded.

These genera may be paralleled also in the following manner, in illustration of the law of heterology:*

<table>
<thead>
<tr>
<th>Plethodontae</th>
<th>Spelerpeæ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stereochila.</td>
<td></td>
</tr>
<tr>
<td>A.</td>
<td></td>
</tr>
<tr>
<td>One premaxillary.</td>
<td>No fontanelle.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anaides.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
</tr>
<tr>
<td>Toes 4—5.</td>
<td>Teeth large.</td>
</tr>
</tbody>
</table>

* * *

<table>
<thead>
<tr>
<th>Batrachoseps.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
</tr>
<tr>
<td>Two premaxillaries.</td>
<td>Toes 4—4.</td>
</tr>
</tbody>
</table>

* * *

<table>
<thead>
<tr>
<th>Hemidactylium.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plethodon.</td>
<td></td>
</tr>
<tr>
<td>Toes united.</td>
<td></td>
</tr>
</tbody>
</table>

* * *

The minor relations may be more readily expressed thus:

<table>
<thead>
<tr>
<th>Plethodontæ.</th>
<th>Spelerpeæ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plethodon.</td>
<td></td>
</tr>
<tr>
<td>Anaides.</td>
<td></td>
</tr>
<tr>
<td>A.</td>
<td></td>
</tr>
<tr>
<td>Digits 4—5.</td>
<td>Two premax.</td>
</tr>
</tbody>
</table>

* * *

<table>
<thead>
<tr>
<th>Batrachoseps.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Or thus:</td>
<td></td>
</tr>
<tr>
<td>Two premaxillaries.</td>
<td>Digits 4—4.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hemidactylium.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyrinophilus.</td>
<td></td>
</tr>
<tr>
<td>Plethodon.</td>
<td></td>
</tr>
<tr>
<td>Geotriton.</td>
<td></td>
</tr>
<tr>
<td>Oedipus.</td>
<td></td>
</tr>
</tbody>
</table>

The above genera present, within restricted limits, not only the relations which will be found to characterize genera elsewhere, but the relations between all natural groups of whatever rank, or in other words, between groups defined by structural peculiarities. From such simple cases we may derive the following rationale of classification with reference to characters above the specific:

*See origin of Genera, p. 53.

1869.

1
those characters are highest which cover the greatest number of cases, (i. e. of species.) Second, the extent covered by each of a given number of characters being equal or nearly so, that is highest which expresses modifications of those characters which distinguish the group which embraces them all, from other groups of similar high rank. Third, the lowest grade of characters, except the specific, i. e. those which distinguish nearest allies, are always those which are assumed latest in the life history of each. These rules are without significance if they do not point to a derivative hypothesis.

**BATRACHOSEPS Bonap.**


This genus embraces the forms which may be considered the lowest in the family, if Necturus be excluded. It differs from Hemidactylium nearly as Opheobatrachus does from Spelerpes, i. e., in the non-osification of the parietal bones. This low grade of development is here seen in the extremities also, which are much reduced, and the snake-like form of one of the species. The species are three, as follows:

I. Costal plice 18; the toes well developed, palmate.
   Outer posterior toe well developed; hind limb extending over 7-5 costal interspaces, fore limb to orbit; tail equal body and head to orbit, more slender than the body; belly yellowish................................................. B. pacificus.

II. Costal plice 20—1; toes very rudimental, little distinct.
   Hind limb extending over six costal interspaces; fore limb nearly to orbit; tail as long as body and head to orbit; width of head seven times from muzzle to groin; belly black................................. B. nigriventris.
   Hind limb extending over four costal interspaces; fore limb not to angle of mouth; tail thick as body, as long as body and head plus the length from muzzle to axilla; width of head eight times from muzzle to groin; belly brown.

**B. attenuatus.**

This small species resembles the first in general proportions, but is nearer the next in the rudimental condition of the limbs.

Muzzle shorter than orbit; upper lip slightly angulated. A groove from the orbit posteriorly; a gular fold. Costal grooves extending to vertebral line, but not curved forwards there as in H. scutatum; extending across abdomen. Body slightly compressed. The tail as stout as the body at the base, subquadrate in section, becoming compressed at the tip, strongly annulate, not swollen. Inner digits on both feet minute. Vomerine series well developed; sphenoidals as in the others.

<table>
<thead>
<tr>
<th>Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total length</td>
</tr>
<tr>
<td>Do., exclusive of tail from vent</td>
</tr>
<tr>
<td>Muzzle to axilla</td>
</tr>
<tr>
<td>Width head</td>
</tr>
<tr>
<td>Length fore limb</td>
</tr>
<tr>
<td>&quot; hind &quot;</td>
</tr>
</tbody>
</table>

Color above deep brown, separated abruptly from the black of the lower surfaces; tail black.

Two specimens of this species were brought to the Museum of Academy Natural Sciences from Ft. Tejon, California. One of these, Mus. Smithsonian, is No. 6734, 1 specimen, Ft. Tejon, Cal. 1865, Acad. Nat. Sciences. Geo. H. Horn, M. D.

**BATRACHOSEPS attenuatus Eschscholtz.**

Hemidactylium pacificum Cope.


**HEMIDACTYLIUM** Tschudi.


This genus is only distinguished from *Plethodon* by the deficiency of its hind foot in digits. Those that remain are quite rudimental. There is but one species known, and its habits are entirely terrestrial.

**HEMIDACTYLIUM scutatum** Schlegel.


**PLETHODON** Tschudi.


Tongue attached by the median line below, from the glossohyal bone to near the anterior margin; pterygoid teeth in two patches, more or less approximated; a large fontanelle between the spines of the separate premaxillary bones. Toes 4—5, normal. Anterior teeth not enlarged. Cranium well ossified. Two premaxillary bones, their spines embracing a fontanelle.

This genus is highly characteristic of the Regio Nearctica, where three species represent it on the Pacific slope, and two in the Eastern district. A species from Japan, named *P. persimilis* by Gray, is shown by Mivart not to belong to this genus. The species are all terrestrial in their habits, and three which I have observed (*P. oregonensis*, *P. glutinosus*, *P. erythronotus*) undergo their metamorphosis while quite small. The last named, and probably *P. glutinosus*, never enter the water, but are hatched in damp places on land. The branchia have therefore no functional service.

a. The pterygoid patches in contact throughout; vomerine series well separated medially.

Costal plicae 16 to 19; form slender, tail cylindrical, limbs weak, inner toes rudimental; vomerine series not extending beyond nares externally; belly brown marbled; above plumbeous or with a red longitudinal band.

P. erythronotus.

Costal plicae 13; form slender, tail well compressed; limbs weak, inner toes rudimental; vomerine series not extending outside of nares; belly brown marbled; above with a red dorsal band. P. intermedius.

Costal plicae 14; form stout, tail rounded; limbs short, stout; inner digits distinct; vomerine series extending outside of inner nares; black, usually with gray lateral blotches and smaller dorsal spots. P. glutinosus.

αα. The pterygoid patches well separated, vomerine series closely approximated medially.

* Mivart calls it Pectoglossa, but gives no character by which it can be separated from *Amblystoma*.

1869.]
Costal pleœa 13; form stout, head large, wide; lower jaw wider than upper; muzzle broadly truncate; tail slender subcylindrical; black, limbs, belly, and spots of back, orange........................................P. croceater.

Costal pleœa 10—11; form stout, head wide, maxillaries wider than mandible; muzzle narrowly truncate; tail slender, subcylindrical; light brown above; limbs and below yellow...................... P. oregonensis.

PLETHODON ERYTHRONOTUS Green.

Var. a. cinereus.
Sal. c. (Sept. 1818) Green, J. A. N. S. i. 356.

Var. b. erythronotus.

PLETHODON,GLUTINOSUS Green.


Sal. cylindraca, (Nov. 1825) Harl., J. A. N. S. v. 156.


P. g. (1838) Tschudi, Class. der Bat.
Whole eastern district R. nearctica.

PLETHODON OREGONENSIS Girard.


Oregon, California.

PLETHODON CROCEATER Cope.
Lower California.

STEREOCHILUS Cope.

Char. Tongue attached along the median line to the anterior margin. Pterygoid teeth in two elongate patches. Toes 4—5. Premaxillary bones confluent, with a simple spine, without fontanelle.

This genus is represented by but one species of the Eastern district of the Nearctic region. It is evidently of aquatic habits and is of larva-like proportions and appearance, but has the cranium fully developed, and in some respects more solidly than its allies. In the only skeleton I have examined, the prefrontal is present on one side and wanting on the other. The premaxillary bone is like that of Desmognathus, while the tongue is slightly freer than in Plethodon. The species exhibits weak extremities. It is from S. E. Georgia, and is quite rare.
Costal plice 17; elongate, head narrow, width more than seven times to
groin, more than twice to axilla; no canthus rostralis; tail compressed from
base, finned; small; pale yellow, brown lined.............S. marginatum.

**Sterechilus marginatum** Hallowell.

**Pseudotriton marginatus** Hallowell, Proceedings Ac. Nat. Sci. Phila. 1856, 
p. 130.

**Manculus** Cope.

Tongue free all round, boletoid. Toes 4—4. Parietal bones ossified, and
without fontanelle. Premaxillaries co-ossified.

This genus only differs from Spelerpes in the absence of a digit from the
hind foot, standing thus in the same relation to it that Hemidactylium does to
Plethodon. Its only species was formerly referred to Batrachoseps, but besides
the great difference in the tongue, the latter has a parietal fontanelle and lacks
the prefrontal bone. The latter point is indicated by Eschscholtz in his Atlas.
In the present genus that bone is present:

But one species is as yet known, which has a limited distribution. It is the
smallest North American Salamander.

**Manculus quadridigitatus** Holbrook.

Salamandra quadridigitata Holbrook, N. Amer. Herpetology, 2d ed. v, 65,

South East Georgia.

**Opheobatrachus** Gray.

Edipina Keferstein, Archiv. fur Naturgeschichte, 1863, 299.

This genus differs from Spelerpes in the larval character of the cranium;
its diagnosis is as follows:

Tongue free all round, boletoid. Digits 4—5, very short, distinct. Spheno-
didal series of teeth not united. Cranium membranous above, parietal bones
separated, scale-like. Internal nares enclosed except at the external fissure.

Gray gives the generic name to the O. vermicularis, on account of its re-
markable vermiform shape. This is, however, among animals with reduced
limbs, always a more or less variable character, and when constant in a species
is certainly not of higher value. The relative elongation of the body and tail
is a marked specific character in Amblystoma, Plethodon and Spelerpes, and
in many Lacertilian genera, e.g. Gerrhonotus. It distinguishes species other-
wise nearly identical, and in some cases, as in G. multicularis, mere
varieties of the same species.

The species of this genus are very similar to those of Spelerpes in all respects;
the difference is not quite the same as that between Batrachoseps and Hem-
dactylium. They are weak and of small size. The type species are distin-
guished by elongate tails. None are known outside of the Mexican zoological
district, in the broad sense.

The generic characters were first indicated by the writer in the Journ. A. N.

Costal plice fourteen..........................O. lineolus.
Costal plica nineteen..........................O. vermicularis.

**Opheobatrachus lineolus** Cope,


Char. Fourteen costal plice; vomerine teeth in long series, extending behind
internal nares; tail twice as long as head and body, cylindric. Three median
toes, subequal.

Though the carpus and tarsus in this species are cartilaginous, the repre-
1869.]
sentatives of the bones present in the osseous types (Amblystoma and others) are developed as they are in many other species of this family. The phalanges are 1—2—2—2—1 on the feet. The metatarsals are not fully ossified medi ally.

From Eastern Mexico.

Ophogasteria vermicularis Gray.


I had formerly supposed this species to be the same as the preceding, till I read Dr. Keferstein's description, where the specific characters are for the first time pointed out.

Guatemala, Costa Rica.

Geotriton Gené.


Tongue attached by the glossophyal pedicel only. Two premaxillary bones, which embrace a fontanelle; parietals ossified, palatines well developed. Digits 4—5, united, extensively connected by membrane.

But one species of this genus is known, which is interesting as being the only species of the Plethodontide which occurs in Europe. Its characters are quite identical with the Edipus of the warmer parts of America, except in respect to the distinction of the two premaxillary bones, which are consolidated in Edipus. Until I determined the existence of this character, I regarded the latter name as a synonyme of Geotriton.

a. Two phalanges, free.

Costal plicae ten; head wide, width less than five times to groin; parasphenoid patches widely separated from vomerine teeth; pale brown above.

G. fusca.

Geotriton fusca Gesner.


Sardinia.

Edipus Gray


This genus is remarkably characterized by the structure of its feet, in which the digits, though possessed of the usual number of phalanges, are not ossified until and are not distinguished by the external division of the integuments. This, as is well known, is the condition of the extremities in one of the early stages of digit-bearing vertebrates, and in their number and proportions resemble especially fetal mammalia and Batrachia, at different periods of embryonic and larval life.

The species are found from Northern Mexico to the mountains of New Grenada.

a. One phalange free.

Body rather stout, head width a little more than five times in length to groin; thirteen costal folds; parasphenoid teeth approximating the vomerines; black, below paler with whitish specks

Edipus morio

aa. No phalanges free.

Body elongate, width of head more than six times in length to groin; costal plicae thirteen; parasphenoid teeth in contact, and much produced anteriorly;

[May
black below, dorsal region yellow to orbits, with black spots; sometimes forming a median band...........................................O. carbonarius.

"Body short, stout; plice?; head width more than one-sixth length to groin; black, with pale specks, which may form series or not" (Peters).

Body short, stout; twelve costal plice; vomerine series commencing within inner nares; width of head less than five times in length to groin; black above; brown, white speckled below..............................O. adspersus.

ŒDIPS morio Cope.


This species is near the G. carbonarius, and differs almost entirely in its free terminal phalanges, shorter body, and in coloration.

The muzzle is slightly truncate and the head flat, and not so wide as in G. fuscus; its width enters the length to the groin 5.33 times, indicating a shorter body than in O. carbonarius. The plice of the sides are, however, equal in number and well marked. Similar folds mark the sides of the tail. Those behind the eye are similar to those of G. fuscus, but less marked. The vomerine series are well arched, and nearly meet medially; they are nearly approached by the prolonged point of the parasphenoid patches, which together form a triangle, with the (posterior) basal angles rounded. The patches are separated by a groove for only about half their length. The distances between inner and outer nares are the same. The end of the muzzle projects beyond the mandible.

The limbs appressed leave two intercostal intervals between them. The inner toe is not free on either foot; one phalange of the others is free, except the median, where 1/2 phalanges project. The free termination has a rounded thickening below.

Tail thickened, round, tapering.

Color. Black above; leaden black below; the under surfaces and lower parts of sides, with outer faces of limbs, speckled with indistinct whitish dots.

Measurements. No.

<table>
<thead>
<tr>
<th>Description</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (axial) from end muzzle to orbit</td>
<td>1.05</td>
</tr>
<tr>
<td>&quot; &quot; &quot; cannus oris</td>
<td>0.22</td>
</tr>
<tr>
<td>&quot; &quot; &quot; axilla</td>
<td>0.63</td>
</tr>
<tr>
<td>&quot; &quot; &quot; groin</td>
<td>1.66</td>
</tr>
<tr>
<td>&quot; &quot; &quot; end vent</td>
<td>1.94</td>
</tr>
<tr>
<td>&quot; &quot; &quot; end tail</td>
<td>3.29</td>
</tr>
<tr>
<td>&quot; fore limb</td>
<td>0.45</td>
</tr>
<tr>
<td>&quot; &quot; foot</td>
<td>1.145</td>
</tr>
<tr>
<td>&quot; hind limb</td>
<td>0.45</td>
</tr>
<tr>
<td>&quot; &quot; foot</td>
<td>0.17</td>
</tr>
<tr>
<td>Width &quot; (sole)</td>
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</tr>
<tr>
<td>&quot; head</td>
<td>0.28</td>
</tr>
<tr>
<td>&quot; body</td>
<td>0.28</td>
</tr>
<tr>
<td>&quot; sacrum</td>
<td>0.22</td>
</tr>
</tbody>
</table>

The only specimen I have seen is the following:

No. 6888, 1 specimen, Mountains of Guatemala, Dr. Van Patten.

ŒDIPS CARBONARIUS Cope.


? "ŒDIPS platydactylus" Tschudi, Classif. der Batrachier, p. 93, 1838, not described.

Bolitoglossa Mexicana Dumeril, Erp. Gen. vol. ix, p. 93, 1854 (specimens from Vera Paz) pl. 105, fig. 1.

1869.]
EDEPUS ADBSPERUS Peters.


Habitat. Near Bogota, New Grenada.

Interesting as the most southern of the American salamanders.

EDEPUS REFUSCENS Cope.

Sp. not.

This species is near the G. carbonarius, but is notably more abbreviated, and has a different coloration. The vomerine series is shorter, and there is a lateral plica less.

Muzzle truncate with prominent subnarial projections; its length 1-5 line, the width between anterior canthus of eyes. Appressed limbs, separated by two and a half costal spaces. Plice eleven, with a twelfth indistinct axillary fold. Width of head 5-4 in length to groin. Tail short, thickened, cylindric, equal from end vent to shoulder.

The vomerine do not extend outside of the inner nares, and nearly meet. The parasphenoids are as in other species, in two approximate patches, narrowing in front and but little divided behind.

Color. Sides and above black, the back and top of head with a rufous cast. Under surfaces brown, white specked.

Length to axilla .......................................................... 39
" groin .............................................................. 1-04
" cud tail ............................................................ 32
" fore limb .......................................................... 26
" hind .............................. ............................... 26

From Vera Cruz, Mexico.

No. 6886, 1 specimen, Orizava, Mexico, F. Sumichrast.

The Edepus variagatus Gray, Catal. Brit. Mus. p. 48, may belong to this genus, or even to one of the species here described—as the present one. It is described in the following language: "Yellow brown, with three irregular slightly inoculatory dorsal streaks." Gray.

SPELERPES, Rafinesque.


The tongue free, except at the glossobyal support. Palatine and paretial bones fully ossified; premaxillaries consolidated, and their spines embracing a fontanelle. Teeth small; toes 4—5. Pterygoid patches distinct from each other.

This is a natural genus, and is abundantly represented by individuals in the eastern district of the Nearctic Region, and the Mexican of the Neotropical. Its digital characters only distinguish it from Manculus, and some of the Mexican species approach that genus in the great reduction of the inner digit, which results from a diminution in the number of phalanges. The consolidation of the premaxillaries, a marked character, appears very early in the developmental history of such of the species as I have been able to study (S. ruber, S. bilineatus). The Mexican species pass their metamorphoses soonest, then such as S. bilineatus, and the S. ruber remains longest a larva.

I. Vomerine teeth not continued back to pterygoid patches; extended outwardly beyond nares.

a. Costal fold 11—12, tail cylindric, inner toes rudimental.

Plicae 12; extremities of inner toes free, others short, thick, subequal; a canthus rostralis, muzzle truncate, vomerine series in contact; lead colored, usually with two dorsal series of red spots; largest .................. S. belli ii.

[May,
Plice 12; inner toe and joint distinct, other toes well developed, cylindric; width head 5 to 6 times head to axilla, 2-5 to 3 times to groin; tail generally more elongate; black, sides, tail, and often back, grey varied; larger.

S. leprosus.

Plice 11; inner toe not distinct, other toes very short, margined; width of head 4-2-5 to axilla, 1-3 to groin; tail short; black, unspotted; medium.

S. cephalicus.

II. Vomerine teeth not continued posteriorly to the pterygoid patches, nor exteriorly to beyond the nares.

a. Tail round, costal grooves 11—12, inner toes rudimental.

Plice 11 (without inguinal); width of head 4-5 length to axilla, 2-5-6 times in length to groin; tail rather short; upper lip more or less truncate and angulate............. ............. ............. S. chiropterus.

aa. Tail subround, costal grooves 21, inner toes minute.

Width of head near 1-7 length to axilla, 33 of length to groin; limbs short; tail thick at base; brown, dorsal region darker; small.

S. multiplicatus.

aaa. Tail compressed, costal grooves 13—14, inner toes longer.

Plice usually 14; width of head less than one-sixth to groin; head to axilla well over 33 of the same; body longer, tail not keeled above proximally, comparatively short, vomerine series turned obliquely backwards. Yellow, with two latero-dorsal black lines; tail dark laterally; belly immaculate; small.................... S. bilineatus.

Plice 13; width of head equal one-sixth length to groin; muzzle to axilla more than one-third the same; tail long, keeled above. Yellow, sides many black spotted, a median dorsal series of spots; tail yellow, black barred; belly immaculate; large............................ S. longicaudus.

Plice 13; width of head greater than one-sixth length to groin; from muzzle to axilla considerably more than 33 length to groin; tail long, keeled above. Yellow, with three black bands; tail black, yellow barred; belly mottled; large............................ S. guttolineatus.

III. Vomerine series of teeth continuous posteriorly, with the pterygoid brushes, and originating behind nares.

Costal plice 15—16; head wide, not more than seven times to groin, not more than twice to axilla; no canthus rostralis; tail rounded at base; not finned; large; vermilion red, black or brown spotted............. S. ruber.

Spelerpes bellii Gray.


North Eastern Mexico.

Spelerpes leprosus Cope.

Species nova.

This salamander is one of the numerous additions made to herpetology by Sumichrast's explorations in the mountains of Eastern Mexico. Of the seven species of Urodèles which he found in that region, this appears to be the third in size; it approaches in this respect, and in some degree in coloration, the Plethodon gutinoius.

The form is stout, the head broad with short muzzle, and the tail cylindric and glandular; it is not unfrequently swollen at the base. In the largest specimens, selected as the stoutest, the length of the head from the postorbital line is only 3-5 the width at the same point. The fore limb extended reaches to the posterior margin, or to the middle of the orbit, for in extreme speci-1869.]
mens there is a difference in the degree of elongation of the body to the following amount: In the stouter, the length to axilla enters $2\frac{3}{4}$ to groin; in the more slender 2; in the former the width of head goes 5 times in length to groin; in the latter 6:25 times. There is no axillary costal fold; the inguinal is not marked; the plece do not extend on the back (where there is a faint median groove), but are distinct on the belly; tail annulate. The feet are very wide and the toes short, but not so much so as in *S. cephalicus*. The inner digit is developed on both feet, though short, especially the posterior; the outer is also larger than in the species just named. The toes are thickened at the extremities. The hind limb extends over 6:5 intercostal spaces from groin. The gular fold is well marked, while the longitudinal post-orbital groove is not or scarcely visible. The upper lip is slightly truncate, and with small subnareal angles.

The color is black as a ground, less obscured below, where it, however, varies to brown. The gular region splotted or speckled with gray.

The sides of the body with the tail are splotched lichen-like with light gray, the same sometimes covering the dorsal region. In one specimen there is a pale red dorsal band. Head black.

**Measurements.**

<table>
<thead>
<tr>
<th>No. 6340, Type.</th>
<th>Inches.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length from snout to gape</td>
<td>1.18</td>
</tr>
<tr>
<td>&quot; &quot; axilla</td>
<td>0.59</td>
</tr>
<tr>
<td>&quot; &quot; groin</td>
<td>1.75</td>
</tr>
<tr>
<td>&quot; &quot; end vent</td>
<td>2</td>
</tr>
<tr>
<td>&quot; &quot; &quot; tail</td>
<td>3.5</td>
</tr>
<tr>
<td>&quot; forelimb</td>
<td>0.42</td>
</tr>
<tr>
<td>&quot; &quot; foot</td>
<td>0.12</td>
</tr>
<tr>
<td>&quot; hind limb</td>
<td>0.433</td>
</tr>
<tr>
<td>&quot; &quot; foot</td>
<td>0.16</td>
</tr>
<tr>
<td>Width head</td>
<td>0.3</td>
</tr>
<tr>
<td>&quot; body at sacrum</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Like other Mexican *Spelerpes* this animal seems to pass its metamorphoses early; a young one sent with the adults measures 21 lines in length. The largest specimen measures 4:4 inches.

This species, according to Sumichrast, is confined to the Alpine region, in Vera Cruz, Mexico. In life, the light tints are of a pale yellow.

No. 6340, 6 specimens, Orizava, Mexico, Pr. Fr. Sumichrast.

**Spelerpes cephalicus** Cope.


N. E. Mexico.

**Spelerpes chiropterus** Cope.


N. E. Mexico.

**Spelerpes multiplicatus** Cope.

Species nova.

This small species resembles in general proportions *Hemidactylium scutatum*. It is well characterized in this genus by its numerous costal plece, and thickened, scarcely compressed tail.

The width of the head enters the length to the groin 6:75 times; the length to axilla enters thrice. The hind limb extended passes six intervals from the groin; the foot is wide, and the toes short, especially the inner and outer; the inner has but one minute joint free. The same may be said of the anterior digits. The tail is compressed a little, and considerably thickened; in [May,
the smallest specimen the terminal .75 above and .33 below are keeled; in others the superior keel is more distal.

Upper lip moderately truncate, with infra-nareal angles, and in one, rudimen-
tal cirri. The muzzle is rather thick and short, the head flat; in one smaller specimen the former is a little longer than in the others, and the width of the head relatively less. The vomerine teeth form short series, each rather suddenly bent backwards; the pterygoids two narrow patches, not approaching the vomerines, the relations in this respect being as in S. bilinea-
tus.

The color in four specimens is an unsotted brown, the inferior surfaces paler, especially the pular region. In the smaller specimen above mentioned, which seems to constitute a variety, the brown color forms a broad dorsal band, with dark points; the sides are of a pinkish gray, and the under sur-
faces light yellow.

Measurements of the largest specimen, on the axis of the body:

<table>
<thead>
<tr>
<th>Part</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length from muzzle to orbit</td>
<td>.05</td>
</tr>
<tr>
<td>axilla</td>
<td>.12</td>
</tr>
<tr>
<td>groin</td>
<td>.425</td>
</tr>
<tr>
<td>end of tail</td>
<td>.3-24</td>
</tr>
<tr>
<td>of fore limb</td>
<td>2-33</td>
</tr>
<tr>
<td>foot</td>
<td>.08</td>
</tr>
<tr>
<td>hind limb</td>
<td>.29</td>
</tr>
<tr>
<td>foot</td>
<td>.133</td>
</tr>
<tr>
<td>Width head at anterior angle orbits</td>
<td>.1</td>
</tr>
<tr>
<td>rictus</td>
<td>.22</td>
</tr>
<tr>
<td>body at sacrum</td>
<td>.15</td>
</tr>
</tbody>
</table>

The form of this species would indicate it to be terrestrial in its habits.

Of its geographical range we have as yet little information.

No. 4038, 5 specimens, Red River, Arkansas, Dr. L. A. Edwards.

**Spelerpes bilineatus** Green.


_Habitat._—From Maine to Wisconsin, to Florida and Louisiana.

**Spelerpes longicaudus** Green.

_Sal. I. (Sept. 1818)_ Green, J. A. N. S. i, 351; (1838) Hol. Herp. 1st ed. iii, 111, pl. 26; (1842) 2d ed. v, 61, pl. 19; (1842) Dekay, N. Y. Rept. 78, pl. 17, fig. 41.

*Spelerpes lucifuga* (1832) Raf., Atlantic Journal, No. 1, p. 22.

*Cylindrostoma longicauda* (1838) Tsch., Class. der Bat.

*Spelerpes longicauda* Baird, J. A. N. S. (2) i, 287; Hallowell 1. c., 345; Gray 1. c., 43.

_Habitat._—Same as the last species.

**Spelerpes guttolineatus** Holbrook.


_Habitat._—South Carolina, Georgia. Alabama.

**Spelerpes ruber** Daudin.

_Sal. rubra* (1803) Daud., Hist. Rept. viii, 227, pl. 97, f. 2; (1842) Holb Herp. 2d ed. v, 35, pl. 9; (1842) Dekay, N. Y. Rept. 80, pl. 17, f. 43.

1869.]
Sal. rubriventris (Sept. 1818) Green, J. A. N. S. i, 353 (ad. living).
Sal. maculata (Sept. 1818) Green, J. A. N. S. i, 350 (bleached in spirits).
Sal. subfuscus (Sept. 1818) Green, J. A. N. S. i, 351 (ad. in spirits?)
Pseudotriton subfuscus (1838) Tsch., Class. Mycetoglossa ruber Bibron fide Bon. Fauna Italica.
Siren operculata (1796) Pal de Beauv. Am. Phil. Trans. iv, 279, pl. —, f. 3 (larva).

Proteus neocanariensis (Sept. 1818) Green, J. A. N. S. i, 358 (larva bleached in spirits).
Pseudotriton ruber Baird, Journ. A. N. Sci. Phil. i, 286; Hallowell l. c., 347.
Spelerpes ruber Gray, Cat. B. M. 1850, 45.

There are several varieties of this species, which, though quite distinct, pass into each other:

Var. P. r. stricticeps Baird, S. Carolina.
Var. P. r. flavissimus Hallowell; Pseudotriton flavissimus Hallowell, Proceed. A. N. Sci. Phil. 1850, 139, Georgia.
Var. P. r. montanus Baird; Pseudotriton montanus Baird, Journ. A. N. S. i, 287—293; Gray l. c., 46. The Allegheny Mountain region from Pennsylvania to S. Carolina.

Habitat.—The Spelerpes r u b e r is distributed over the Eastern district of North America from Maine to Minnesota, and to Texas and Florida.

GYRINOPHILUS Cope.

Tongue supported only by the glossohyal pedicel, boletoid; cranium fully ossified, the premaxillary bones remaining distinct, and embracing a fontanelle. Digits entirely distinct, 4—5.

This genus is now first distinguished from Spelerpes, on account of the marked peculiarity of the premaxillary bone, in which it resembles Plectodon rather than the first named. But one species is as yet known. It has a superficial resemblance to the Spelerpes r u b e r, but differs in several osteological peculiarities. Its nasal bones are well separated, and the prootic squamosal crests are peculiar. The anterior or prootic crest is short, distinct and curved inwards and backwards; that on the proximal extremity of the squamosal curves towards it, but leaves a considerable interspace. This is occupied by two osseous processes like two teeth of a comb. In S. r u b e r the anterior crest only is present, and forms a rectangle, the anterior limb being transverse, and the angle inwards. The nasal bones also are in contact across the premaxillary spines.

The type of the genus remains for a more than usually long period in the larval condition, and just before its metamorphosis is quite identical in its osteological characters with the genus Necturus.

Costal plicae 1; head wide, width less than seven times to groin, not over twice to axilla; a strong canthus rostralis; tail rounded at the base, not lined; large; uniform purple-gray above........................G. p o r p h y r i t i c u s.

GYRINOPHILUS Porphyriticus Green.
Salamandra porphyritecta Green, Cont. Mac. Lyc 1827, vol. i, pl. 1, fig. 2.


There can be little doubt that, as Baird has suggested, this is the Salamandra porphyritecta of Green. The angulation and pale color of the canthus rostral is described accurately, as well as the color. The large larva, four inches long, is only referable to this species. The Amblystoma m i c r o s t o m u m, which Holbrook and Hallowell have imagined to be Green's species,
is not indicated by Green’s description. It is not so large, has not the canthus rostralis, the larva is very small, and the coloration is quite different. Green’s figure represents it well, though the Amblystoma jeffersonianum, on the same plate, is represented as larger, a relation of size, the reverse of what usually holds in nature.

This is the only one of our eastern Salamanders which attempts self defence. It snaps fiercely but harmlessly, and throws its body into contortions in terrorem. It prefers the coolest localities throughout the Alleghany Mountain region from New York to Alabama. It is aquatic, but prefers the still waters of swamps or springs to running streams. It is common in the region whence Green procured it, while A. microstomum is rare if existing at all.

**ANAIDES** Baird.


Tongue attached from glossophyal to anterior margin, on the median line; considerably free. One premaxillary bone. Pterygoid teeth on a single plate. Vomerine teeth on a ridge which is continuous between the interior nares. Maxillary teeth* longer on the anterior than posterior part of the arch, compressed, knife-shaped, with entire enamel; mandibular teeth of similar form and large development, few in number, and confined to the anterior half of the ramus. Toes 4—5, obtuse and slightly dilated at tip.

This curious genus is furnished with by far the most powerful dentition of any existing Salamander, and resembles in this respect the genera of the coal measures, Brachydectes, Hylerpeton and Hylonomus. In other points there is little difference between it and Plethodon. One marked feature brings it nearer Desmognathus than any other genus of Plethodontidae. The ? opisthotics are each furnished with a high longitudinal crest over which the temporal muscle passes from its origin on the atlas. It has, however, the usual origin from the median line of the parietals, which scarcely exists in Desmognathus. This line is marked in A. lugubris by an elevated crest. The end of the muzzle in that species bears evidence to a habit similar to that which accompanies the singular structures of Desmognathus, viz., that of burrowing or rooting among stones or other resisting objects. The derm is similarly adherent to the bone, and the latter is exostosed and rugous. The prefrontal bones are well developed.

No species has yet been found east of the California or Pacific Coast region.

Large, stout; thumb developed, fingers short; pterygoid series narrow, vomerines strongly curved backwards; width of head 2-6 to groin; light brown above, with yellow spots. A. lugubris.

Smaller, slender; thumb not distinct, fingers long, slender; pterygoid series wider, vomerine series scarcely recurved; width of head 6-33 times in length to groin. A. ferreus.

**ANAIDES** lugubris Hallow.


**Habitat.**—California from Ft. Tejon to Oregon.

**ANAIDES** ferreus Cope.

**Spec. Nov.**

This is a smaller and more slender species than the last, not being very

* Girard l. c. describes the teeth as not fixed to the jaw, and capable “of a depression backwards.” This is only true of successional teeth, or teeth about to be shed; the functional teeth are firmly anchylosed.

1869.]
different in proportions from Plethodon intermedius, but with a broader and more flattened head.

The head is an elongate oval, slightly truncate in front; the nostrils are antero-lateral, and with a delicate groove connecting with the commissure of the mouth. Canthus rostralis not marked. The muzzle is as long as the fissure of the eye, while the length of the commissure of the mouth (diagonal line) is equal to the width of the head at the rictus. The tongue is largely free, the posterior portion rather narrowly. The inner nares are nearer together than the outer. The vomerine teeth commence behind the nares and form a single series of eight on a ridge, which is gently arched backwards on the median line. The paraphysial patch does not extend quite forwards to the middle of the orbits; it is much flatter and wider anteriorly than in A. lugubris, and contains opposite the posterior margin of the orbits ten longitudinal series of teeth, those of adjacent rows alternating.

Gular fold well marked; costal folds fourteen, not continued on back or abdomen. The limbs, and especially the digits, are slender; appressed to the side they fail to meet by the length of the fingers. The form of the body is slender and cylindrical, and the width of the head enters the total length of the groin seven times. The tail is as in A. lugubris, equal to the head and body in length, cylindrical, slender, and slightly compressed at tip.

The thumb possesses a short phalange, but no part of it is free as in A. lugubris; on the other hand, all the phalanges of the other toes of both feet are more slender than the A. lugubris, and the distal ones distinctly truncate and slightly emarginate, with dermal thickening below tip. All are quite free. Number of phalanges 1—2—3—2, 1—2—3—3—2.

Coloration.—Sides and nape greenish gray; top of head and dorsal region behind in the form of a serrate band, with the tail black; below yellowish brown. Limbs black above, brown below. Inferior regions unspeckled.

**Measurements.**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (axial) from snout to rictus oris</td>
<td>1.42</td>
</tr>
<tr>
<td>&quot; &quot; &quot; axilla</td>
<td>1.70</td>
</tr>
<tr>
<td>&quot; &quot; &quot; groin</td>
<td>1.75</td>
</tr>
<tr>
<td>&quot; &quot; &quot; end vent</td>
<td>2</td>
</tr>
<tr>
<td>&quot; &quot; &quot; end tail</td>
<td>3.65</td>
</tr>
<tr>
<td>&quot; fore limb</td>
<td>0.5</td>
</tr>
<tr>
<td>&quot; &quot; foot</td>
<td>2</td>
</tr>
<tr>
<td>&quot; hind limb</td>
<td>0.55</td>
</tr>
<tr>
<td>&quot; &quot; foot</td>
<td>0.26</td>
</tr>
<tr>
<td>Width &quot; (sole)</td>
<td>0.11</td>
</tr>
<tr>
<td>&quot; head at rictus oris</td>
<td>0.28</td>
</tr>
<tr>
<td>&quot; body at middle</td>
<td>0.24</td>
</tr>
<tr>
<td>&quot; &quot; sacrum</td>
<td>0.2</td>
</tr>
</tbody>
</table>

The maxillary bone displays the same sudden decurrature anterior to and below the orbit which the A. lugubris does, but it is less marked; in consequence the commissure of the mouth is less sinuate. The long mandibular and maxillary teeth, while of similar structure, are less developed; perhaps larger specimens of this species may be found where they may be larger, as in small specimens of A. lugubris, they are nearly similar in proportions.

Though nearly allied to the A. lugubris, the present species will never be confounded with it. It is a much weaker form, and does not display the characters of the genus in so striking a degree. But one specimen has come under my observation, as follows:

No. 6794; one specimen; Fort Umpqua, Oregon, Dr. Vollen.

**Thoriiidae.**

Palatines not prolonged over parasphenoid bone; no postorbital arch.

[May,
Vertebral opisthocranial.
Carpus and tarsus osseous.
Dentigerous plates on the paraspheniod.

This family combines the peculiarities of the Desmognathidae, Plethodontidae and Amblystomidae in a remarkable manner. The well developed opisthocranial vertebrae are characteristic of the first named and of the Salamandridae, the fully ossified tarsus and carpus of the Amblystomidae. The dentition is entirely that of the Plethodontidae. This was the less to have been anticipated, as the general characters of the only genus are those of the genus Spelerpes. The history of the metamorphosis is as yet unknown. The only known genus is Mexican.

THORIUS Cope.

Parietal and palatine bones rudimental, represented by cartilage and membrane. Posterior nares therefore not separated from orbit; sphenoidal patches of teeth entirely united; tongue boletoid, free in front. Toes distinct, rudimental, 4—5.

The tarsal bones consist of astragalus, calcaneum, a scaphoid and three minute cuneiform bones. The metatarsals and phalanges are fully ossified, as are the corresponding elements of the fore limbs.

This genus is highly interesting, as indicating the lowest grade of ossific deposit found among the tailed Batrachians, accompanied by characters of full development in other respects. Thus, while the cranium is but imperfectly ossified, and less developed than in a comparatively early larval stage of Amblystoma, the tongue, vertebral column, and extremities have advanced far beyond its larval condition, which is permanent in the latter genus, and the branchial apparatus disappears while the individuals are but little more than half their adult size.

It is represented as yet by but one species, from Mexico, of terrestrial habits.

THORUS PENNATULUS Cope.

American Naturalist, 1869, 222.

This is a small species, with smooth skin, very weak limbs, and stout tail. The head is scarcely wider than the neck; it is not flattened, the loreal region is rather elevated and distinct, and the muzzle slightly prominent. The upper lip is sometimes truncate, with infranarial angle prominent, sometimes regularly rounded. The nostril is larger than any known salamander, its diameter equaling half that of the pupil.

The vomerine teeth are situated on a transverse, elevated crest, which is a little behind between the inner nares, and though curved backwards, is but little interrupted medially. Each half contains four teeth, perhaps five when complete. The sphenoidal series is large, pyriform, the anterior extremity narrowed and prolonged to opposite the middle of the orbits.

There are thirteen costal folds; three and one-half of their interspaces are covered by the extended hind limb, from its origin. The toes are very small; only the three median behind and three outer before are developed beyond the metatarsus. The phalanges are, anteriorly 0—2—2—1; posteriorly 0—2—2—2—0. Their extremities are distally free; that of the median posterior projects more beyond those adjacent than in O. l i n e o l u s. The costal plates are not marked on the dorsal, and only on the ventral in the color variety mentioned. The tail is stout, and for a short distance at the base subquadrate in section, and nearly as thick as the body; distally it is more compressed, but is not keeled; length equal to that of head and body. The width of the head enters 6:5 times, and the length in front of the axillae 3:33 times the length to the groin.

The color is brown, yellowish and clouded below, the dorsal region covered with a gray band, which extends to the end of the tail. This band is particularly light and slightly metallic on its margins, which are undulate or serrate, 1869.]
and which are in strong contrast to the black of the lateral regions. The latter graduates into the brown of the belly. The gray dorsal band is marked by a number of short divergent spots, which are in pairs and open backwards, V-shaped, one to each costal interval. One specimen constitutes a color variety, as I find no other points of peculiarity. It differs in being nearly black above, in having the sides longitudinally streaked, and the gular region specked with white; a whitish incomplete triangle on the front and muzzle.

**Measurements (axial).**

No. 6341. Type ♀

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length from snout to rictus oris</td>
<td>0.11</td>
</tr>
<tr>
<td>&quot; &quot; axilla</td>
<td>0.3</td>
</tr>
<tr>
<td>&quot; &quot; groin</td>
<td>0.866</td>
</tr>
<tr>
<td>&quot; &quot; end vent</td>
<td>1.016</td>
</tr>
<tr>
<td>&quot; &quot; tail</td>
<td>1.95</td>
</tr>
<tr>
<td>Width head behind</td>
<td>1.133</td>
</tr>
<tr>
<td>&quot; body at sacrum</td>
<td>1.133</td>
</tr>
<tr>
<td>Length fore limb</td>
<td>1.14</td>
</tr>
<tr>
<td>&quot; hind</td>
<td>1.17</td>
</tr>
<tr>
<td>&quot; foot</td>
<td>0.05</td>
</tr>
</tbody>
</table>

The specimen measured is the largest; it contained numerous eggs in the oviducts, which have attained a diameter of line, without indication of embryo. This size is remarkable when compared with that in the Pleurodelidæ, and other salamanders. As the body is little above six lines in length, the number discharged at any one time must be small. The smallest specimen measures 0.6 inch from muzzle to groin, so that it appears that this species passes its metamorphosis quite early. F. Sumichrast, to whom we are indebted for this species, says of it:

No. 6341, 6 specimens, Orizava, Mexico, F. Sumichrast (No. 48).
No. 6744, 1 specimen.

**Color var.**

**DESMOGNATHIDÆ.**


Prefrontals and pterygoids wanting.
Parietals not embracing frontals.
Orbitosphenoid separated by membrane from prootic.
Vestibule, internal wall osseous.
Dentigerous plates on the parasphenoid.
Carpus and tarsus cartilaginous.
Vertebrae opisthocoelian.

The peculiarity of the vertebrae chiefly distinguishes this family from the Plethodontidæ. In the only genus which represents it there are numerous peculiarities, which are not found elsewhere. Should other genera be found which do not possess them, the above diagnosis would probably be the proper test of their family affinities.

The distribution is confined to the eastern district of the Nearctic fauna so far as yet known.

**DESMOGNATHUS** Baird,


Premaxillaries united, embracing a fontanelle; parietal bones ossified. Occipital condyles on cylindric pedestals. Temporal arising only from the atlas, with a tendinous external margin and insertion; passing freely over the parietal and prootic bones. Tongue attached, except by its lateral and posterior margins. Vomerine and sphenoidal teeth present.Digits distinct, 4–5.

The absence of o. prefrontale does not appear to be the result of its confu-
ence at any late period, with the naasale; its ordinary position is traversed by the frontal suture. The frontal bone is decurved, and closes the preorbital aspect of the superpalatal vacuity, usually open.

This marked genus, so abundantly represented by individuals in the eastern district of North America, is not admitted by either Duméril or Hallowell, probably because it does not differ in external characters from Plethodon. It is an excellent illustration of the error of adhering to external characters only, in the explanations of the relations and affinities of organized beings, except for a limited range. The examination of the skeleton of species of this genus utterly changes the impressions produced by a consideration of the external characters. It may be stated as characteristic of the Batrachia in general, that their affinities cannot be determined without study of the skeleton.*

There are no dermal appendages developed in this genus at the breeding season.

I. Males with posterior half mandible concave and edentulous.


II. Males with mandibular alveolar margin continuous and completely toothed.

Inferior lateral series of pores well developed, superior irregular or wanting; a tubercle in canthus oculi; tail compressed, and keeled; fourteen costal plicae. Above dark spotted, below marbled. Size medium. D. fusca.

Desmognathus ochropha Cope.


This small species bears a strong resemblance to the Spelerpes bilineatus Green, and apart from generic characters, may be known from it by the rounded tail, the paler colored abdomen, and the light bar from the eye to the angle of the mouth. Its proportions are stouter than in Plethodon erythronotus, to which it also bears some resemblance.

The costal folds are thirteen, but fourteen, if that which is immediately above the groin be counted. The first falls immediately into the axilla. This is the characteristic arrangement in D. fusca also, while in D. nigra the fold above the groin usually extends to it, and is the twelfth, while that which corresponds to the first of the species before named falls just in advance of the axilla. Though this is typical of D. nigra, occasionally another plica appears above the groin, and the twelfth is slightly in front of it. The pores in D. ochropus a are very difficult to observe; in a few specimens I have seen a few of those of the lower series, the upper I believe to be wanting. The gular fold is distinct, and another vertical fold commences behind its extremity, and turning longitudinally extends more or less distinctly to the orbit. As in other species the derm adheres closely to the frontal bones and is more or less rugulose. The head is oval with rounded depressed muzzle; its greatest width enters the length to the groin 52 times. The commissure of the mouth is slightly flexuose.

The appressed limbs fail to meet by four intercostal spaces. The inner digits of both feet are short, but free; longer than in Plethodon species of similar size; the other digits are also longer and more distinct; proportions, 1—4—2

* The skeletons on which the present observations are based are in large part the preparations of Prof. Baird.

1869.J 8
—3; 1—5—2—4—3; only three phalanges in longest toes. The tail is quite slender, and only compressed at the tip; in some there is a keel above on the distal third, but never any dermal fin.

The vomerine teeth are very few and small when present; they are often wanting. Their basalline is on a ridge which is convex backwards, nearly continuous medially. The paraphenoid teeth stand on two narrow plates which are well separated, especially behind, and are shortened; anteriorly they only reach to near the middle of the orbits. The mandibular teeth present peculiarities in the male, by which it may be readily distinguished from the female. In a large number of specimens the oral commissure is but little undulate, and the mandibular teeth, though longer medially, are continued to near the basis of the coronoid process. The males exhibit a strongly flexuous commissure, and the alveolar margin of the mandible is deeply concave below the front of the orbit, and edentulous. The distal portion is abruptly convex and armed with long teeth. The margin is slightly concave anterior to this point, and finally rises again at the symphys, which is prominent and protected externally by a pad of crypts as in D. fusca. The structure of the males is in the mandibular dentition quite that of the genus Anaides, the A. ferreus n. presenting the characters but little more strongly. No such sexual difference can be found in the D. fusca, though the commissure only may be sometimes more flexuous in males. The jaws and dentition in the D. nigra do not differ in the two sexes. I have observed that two of the many males of D. ochrophæa, possess the female dentition. The tongue in D. ochrophæa is an elongate oval, considerably free behind.

The color of the females is a bright brownish yellow, fading to a dirty white below, with a dark brown shade on each side from the eye to the end of the tail which is darkest above, and gives the dorsal hue the character of a band. There is an irregular series of brown dots along the vertebral line. Males are rather longer and usually darker in color; thus the dorsal band is brownish, the lateral bands blackish, and the dorsal spots more distinct. In most specimens of both sexes there is a light band from the eye to the rictus oris, and the belly is always immaculate, the gular region nearly always. The testes and vas deferens are covered with black pigment; no pigment on the peritoneum of the female.

This species scarcely attains half the size of the D. fusca, as indicated by the numerous females with developed eggs in our collections. As the eggs are equal in size to those of D. fusca when ready to be discharged, and as the species is only half the size of the same, the eggs in the oviduct of a gravid female at one time are only half as numerous. I have only found from 6—10 in D. ochrophæa, in each oviduct, while from 13 to 30 may be counted on one side in D. fusca.

**Measurements.**

<table>
<thead>
<tr>
<th>Length (axial) from snout to rictus oris</th>
<th>Inches</th>
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<tbody>
<tr>
<td>1.2</td>
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<tr>
<td>1.46</td>
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<td>0.17</td>
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<td>0.8</td>
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<td>0.2</td>
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**Width**

<table>
<thead>
<tr>
<th>Width</th>
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<tbody>
<tr>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>0.22</td>
<td></td>
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</table>

**Habitat, etc.—** This Salamander is chiefly abundant in the chain of the Alleghenies and their outlying spurs; I have never seen it in the hill country of [May,
Pennsylvania, or the lower plains of New Jersey and Maryland. Nor have I observed it in the Alleghenies of south-western Virginia; the most southern locality yet known is the Broad Top Mountain in Southern Pennsylvania, from which the Academy possesses numerous specimens from Dr. Leidy. In northern Pennsylvania and the Adirondacks it is very abundant. The Academy has numerous specimens from Warren county, Penn., from Dr. Randall.

The habits of this animal are terrestrial. It occurs under the bark of every fallen log of hemlock (Abies canadensis), and in the debris of the dark damp forests of the north. I never saw one in the water of streams and runs, the habitat of the other species of the genus.

Prof. Baird was familiar with this species before I described it. I published his suggestions expressed in a letter, that it was the S. haldemani of Holbrook. Holbrook's figure does not represent this species in any degree, nor is his description more conclusive as to the reference of this species to it rather than some others. He says it is marked with spots on the upper surfaces, which are "disposed without much regularity," but the largest are on the flanks. There are but few spots above in this animal, and they are in a regular series.

The sides are banded.

No. 3917, 10 specimens, Alleghany Co., N. Y., Dr. Stevens.
No. 4041, 3 specimens, Bradford Co., Pa., C. C. Martin.
20 specimens, Meadville, Pa., Prof. Williams.
No. 4539, 5 specimens, Susquehanna Co., Pa., Prof. Cope.

**Variety**—A specimen with the dentition, coloration and proportions of body and tail of this species was sent to the Smithsonian Inst., from Georgia, by Dr. Jones. It approaches the *D. fusca* in having a small *tuberculum canthus oculi*, and a well developed inferior series of mucous pores.

**Desmognathus fuscus**, Rafinesque.


This, perhaps the most abundant Salamander in North America, is quite variable in coloration, but not in proportions and structural peculiarities. Those of the latter which characterize it are the presence of fourteen costal plicae; one well, and one little developed lateral series of mucous pores; the central and regular distribution of teeth in the mandible of males; the compressed tail, keeled above, and finned distally; the presence of a tubercle in the anterior canthus of the eye; the marbled color of the belly. In many quarts of specimens I find four specimens from southern localities—two in Academy from Charleston, two in Smithsonian from Biloxi, Miss., which have fifteen plicae, but one of the latter has fourteen on one side. In specimens which have been preserved in too strong spirits the pores are rendered invisible; the same occurs when the spirit is impure or weak. In soft specimens the canthal tubercle sometimes disappears, and in many young specimens and some adult females it does not appear to exist.

The head is more depressed and the muzzle prolonged than in species of the other genera. The eyes are prominent; the plicae behind them strongly marked. These consist of one on each side the head and nape, which converge posteriorly and then turn abruptly outwards to be continued into the gular plica. A second plica extends from the mandible across the rictus oris to the upper plica. A second longitudinal plica extends from this to the gular enclosing an ovate enlarged area; and a short one to the orbit encloses a post-orbital subround and smaller area.

The commissure of the mouth is more undulate in males than in females, but both present a slight elongation of the symphysis produced externally by 1869.]
a pad of crypts. The width of the head enters the length 5·66 times. The vomerine teeth are often wanting, and when present, minute and few. Their basis is a ridge which extends from behind the middle of the posterior nares, across the palate with a posterior convexity. The paraphenoid patches are small and not in contact; they do not extend to opposite the middle of the orbits.

The median toes are elongate and as in D. o c h r o p h a e a; they fail to meet by four interspaces when pressed to the side. The tail has a characteristic form, which is invariable at all periods; near the base the section is trigonal; the dorsal keel increases in elevation, and becomes a narrow fin posteriorly; the extremity is attenuated. Its length is just equal to that of the remainder of the animal.

There are two color varieties which blend together so as to indicate that no higher value can be attached to them; one of these is the Salamandra auriculata of Holbrook.

Above brown with gray and pink shades; sides and belly marbled, the pale predominating; no red spots on sides................. var. fusca.

Above and sides black; the latter with a series of small red spots; a red spot from eye to canthus of mouth present or absent; belly marbled, the dark predominating.................... var. auriculata.

The latter variety occurs only in the Southern States; the tube of the angle of the eye and the upper lateral pores are often better developed in it than in var. fusca, therefore approaching D. nigra. It is, however, easily distinguished from the latter.

Sundry specimens lack the red spots, and others have paler bellies, resembling thus the darker fusci. The size is the same.

In the young of D. fusca there is a series of pinkish incompletely separated alternating spots, in two series, covering the whole dorsal region; they are rarely so well distinguished or so bright as in the specimen of the same which furnished the type of Holbrook's S. quadrimaculata. The pink fades to orange brown or ochre, and to pale brown with age, and at the fullest maturity all are lost in a uniform blackish.

Measurements. No. 6832.

Length (axial) from snout to rictus oris............................ 3·3
"    "    "    axilla.......................... 7·11
"    "    "    groin.......................... 1·95
"    "    "    end vent........................ 2·3
"    "    "    tail.......................... 4·6
"    "    "    fore limb........................ 4·2
"    "    "    foot........................... 1·15
"    "    "    hind limb...................... 6·2
"    "    "    foot........................... 2·6
Width sole do.......................... 1·6
"    "    head at rictus oris............. 3·75
"    "    body at middle................... 5·5

Habitat, etc.—This species lives chiefly among the stones in the many shallow rivulets and springs of the hilly and mountainous regions of the country. It is not so partial to deeper and stiller waters as the Spelepes ruber, but prefers the rapid and shallow streamlets; here it may be found under every stone, or its delicate larva may be observed darting rapidly from place to place, seeking concealment among mud and leaves. The D. fusca is one of the most active and vigorous of our species. The peculiar structure of the temporal muscle and its tendon, and of the occipital condyles, with the strength of the bones of the front, enable it to burrow among stones and in earth more readily than the species of other genera. When pursued it runs

[May,
and wriggles out of sight with the greatest rapidity, and is quickly concealed by assistance of its dusky colors.

Prof. Baird originally noticed the curious disposition of the eggs in this species, which I have verified on a few occasions. As in the Anuraous genus Alytes, the eggs on emission are connected by an albuminous thread, which soon contracts and hardens. One of the sexes protects this rosary by wrapping it several times round the body, and remaining concealed in a comparatively dry spot. How long this guard continues is not known.

The most eastern specimen I have seen is from Essex Co., Mass. Besides a great number of specimens in the Museum of the Academy, the following form the Smithsonian basis of the examination.

No. 3678, 2 specimens, Summerville, S. Ca., ?
" 3880, 8 " Anderson, S. Ca., Miss Paine.
" 3876, 2 " Summerville, N. Ca., J. McNair.
" 3883, 25 " Meadville, Pa., Prof. Williams.
" 3882, 5 " Orange, N. J., ?
" 3896, 10 " Columbus, Ohio, Leo Lesquereaux.
" 3892, 3 " Clark Co., Va., Dr. Kennerly.
" 3893, 8 " Pittsburg, Pa., S. F. Baird.
" 3891, 7 " Mississippi, B. L. C. Waites.
" 3904, 15 " Abbeville, S. Ca., J. B. Barratt, M.D.
" 3919, 1 " Salem, N. Ca., J. Lineback.
" 3909, 9 " " " "
" 3914, 6 " Highland Co., Ohio, ?
" 3910, 4 " Knoxville, Tenn., Prof. J. B. Mitchell.
" 3912, 1 " Adirondack, N. Y., R. Clark.
" 3905, 1 " Columbia, Co., Pa., Dr. Henderson.
" 3923, 3 " Gloucester Va., ?
" 3798, 5 " Etaw, Ala., ?
" 3921, 1 " Dayton, Ala., Edgeworth.
" 4718, 2 " Georgia, Dr. Jones.
" 4843, 1 " Brookville, Ind., Dr. R. Raymond.
" 5039, 1 " Georgia, Dr. Jones.
" 3901, 10 " Riceboro, Ga., Dr. Jones, var. auriculata.
" 4717, 2 " Georgia, " " " "
" 6830, 5 " Georgia, ? " "
" 6831, 2 " Biloxi, Miss., C. Billman, var. fusca.
" 6832, 4 " Georgia, Dr. Jones, " "

Desmognathus nigra, Green.


This is the most robust Salamander of the eastern regions of our Zoological district; it is not so slender as the Gymnophilus p o r h y r i t i c u s, but a much stronger animal. As compared with the D. f u s c a, it is much larger, the tail is more compressed and extensively finned, and the color is uniformly different. Besides the characters already pointed out in the table, it differs from D. f u s c a, as follows. The paraspheuoid patches of teeth are prolonged more anteriorly, and approach very near the vomerines in most instances; they are always prolonged beyond the middle of the orbits; their prolongation is at the same time narrowed, and in most, the patches are not distinguished at this point. The vomerine series are better distinguished (though not always) being oblique, separate, and not extending beyond nares. The tongue 1869.}
is, in eight specimens examined, nearly round, while it is always a long oval in the two other Desmognathini; finally the only male does not possess the black pigment coat of the testes, always present in the others, though as in them the vas deferens is black. The body is stouter, and the width of the head enters the length to the groin less than five times; in the others always more; this is also expressed by the existence of only twelve costal plicae, and the fact that the appressed limbs are only separated by 2 ½ intercostal spaces.

The postorbital plicae are not strongly marked. The mucous pores are well developed, and the two lateral series are often distinct in alcoholic specimens by their white color; when they become dry they are difficult to observe. There are two rather distinct gular series within the mandibular ramus on each side, and one on each side extending inwards and forwards from the gular plicae. The superior lateral series extends from the orbit to near the end of the tail; the inferior turn round the humeri to each side the pectoral region.

The proportions of the fingers are as in D. fusca; they are entirely free. The eyes are prominent, with thick, opaque palpebrae. A tubercle occupies the anterior angle, which, after an examination of that in D. fusca, is a dismemberment of the superior eyelid.

The coloration is uniform in about twenty specimens examined. It is simple, viz., uniform black above and below, except the muzzle from between the eyes, the lower jaw, the end of the tail and the soles of the feet, which are brown.

**Measurements of 3923.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (axial) from end muzzle to orbit</td>
<td>2 29</td>
</tr>
<tr>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>&quot; canthus oris</td>
<td>3 55</td>
</tr>
<tr>
<td>&quot; axilla</td>
<td>1 22</td>
</tr>
<tr>
<td>&quot; groin</td>
<td>2 23</td>
</tr>
<tr>
<td>&quot; end vent</td>
<td>3 76</td>
</tr>
<tr>
<td>&quot; tail</td>
<td>6 96</td>
</tr>
<tr>
<td>&quot; of fore limb</td>
<td>6 9</td>
</tr>
<tr>
<td>&quot; foot</td>
<td>2 6</td>
</tr>
<tr>
<td>&quot; of hind limb</td>
<td>1 02</td>
</tr>
<tr>
<td>&quot; foot</td>
<td>4 7</td>
</tr>
<tr>
<td>Width</td>
<td></td>
</tr>
<tr>
<td>&quot; between eyes in front</td>
<td>2 7</td>
</tr>
<tr>
<td>&quot; at canthus oris</td>
<td>3</td>
</tr>
<tr>
<td>&quot; at sacrum</td>
<td>6 5</td>
</tr>
<tr>
<td>&quot; of body</td>
<td>7 5</td>
</tr>
<tr>
<td>&quot; at sacrum</td>
<td>5 4</td>
</tr>
</tbody>
</table>

**Habits, etc.—** This creature is aquatic; but after the fashion of the D. fusca it occurs only in shallow stony brooks. It is, so far as known, confined to the Alleghany Mountain ranges from Pennsylvania southwards. It is abundant in the streams of the rocky ravines and cold springs in the remotest depths of the forest, where its retreat is cool and dark. It seeks concealment under loose stones and slabs of slate with great activity, and is not easily caught. Its habitat does not seem to be shared by any species but the D. fusca; the Gyrinophilus porphyriticus, the other characteristic Alleghany species, hauntling standing springs and bogs where stones are not so numerous. Green described it from Pennsylvania, but Baird who is familiar with the Alleghany fauna of our State, says he has not observed it near Carlisle. Nor have I met with it north of Virginia, where it is common. Besides Green's type, and specimens from near the Kanawha River in S. W. Virginia, in the Academy of Mus.; the Smithsonian contains the following:

No. 3886, 2 specimens, Georgia, Dr. Jones.
3923, 4 "  Abbeville, S. Ca., ? ?
2 "  Giles Co., Va., E. D. Cope.

[May,
Further Notes on MICROSCOPIC CRYSTALS in some of the Gems, &c.

BY ISAAC LEA.

In a paper which I recently read to the Academy, I mentioned having found acicular crystals in Precious Garnets. Since then I have had the opportunity of examining a number of cut specimens of Sapphire in the forms of Asteria, Catseye, &c. I have also examined many specimens of Cinnamon Stone from Ceylon, brought by Dr. Ruschenberger, of the United States Navy, also, among others, a very fine specimen of bluish Sapphire, in the collection of Prof. Leidy.

Having made microscopic drawings of these and other species, having included microscopic crystals, I propose to present them with as nearly correct illustrations as possible.

The whole subject of microscopic mineralogy has been of great interest to me, and I hope these short notes may induce some student to pursue the subject to a greater extent than I have had it in my power to do. It cannot fail that, with the use of the numerous admirable microscopes now made in this country, working with so much more facility than with those we have been accustomed to from abroad, observers may continue to bring to our knowledge much that has been heretofore unknown and very little suspected in this branch of science.

In my former paper I stated the proportional number among Bohemian Garnets which I found to contain microscopic crystals. I now propose to give descriptions and figures of the appearance of these crystalline forms, and with this view I have made drawings of their apparent forms under a power of about 100 diameters.

Sapphire. A very remarkably beautiful Asteriated bluish Sapphire, procured by Dr. Ruschenberger when in Ceylon, presented to the naked eye the six rays which in the sun were sharp and of great beauty. The specimen being set as a gem of luxury, I could not get a view by transmitted light, but by reflected light, with great care, the exceedingly minute crystals were distinctly seen. They are very short, of pearly lustre, at three different equal angles, thus producing the bands which form the rays in three directions of 60° each. The reflection from the sides of these minute crystals cause, of course, the asterism of six rays over any point of the curved polished surface of the specimen. These rays are formed on the same principal precisely as the asterism in Phlogopite, which I have mentioned elsewhere.

Fig. 1 represents the delicate, numerous, minute crystals in the beautiful Asteria referred to above belonging to Dr. Ruschenberger. The acicular crystals are so small that it was with great difficulty I obtained their position as here represented.

The variety of Sapphire (Corundum) which goes under the name of Catseye, has irregular coarse striae, which have the appearance of being Asbestos as is generally supposed. In this gem there is a single band which varies according to the position it may be placed in, and by no means has the beauty of the asteriated Sapphire. Several of these are now before me which came from Ceylon.

Fig. 2 represents the crystals which I observed in a fine small bluish Sapphire, in Prof. Leidy's fine collection of gems. The cuneiform or arrow-headed crystals are very extraordinary, and they may be simply twin crystals of some substance of which at present we can have no perfect idea. They remind us in their form of Selenite crystals, such as are found in the Paris Basin, and at once we recognise the similarity to the cuneiform character stamped on the bricks of Babylon, and cut in the alabaster monuments of Nineveh. The group which I have drawn represents six of these cuneiform crystals, and six acicular crystals. Of the former six, four had a bluish tinge and two were pinkish. The acicular crystals were disposed to take three different directions, parallel 1869.]
to the prismatic hexagon sides of Corundum. Both sets of these crystals are enlarged to about 200 diameters, for the purpose of giving distinctly their very singular form.

Specimens of Garnet examined from all localities obtainable, presented very different aspects. When crystals were found in them they always proved to be acicular in form, but by no means similarly regular or of the same length, direction, or of the same size.

Fig. 2. A Bohemian cut Garnet presented three sets of numerous, thickly set, parallel, acicular crystals, which crossed at an angle of 120°, forming a very regular lattice-work appearance.

Fig. 4. A Bohemian cut Garnet presented only two sets of acicular crystals, which were usually at right angles, but some were inclined from perpendicularity and they were not so long as those of figure 3.

Fig. 5. A Bohemian cut Garnet presented a very different set of crystals. They were generally short, comparatively, and pointed in every possible direction.

Fig. 6. Garnet from Ceylon—Cinnamon-stone—fractured portions, not cut and polished. The acicular crystals were much shorter, rather thicker and much more bluntly terminated than in Fig. 5. They are placed at all angles. Ten specimens only in 80 examined had any thing like crystals, while all had irregular riffs or cavities within.

Fig. 7. Precious Garnet—Pyrope? from Green's Mill, Delaware Co., Penn., presented acicular crystals somewhat like Bohemian Garnet, fig. 3, but the three sets, while they take the same three directions, are shorter and left interspaces as shown in the figure.

Fig. 8. Garnet from North Carolina. A thin fracture from a compact garnet of large size, perhaps two inches in diameter. The acicular crystals are not very numerous—they are thin and not continuous. Connected with these are a few dark crystals. These take no particular direction like the others, but seem to be interspersed throughout.

Fig. 9. Labradorite. This specimen is a small polished one from Ceylon, and belongs to Dr. Ruschenberger. Besides the usual play of pavonine colors in Labradorite, I have found in all the specimens I have examined from various other localities, very minute reflecting crystals like those in Sunstone, and which are no doubt the same, but differing in size, being smaller so far as I have observed. The microscopic forms as figured will be observed to consist of two sets apparently distinct. The larger are rather irregular and black. The thinner are rather shorter and more delicate. These are not the reflection of the plates of Gökite,* they are the black crystals which are usually in dark Feldspar.

Fig. 10. Black Feldspar. A small specimen of black Feldspar, translucent in thin pieces, from Chester Co., Penn., presented quite a different appearance from Labradorite in its minute, black included crystals. They are very numerous, very short, opake black, and irregular in form. They are closely set and irregular in their direction. There were no reflections from any of these included crystals.

Fig. 11. Barite, from Antwerp, Jefferson Co., New York. a represents some opake crystals observed in a small prismatic crystal. They cannot be, I think, riffs, and yet they are evidently without planes. b represents singular impressions on the surface of one of the prismatic planes, and their singular form, like the common horse-shoe magnet, induces me to call attention to them.

Fig. 12. Amethyst. A specimen from Thunder Bay, Lake Superior, presents very remarkable globules, some of an orange-yellow and some of a dark-green. These are very visible to the naked eye, and in the figure they are not

* The plates of Gökite when held at a proper angle may easily be seen by the naked eye.
very greatly magnified. They vary somewhat in size, and the orange-colored ones are most numerous in the specimen before me. There is a cloudiness in these yellow globules and a few are not completely spherical, presenting a cup-shaped form. To the naked eye the green globules appear to be black, but under the microscope they are evidently dark green. The composition of the two sets are no doubt the same, and the color probably depends on their being in a different state of oxidation. In a few cases I observed the two colors in the same globule. In another specimen from the same locality I found the globules to be much smaller and the green ones to prevail.*

Fig. 13. An Asteriated Sapphire, also belonging to Dr. Le Conte, of an obtuse conical form, and of unusual beauty, presented very remarkable microscopic crystals of a white silken hue. The larger of two sets were generally, though not always, cuneate and lay in three directions, differing somewhat in size. In the smaller set the crystals are very minute, having the same pure white, silken appearance. These fill up the interstices of the larger crystals.

A Sapphire of large size and peculiar beauty, in the possession of Dr. Le Conte, presented a few distant, white silk-like lines, running in one direction, and parallel to each other. It is of unusual brilliancy and fine color and is thirteen-twentieths by eleven-twentieths of an inch in size.

Fig. 14. A Pyrope from New Mexico, in which the microscopic crystals differ from any of the many Garnets I have examined. In other specimens from this locality—of which I have examined twenty in the collections of Prof. Frazer and Dr. Le Conte—acicular crystals alone were found. In this specimen the crystals are much larger, less in number and of an entirely different character. Some are geniculate and transparent, while some are dark or semi-transparent. A very short and rather thick crystal seems to present three sides of an hexagonal prism. These New Mexican Pyropes are of uncommon beauty and perfection. This specimen is in the collection of Prof. Frazer. His other seven specimens have acicular crystals. Of Dr. Le Conte’s twelve specimens, six had acicular crystals, and six presented no appearance of inclusions. When the acicular crystals are examined in the direct rays of the sun at right angles to their axis, they reflect all the spectral colors in a very beautiful manner.

A small brilliant Ruby, which has the appearance of being oriental, but which may be a Spinel Ruby, was found to be very full of long acicular crystals which were observed to be in all directions, and were to all appearances the same as observed in Precious Garnets. A larger specimen has the same kind of acicular crystals, but in this specimen these crystals take generally two directions and are oblique to each other.

Two out of four other very beautiful small Oriental Rubies — Sapphire were found to have very minute acicular crystals. In one of them these crystals were in three directions; in the other they were in two directions. Both these gave that peculiar changable band observed in the “Cutseye” Sapphires. All these rubies were cut as brilliants and were of great beauty.

It is apparent that the microscopic crystals in the various minerals above described, cannot all be of the same substance. Their forms and appearance forbid that, and chemical analysis will never probably reach, with any degree of satisfaction, their ultimate constituents. Spectral analysis may, however, be able to give us some results when properly applied, which may in some measure satisfy us in regard to the composition of these interesting included microscopic crystals.

Sexual Law in the CONIFERÆ.

BY THOMAS MEEHAN.

In some various papers last year before this and other bodies, I was able to prove, I believe, to the satisfaction of my fellow botanists, that the true leaves

*The Amethysts of Chester County, Penna., very frequently have minute acicular crystals of Rutile.

1869.]
of Conifera are mostly adherent to the branches, and that the degree of adhesion is in exact proportion to specific or individual vigor. I believe I can now show that the production of the sexes is influenced by the same law,—that a high stage of vitality, or vigor, is favorable to the production of female flowers; and a low stage, or comparative weakness, to the production of male ones.

Every one must have noticed that the cones of these trees are always on the strong vigorous branches towards the top of the tree, or on the ends of the strong laterals. Only this year did I observe that the male flowers are never on these strong branches, seldom near the ends of the main shoots, but down amongst the lowermost and weakest branches, and in the more interior parts of the trees.

My observations have been confined to Pinus and Thuja. I have examined many hundreds of trees; and so clearly does this law universally prevail, that I am certain I have but to point it out in order to obtain a ready assent to it.

The effects of vigor in bringing about these different sexual relations are very interesting. Taking the Scotch, Austrian and Table Mountain Pines, which I have had daily before me, the young shoot commences its axial growth early in spring. Its base is the weakest part of it, being partially formed late in the previous season, when vitality was about to take its annual rest. Therefore, according to the laws of adnation or cohesion which I have before indicated, there are no branches, but the leaves are mostly free, taking the form of long chaffy scales. As the shoot grows it gathers strength, the leaves become more and more adnate with the stem, and after a few inches of such growth the branchlets in the shape of phyllloid shoots or fascicles of "pine needles" appear. These gather strength as the shoot progresses, as shown by their increasing length, until if the axis or shoot is very strong, a female cone appears. The whole process exhibits a regularly increasing vigor, during which the leaves are first suppressed, and ultimately both leaves, stem, and axis with the culmination of vigor are suppressed or metamorphosed into a female cone.

Turning again to another and weaker branch, pushing forth into spring growth, we find the base, instead of being bare of all except the free leaf scales, has little conical heads of male flowers pushing from the axils of the leaf scales, and which, if higher up, and when the shoot has attained more vigor, would be phyllloid fascicles. These male heads of flowers are evidently metamorphosed branch fascicles, the first transformation of which commenced the year previous when active vitality was about to cease. It might occur here to inquire why lingering vitality would not produce in the fall rudimentary changes of the embryo fascicles at the base of the strong and ultimately cone-bearing shoots, as well as the weaker ones? This must be left to future examinations. Possibly, to hazard a guess, strong shoots may have the power of more rapidly maturing in the fall than the other ones.

Another very interesting fact in connection with this subject is the loss of power to branch, which the formation of male flowers induces. Taking a branch of a Scotch Pine, if it lay not the foundation of a series of male flowers in the fall, it will provide at least three smaller buds around one stronger and central one, from which to make its axial growth next season. But if these rudimentary male flowers are formed, no side buds appear; very seldom at least do we find one weak spike along side the main and stronger one.

What that force is which I have called vigor, or by what laws it is governed, I do not pretend to say. I know it only by its effects. In the one case I see a strong axial growth, associated with strong vigorous branchlets, and suppressed foliage, culminating in the formation of female flowers; on the other hand I see a more weak axial development, associated with fewer cotemporary axes, weaker branchlets and greater freedom of the foliage from cohesion, and together with this the production of male flowers. The law is apparent; the nature of the law must be left to further explorers.

[May,
June 1st.

The President, Dr. HAYS, in the Chair.

Twenty-one members present.

Prof. Cope exhibited some specimens of extinct reptiles of interest. One of these was the cranium, minus a portion of the muzzle of a gavial, from the New Jersey Green Sand, previously described under the name of *Thoracosaurus brevissimus*, but which this specimen demonstrated to belong to another genus, since it did not present the lacrymal foramina of the former. He applied the name Holops to it, and stated that he had evidence that *Crocodilus tenesrrosus Leidy*, and probably *C. obscurus L.*, also belonged to it.

He also exhibited drawings with measurements of portions of the limbs of a very large Dinosaur, in the collection of Dr. Samuel Lockwood, of Keyport, Monmouth County, N. J. It was discovered by this gentleman in the lower cretaceous clays on the shores of Raritan Bay. It consisted of the extremity of the tibia with astragalus and fibula. He said it indicated the second genus of his suborder Symphypoda, and was thus allied to *Compagnathus*, differing in the remaining indication of suture between astragalus and tibia, which disappeared in *Compagnathus*. The astragalus thus entirely anchylosed was also confluent with the calcaneum, forming a continuous condyloid surface for the tibia. In an anterior projection externally, the extremity of the fibula exposed by a condyloid extremity, the shaft lapping over the outline of the tibia. This demonstrated what he had already stated, that the fibulae of *Iguanodon* and *Hadarosaurus* had been reversed. The length of the fragment was sixteen inches, the fractured section was a transverse oval, the medullary cavity nearly filled with cancellous tissue. The transverse width of the extremity 12 in.; oblique diameter 14 in. This form he called *Ornithotarsus immanis*, and placed it between *Hadarosaurus* and *Compagnathus*.

He made some observations on a fine fragment of the muzzle of a large Mosasauroid, which pertained to a cranium of near five feet in length. The pterygoid bones were separated from each other, and support nine teeth. A peculiarity of physiognomy was produced by the cylindric prolongation of the premaxillary bone beyond the teeth, and a similar flat prolongation of the extremity of the denterary. He referred the species to *Macrosaurus Owen*, under the name of *M. proriger*. The specimen he stated belonged to Prof. Agassiz, who obtained it from Western Kansas, probably from the No. 3 of the upper Cretaceous of Hayden.

The following paper was presented for publication:

“Description of new Carboniferous Fossils from the United States.” By F. B. Meek and A. H. Worthen.

Mr. Jeanes having resigned his position as Auditor, on motion, Dr. Bridges was nominated and elected to fill the vacancy.

June 8th.

The President, Dr. HAYS, in the Chair.

Twenty-seven members present.

The following paper was presented for publication:


June 15th.

Prof. Frazer in the Chair.

Twenty-four members present.

1869.
The following paper was presented for publication:
"Description of six new species of Fresh Water Shells." By Isaac Lea.

June 22d.

DR. RUSCHENBERGER, Vice-President, in the Chair.

Twenty-three members present.

The death of Dr. Charles D. Meigs was announced.

The following paper was presented for publication:
"Notice of certain obscurely known species of American Birds, based on specimens in the museum of the Smithsonian Institution." By Robt. Ridgway.

June 29th.

The President, Dr. Hays, in the Chair.

Twenty-five members present.

The report of the Biological and Microscopical Section was presented and referred to the Publication Committee.

On permission being granted, Mr. Warner spoke upon the mathematical representation of organic forms. Such limitations, he said, might serve to narrow the field of research into the physical causes of organic forms, and perhaps furnish the suggestion of a rational theory of these causes. If no other advantage were derivable from imitations of this kind, they might, he thought, be useful for description and classification.

He exhibited a representation of the longitudinal section of an egg by a curve which he called the hyper-ellipse, and of the section of an embryo by another curve which he termed a deformed lemniscate. Of the egg curve, he said that it very closely resembled an ideal section of an egg taken from a standard modern work. Of the curve representing the embryo he said that it not improbably marked the boundary of matter lying within it, in a different state of temperature, density, or tension from the matter lying without. These representations were verified by the members present. The speaker expressed the intention of making these representations the subject of a future paper, in which he would give drawings and formulae.

The following gentlemen were elected members:
Dr. N. R. Bradner, U. S. N.; Charles B. Nancrede, M. D., and Harry Emlen.

Alexander Carte, of Dublin, was elected a correspondent.

On favorable report of the Committees, the following papers were ordered to be published:

Descriptions of six new species of FRESH WATER SHELLS.
BY ISAAC LEA.

Unio Macnielli.—Testa sulcata, oblonga, valde inaequilaterali, antice subrotunda, postice obtuse biangulata; valvulis crassiusculis, antice crassioribus; natibus prominulis; epidermide fusca vel luteola, postice viridi radiata; den-
tibus carinalibus parviusculis, compressis crenulatisque; lateralibus sublongis lamellatisque; margarita argentea et valde iridescente.

_Hab._—Rio Gigüillilo, Corcueria, Nicaragua, Cem. Am., Mr. J. A. McNeil.

_Goniorasis bacelooides._—Testa lavi, cylindracea. subtenui, luteola, quadrivittata; spira valde elevata; suturis irreguläriter impressis; anfractibus planulatis; apertura parva, rhomboidea, intus vittata et caruleo-alba; labro acuto, vix sinuoso; columna vix incrassata, contorta.

_Hab._—Coosa River, Alab., Dr. Schowalter.

_Goniorasis Lawrencei._—Testa lavi, subcylindracea, subcrassa, tenebroso-cornea, dilute vittata vel evittata; spira elevata; suturis impressis; anfractibus planulatis; apertura parviuscula, rhomboidea, intus albida; labro acuto, sigmoideo; columna incrassata et cortorta.

_Hab._—Washita River, near Hot Springs, Arkansas, Dr. Lawrence.

_Schizostoma Lewisii._—Testa crebrissima striata, subcylindracea, subtenui, luteo-fusca, imperforata; spira conica, plicata; suturis valde impressis; anfractibus instar septenis, ultimo grandi; fissura obliqua brevique; apertura grandi, rhomboidea, intus vittata; labro crenulato, sinuoso; columna alba, incrassata et contorta.

_Hab._—Coosa River, Alab., Dr. Schowalter.

_Physa Carltoni._—Testa lavi, obtusa fusiformi, inflata, valde polita, tenui, subpurpurea; spira exserta, acuminata; suturis impressa; anfractibus sensi, ultimo pergrandi; apertura ovata, grandi; labro expanso, intus marginato; columna impressa et contorta.

_Hab._—Mount Diablo, California, W. G. W. Harford.

_Physa Wolpiana._—Testa subrotunda, valde inflata, polita, tenui, tenebroso-cornea; spira valde obtusa; suturis impressa; anfractibus quaternis, ultimo pergrandi; apertura ovata, grandi; labro expanso; columna medio parum impressa et parum contorta.

_Hab._—Hot Springs, Colorado Ter., Prof. J. W. Powell.

Notices of certain obscurely known species of American BIRDS.

(Based on specimens in the Museum of the Smithsonian Institution).

BY ROBERT RIDGWAY.

Introductory Remarks.

The following notes comprise the result of some examinations in the extensive series of North American birds in the Museum of the Smithsonian Institution, to which I was kindly allowed access by Professor Henry. They were made especially in connection with the determination of collections gathered by myself as Zoologist to the U. S. Geological Survey of the 40th Parallel, under Mr. Clarence King, principally in California, Nevada and Utah.

Crossing so wide an extent of country as that indicated, it so happened that the operations of the party allowed of extensive examination of the region along the lines of junction of the three great "Provinces" of Professor Baird's paper on the migration and distribution of North American birds, and I had frequent occasion to confirm, and in some cases to extend his remarks relative to the affinities of the species of the different regions, and especially to their hybridization, and to learn to what extent this may take place, and therein tend to perplex the naturalist in his endeavors to determine the exact character of his collections. When to this is added the change which confessedly the same species undergoes under different climates, elevation, and geographical distribution, it is no wonder that many cases exist in which even our best critics may reasonably confess themselves at fault as to the precise name of the specimen, especially in view of the fact that many of them 1869.]
are hastily prepared by persons of little skill in such matters, and are more or less deteriorated by packing and transportation.

The first question upon which we propose to treat is the line to be drawn distinguishing "species" from "varieties." I do not, however, intend to discuss at any length this difficult and perplexing point, but only as it touches more directly upon the birds to be noticed, and in the case of several of them it may possibly well be left (as the matter now stands) entirely to one's discrimination, whether he is to regard them as valid "species" or subordinate "varieties."

Now we must do admit a certain extent of variation, influenced by different agencies, as age, season, and locality, when the cause of such variations can be thus satisfactorily explained. It does not follow, however, that, because we have a series connecting by a gradual transition two extremes, we are to consider the whole as one species, the discrepancies indicating different varieties. The difference between these extreme examples is often too great to admit of this; and when we have traced a species through all its variations to a certain point where the discrepancy from the typical style is too great and uniform to be accounted for by any physical cause, it becomes us as naturalists to assign to such extreme conditions a specific rank. What more can we do? and what is more in accordance with the laws of nature? Therefore we cannot do better than to accept as valid these representative forms, when they can be assigned distinctive habitats; and where they are substantiated by a sufficiency of specimens, to such we may allow a reasonable extent of variation, not, however, beyond the limit controlled by physical causes.

We find that in all cases where individuals occur which apparently connect the approaching extremes of two well defined representative forms, that such are almost always from localities inhabited by each, or from the region where their respective habitats overlap. It is under such circumstances that we must admit hybridization among birds, and abundant evidence can be adduced that such hybridization does occur between congeneric species, and that it is not only occasional but general; indeed an instance will hardly be found where, by collecting in the region where an eastern species and its western representative are found together, the collector will not obtain hybrid specimens. Such has been the case with myself respecting several species, as well as with nearly all others who have made ornithological collections in the West.

What more conclusive evidence of hybridization need we have than an examination of the numerous examples of such a condition of Colaptes from the upper Missouri region, where the ranges of eastern C. auratus and western C. mexicanus adjoin. In this instance we have specimens showing as gradual transition between the two extremes as in any other instance where hybridization is usually less evident, because the species are more obscurely colored and the pattern less sharply defined. If we are to consider the C. auratus as one extreme of a single species, the C. mexicanus, its representative of the opposite side of the continent, the other, Colaptes chrysoides, another "sport," and the hybrid specimens from intervening ground the connecting links, all merely variations accruing from changes that might be wrought by longitudinal distribution, etc., we may as well give up the idea of species in birds, and in fact their study in detail entirely.

Besides the case of Colaptes we have other abundant proof of hybridization in specimens which combine the character of an eastern species and its western representative, or two closely allied species, or even two of different genera. Of this category I may mention the following couples, which are represented in individuals in the Smithsonian collection: Tien\textit{us} villosus and \textit{P. harriii} — \textit{P. pubescens} and \textit{P. gardneri} — \textit{Sphyrapicus ruber} and \textit{S. ocellatus} — \textit{Chrysothrix mexicana} and \textit{C. psaltria} — \textit{Zonotrichia leucophyra} and \textit{Z. gambelli} — \textit{Junco oreogonus} and \textit{J. caniceps} — \textit{J. oreogonus} and \textit{J. hyemalis} — \textit{Pipilo erythrophthalmus} and \textit{P. arcticus} — \textit{Agelaius phoeniceus} and \textit{A. gubernator} — Sturr.
nella magna and S. neglecta — Cyanura stelleri and C. macrolopha — Cyanocitta californica and C. woodhousei — Anser gambelii and Bernida hutchinsi, and many others which I need not here mention—all, I may again say, from the regions where the habitats of the two representative species overlap.

Premising these general considerations I proceed to discuss in detail some closely allied species to which my attention has been specially called in the course of the investigations referred to.


Genus HYLOCICHLA, Baird.

Some authors seem inclined to doubt the validity of several species of this group, as characterized by Professor Baird. These are the H. alicie, Baird, H. ustulatus, Nutt., H. nanus, Audubon, and H. audubonii, Baird, these being referred to swainsonii, Cabanis, fuscescens, Stephens, and pallasi, Cabanis. A careful examination of the very extensive series of these birds in the Smithsonian collection has, however, convinced me that they are all (with perhaps the exception of audubonii) justly to be regarded as distinct species.

I do not propose to speak here at any length in regard to the characters of these species, as they have been well presented by Professor Baird, in his work on the "Birds of North America," and in his later "Review of American Birds," but intend merely to give a few additional features which the species constantly present in distinction from one another. The more important synonyms only are given.

The species I arrange according to the following synopsis:

A. Upper surface much brightest anteriorly, the rufous of the crown being decidedly more intense than the olive of the posterior portions; white beneath continuous; spots large, sharply defined, pure black, and extending far back.

This style is represented by a single species, the well known T. musletinus, Gm., which needs no comparison with any other.

B. Olive of back uniform from head to tail, but varying in shade.

T. fuscescens, T. ustulatus, T. swainsoni and T. alicie are of this pattern.

C. Olive of the back passing very sensibly, or even abruptly, into reddish on upper tail coverts and tail.

The species representing this style are the T. pallasi, T. audubonii and T. nanus.

Turdus fuscescens.


Sp. ch. Above tawny rufescent olive, uniform on all parts, but occasionally with a tendency to a greater intensity on dorsal region. Pectoral aspect peculiar; throat with a series of faint brown dashes on each side, these continuing down sides of neck and extending very sparsely across the breast, where they become more sharply defined; the region of these markings with a fine cream colored tinge, quite different from the buff of ustulatus and swainsonii. Like the T. alicie, this species lacks entirely the yellowish or lighter orbital ring.

Turdus ustulatus.


Sp. ch. General appearance of fuscescens, but with pattern of swainsonii, the buff orbital ring as conspicuous as in latter. The olive above is more brown than in this, and less yellowish than in fuscescens, becoming decidedly more 1869.]
rufescent on wings and less observably so on tail. Pectoral aspect different from fuscescens, the spots narrow and cuneate, sharply defined, and arranged in longitudinal series; in color they are a little darker than the crown.

This well-marked and perfectly distinct species is to be compared with swainsonii, not with fuscescens, as has generally been done; the latter, except in shade of colors, it scarcely resembles at all; still greater evidence that such is its affinity is that the T. ustulatus builds its nest on a tree, and lays a spotted egg, like swainsonii, while fuscescens nests on or near the ground, perhaps never in a tree, and lays a plain blue egg.

Turdus swainsonii.


Sp. ch. Olive above dark and pure, of a continuous shade throughout; in extreme western examples, with a clear dark greenish tint. A very broad, conspicuous ring of buff around the eye, running forward over the lore, and a very decided tinge of the same on breast. Pectoral spots well defined, delimited, becoming more transverse posteriorly; dull black.

Specimens examined from the northern regions (G. Slave Lake, Mackenzie's River and Yukon) to Guatemala; from Atlantic States to East Humboldt Mts., Nevada, California, and from intervening localities. The extremes of variation are the brownish olive of eastern and clear dark greenish olive of remote western specimens. There is no observable difference between a Guatemalan skin and one from Ft. Bridger, Utah.

Turdus aliciae.


Sp. ch. The olive above, similar to that of swainsonii, is scarcely more greenish, but is generally decidedly darker, and often with the slightest possible tinge of rich sepia or snuff brown, this becoming gradually more appreciable toward the tail; in these typical examples this tint is quite peculiar; when the shade approaches that of swainsonii it is generally when there are other unmistakable evidences of hybridism. There is in this species not a trace of a lighter loral stripe and orbital ring, so characteristic of swainsonii, this whole region being grayish, scarcely different from the cheek; with the exception of the lack of decided buffy tinge, the pectoral aspect is that of swainsonii.

A specimen from Costa Rica is undistinguishable from typical examples from the eastern U. S.

This bird and the robin are the only species of our thrushes that cross the Arctic circle to any distance, or reach the shore of the Arctic Ocean. It occurs in from Labrador, all round the American coast, to the Aleutian Islands, everywhere bearing its specific character as indicated above. It is extremely abundant on and near the Arctic coast, between the mouth of the Mackenzie's River and the Coppermine, more than 200 specimens (mostly with their eggs) having been sent thence to the Smithsonian Institution by Mr. MacFarlane. In all this number there was not a single bird that had any approach to the characters of T. swainsonii, as just given. From the Slave Lake region, on the other hand, T. swainsonii was received in nearly the same abundance, and unmixed during the breeding season with T. aliciae.

Turdus pallasi.


Sp. ch. Olive above almost exactly that of ustulatus. Rufous of the tail, upper tail coverts and lower part of rump, uniform. Olivaceous of neck continuing along sides; spots on breast sharply defined, and nearly pure black.

[June,
Turdus nanus.


Sp. ch. Above with the clear dark olive of swainsonii, but this even purer and more plumbeous. Upper tail coverts (but not lower part of rump) becoming more rufous, the tail abruptly darker, richer and more purplish rufous, approaching to chestnut. The clear olive of the neck passes into brownish plumbeous along sides; pectoral spots more sparse and less pure black than in pallasi. The white beneath is of an almost snowy purity, appreciably different from the cotty white of pallasi. A very tangible and constant character possessed by this perfectly distinct species is the more slender and depressed bill, as compared with that of pallasi. Specimens vary only in intensity of colors; these variations very limited, and corresponding with those of pallasi. In all cases, however, their precise pattern and peculiar distribution is retained.

Turdus audubonii.


Sp. ch.—Relative proportions of nanus, but much larger even than pallasi, the bill much more elongate and slender. Plumage similar to that of pallasi but lighter and more grayish; the rufous posteriorly more restricted and more yellowish even than in pallasi; pectoral spots larger and more sparse than in pallasi, clove brown instead of nearly black, breast and neck almost entirely destitute of any yellowish tinge. This species, the validity of which may be some be questioned, differs principally from pallasi in being much larger and more slender, with the arrangement of colors as in nanus, although the shades are more as in pallasi.

In regard to the above mentioned thrushes, the discussion as to whether they be all descended from as many primitive creations, whether there be three species with several varieties each, or finally whether all be merely modifications of one original type, would involve the opening of the whole question of the origin of species, and what constitutes genera and species and need not be prosecuted here. Whether one naturalist calls them species, and another races or varieties, so much is, I consider, well established—that there are seven forms of N. American thrushes requiring names, all of definable characters, and all having a well marked region of distribution. Also, that these forms are permanent over a large area, but that as in many other instances where the areas of two overlap, we have suddenly intermediate or hybrid birds that are with difficulty to be referred to either; and that these intermediate birds mixing with the others in their migrations tend to obscure the series; but that, as a general rule, specimens taken in the breeding season are distributed geographically and colored, as stated above.

2. On the uniformly red species of Pyranga, with descriptions of a new N. American species or variety.

In treating of the species of this form of the genus Pyranga, I have endeavored to be as conservative as possible in my conclusions, and have, after careful consideration of the species, represented in all their various conditions by the immense series of specimens before me, made due allowance for the variations which may accrue from natural causes, as difference of habitat, &c., and in designating the species, have allowed to each the widest possible limit, including all varieties as subordinate.

Of the present group we find two styles, one with the Pyranga vestita, Vieillot, as type, characterized by large light colored bill, without conspicuous tooth on commissure, and with no marked contrast between tints of upper and lower surface. This group contains, besides the P. vestita, the P. saira, Sclater, and P. cooperi. The other, with the Pyranga hepatica, Swainson, as type, is distinguished by plumbeous-black bill with prominent commissural tooth, and the 1869.]
upper surface of body being quite different in tint from the lower. The species, besides the type, which belong to this group, are the *P. testacea*, Sclater, and Salvin, and *P. azarce*.

Of all the species the *testacea* has the widest range of habitat, this including the "Eastern Province" of the United States, Eastern Mexico, Central America, and the northern part of South America. In Western Mexico, and the southern "Middle Province" of the United States, the *testacea* is replaced by the closely allied *P. cooperi*. The *P. hepatica* belongs to the mountain regions of Mexico, extending along the elevated lands into the southern Rocky Mountains of the United States; allied to this are the *P. testacea* of Central America, and *P. azarce* of south-eastern South America. The South American representative of the *P. testacea*, is the *P. saira*, of Brazil.

**Pyranga aestiva**, Vieillot.


Sp. Ch.—Length 7-25, extent 12-00, wing 3-81, tail 2-96, culmen 1-70, tarsus 1-68. Bill dilute, horn color, darker towards culmen, paler along commissure. Prevailing tint pure vermilion, the whole upper surface more dusky purplish red, uniform from bill to tail, perhaps a little more reddish on upper tail-coverts and lower part of rump. Exposed tips of primaries, and inner webs of upper secondaries pure umber-brown.

Female.—Yellowish olivaceous, purer dull yellow beneath; above more olive greenish.

This species is one of wide distribution, its habitat in the United States, including the "Eastern Province," is north to Nova Scotia, and west toward the Rocky Mountains, along the streams watering the plains, through Texas, into Eastern Mexico, Central America, the northern part of South America, as well as some of the West India islands.

In the different regions of its habitat the species undergoes considerable variations as regards shades of color, and proportions. Specimens from Texas and Eastern Mexico exhibit a decided tendency to longer bills and more slender forms than those of the eastern United States; the tails longer and colors rather purer. In Central America and New Grenada the species acquires the greatest perfection in the intensity and purity of the red tints, all specimens being in this respect noticeably different from those of any other region.*

Specimens from Peru (39849, 39849², and 39850 ², head-waters Huallaga River,) are undistinguishable from specimens from the eastern United States.

**Pyranga Cooperi**, Ridgway, n. s.

Sp. Ch. Length 8-60, extent 13-50, wing 4-24, tail 3-68, culmen 1-84, tarsus 1-80.† Generally rich pure vermilion, similar to that of *testacea*, but brighter than in eastern examples of this, and less roaceous than in Central American specimens. Upper surface scarcely darker than lower; the head above being scarcely different from the throat, and abruptly lighter than the back, which, with the wings and tail, is of a much

* Of this highly colored form, the average length of five specimens is 7-55; of twelve the wing is 3-67, tail 2-86, culmen 1-97. Thus the size is seen to be slightly smaller than the *testacea* of the north. The bills also appear to be a little darker, but there are no other differences.

† The mean of six specimens is somewhat less—wing 4-00, tail 3-58, culmen 1-82.

[June,
lighter dusky red than in aestiva: exposed tips of primaries pure slaty umber, primaries faintly margined terminally with paler, (in the type, this character is not apparent, owing to the feathers being somewhat worn; in other specimens, however, it is quite a noticeable feature, although possibly not to be entirely relied on.

**Female.**—Above orange olivaceous, beneath more yellowish, purest medially; crissum richer yellow than other lower parts, being in many individuals intense indiana-yellow, with the inner webs of the tail feathers margined with the same; quite distinct line of orange yellow over the lores.

**Habitat.**—Southern "Middle Province" of U. S., south of 35th parallel, and between 104th and 106th meridians. Pacific slope of Mexico.

This species, or at least very well marked race, which I dedicate to Dr. J. G. Cooper, so well known for his researches in the Natural History of Western North America, appears to be well established, and quite distinct from aestiva, to which it is most nearly related. From this it may readily be distinguished, however, by larger size, (length 8-60, instead of 7-25; wing 4-24 instead of 3-81, etc.); the bill especially being much larger, (84 instead of 70), as well as more swollen; the wing is more pointed, the primaries extending 1-16 beyond the secondaries, instead of about 84, as in aestiva. The third quill is generally longest, but in some specimens the second and third are equal; in aestiva the second is usually longest.

The most perfect representatives of this species are three specimens obtained within the limits of the United States; these are a pair (Nos. 34344, and 34345, Los Pinos, New Mexico), collected by Dr. Cones, and an immature male, collected by Dr. Cooper, at Ft. Mohave, on the Colorado River. These specimens have, owing to their peculiar habitat, a faded, or worn plumage, somewhat different from the perfect stage represented in specimens from Western Mexico, but differing from the typical style only in a bleached or faded appearance, more or less characteristic of all birds of the southern portion of the Great Basin.

**Pyranga saira, Spix.**


**Sp. ch.** Wing 4-12, tail 3-52, culmen .81, tarsus .72; 2d and 3d quills longest, 1st intermediate between 3d and 4th. Bill shaped much as in Cooperi; the upper aspect is almost precisely the same in the present bird, being, however, rather broader at the base; the lateral aspect is, however, quite different in the two; the present species having the culmen less regularly arched, the terminal curve being more abrupt, the lower mandible is decidedly inferior in depth to the upper. There is quite a decided indication of a tooth about the middle of the commissure. In this species the color of the bill is much darker than in either of the other species of the group, in this respect approaching more nearly the hepatica style; the upper mandible being dark sepal, the lower much paler and more bluish.

Above rich dark purplish red, almost exactly as in aestiva, but becoming bright scarlet on the forehead, this continuing back over the eye in a quite conspicuous superciliary stripe. Lower parts rich fine scarlet, very pure and clear, somewhat tinged with brownish laterally.

**Female.**—The graduation of the tints exactly as in the male, the scarlet of which is replaced by gamboge yellow, the dusky red by golden greenish olivaceous. The superciliary stripe is in both sexes a conspicuous feature.

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This species, although belonging to the *estiva* style, is nevertheless a well marked one, and one for the identification of which a comparison with the others is scarcely necessary. In uniformity of colors, as well as in general style of color, it much resembles *estiva*; the superciliary stripe, however, at once distinguishes it from this. The red of this species is also very different from that of any other, being purer and richer, approaching in fineness and tint that of *Pyrrhula rubra*.

**Pyrrhula hepatica**, Swainson.


Sp. ch. "Length 8·00," wing 4·12, tail 3·36, culmen 68, tarsus 84. Second quill longest, first intermediate between fourth and fifth. Bill somewhat shorter than that of *estiva*, but broader and higher at the base, becoming compressed toward the end; a distinct prominent tooth on commissure. Color plumbeous-black, paler, or more *bluish* plumbeous on lower mandible. Head above brownish red, purer anteriorly; rest of upper parts and sides brownish ashy, tinged with reddish; edges of primaries, upper tail-coverts and tail, more reddish. Beneath, medially, fine light scarlet, most intense on the throat, growing gradually paler posteriorly. Lores and orbital region grayish white; eyelids pale-red; ear-coverts ashy red.

Female.—Above ashy greenish olivaceous, brightest on forehead; edges of wing feathers, upper tail-coverts and tail, more ashy on the back; beneath nearly uniform olivaceous yellow, purer mediately; lores ashy; a superciliary stripe of olivaceous yellow. Young male similar to the female, but forehead and crown olivaceous-orange, brightest anteriorly; superciliary stripe bright orange, whole throat, abdomen and breast mediately rich yellow, most intense and tinged with orange-chrome on throat.

Hub.—Mountain regions of Mexico and Southern Rocky Mountains of U.S.

This species differs from all the others in the great restriction of the red; this being confined to the head above, and median lower surface, the lateral and upper parts being quite different reddish-asy. The shade of red is also peculiar, this being very fine and light, of a red-lead cast, and most intense anteriorly.

**Pyrrhula azare**, D’Orb.

*Pyrrhula azare*, D’Orb., Voyage, 264.

Sp. ch. Wing 3·60, tail 3·52, culmen 64, tarsus 80. Bill smaller than in *hepatica*, and narrower; commissural tooth obsolete or, in fact, not observable; color blackish plumbeous, as in *hepatica*. Second quill longest: first scarcely shorter than third. General tint below dull light vermil- lion, less clear than in *hepatica* and less restricted, the sides being scarcely obscured by grayish; the shade is also continuous, the crissum being as intense as the throat. Above dull purplish brown, more reddish on edges of primaries and tail feathers; head above strongly tinged with red; lores and eyelids well defined dull white; ear coverts dull red. (Plumage of female unknown.)

This species, of which there is but one specimen in the collection, is most nearly related to *hepatica*; it differs from this, however, in smaller bill, with-
out teeth; less ashy color above, and less restriction of the red below, the white lores and more reddish cheeks.

_Hab._—Paraguay. Type 20996, _♀_. Expl. Parana, Capt. T. J. Page, U. S. N.

I do not feel entirely sure that this bird is the species of D'Orbigny, nor that it may not be undescribed. I present it, however, under the above name for further consideration.

**Pyranga testacea**, Slater and Salvin.

_Pyranga testacea_, Slater and Salvin, Pr. Z. S. 1868, 388, Veragua.

_Sp. ch._ Wing 3-48, tail 3-12, culmen 7-76, tarsus 8-80. Bill very large and much swollen; very broad at base, becoming quickly compressed toward tip; tooth on commissure very prominent and conspicuous. Upper mandible nearly pure black, lower more plumbeous. Color generally very dark testaceous red, becoming gradually purer brownish scarlet medially beneath; lores, suborbital space and extreme border of chin grayish.

_Female._—Olivaceous green above, and deep olivaceous orange anteriorly beneath, the gradation of the tints exactly as in the male.

_Hab._—Veragua, Costa Rica (Angostura), Río Manati and Belize.

Described from a type specimen presented to the Smithsonian Institution by Mr. Salvin.

3. The Smaller _Quiscali_ of the United States.

In making an examination of a very large series of the smaller Grakles of the United States, I was struck by a radical difference in form and color between specimens from the Atlantic and interior States, which I find to be sufficiently constant to warrant the separation into two distinct varieties if not species.

Professor Baird refers to this difference in his work on the Birds of N. Am. (see p. 556), and mentions its constancy, which I have been able to confirm.

The following diagnoses are intended to express the distinctions referred to:

**Quiscalus purpureus**, Bartram.


_Fig. 1._

_Sp. ch._ Length about 12-50, wing 5-50, tail 4-02, culmen 1-24, tarsus 1-28. Second quill longest, hardly perceptibly (only .07 of an inch) longer than the first and third, which are equal; projection of primaries beyond secondaries 1.56; graduation of tail .92. General appearance glossy black; whole plumage, however, brightly glossed with reddish violet, bronzed purple, steel blue and green; the head and neck with purple prevailing, this being in some individuals more blueish, in others more reddish; where most blue this is _46647_ 1869._]
purest anteriorly, becoming more violet on the neck. On other portions of the body the blue and violet forming an iridescent zone on each feather, the blue first, the violet terminal; sometimes the head is similarly marked. On the abdomen the blue generally predominating, on the rump the violet; wings and tail black, with violet reflection, more blueish on the latter; the wing coverts frequently tipped with steel blue or violet. Bill, tarsi and toes pure black; iris sulphur yellow.

Hab. Atlantic and Gulf? States, north to Nova Scotia, west to the Alleghenies.

This species is more liable to variation than any other; the arrangement of the metallic tints varies with the individual; there is never, however, an approach to the sharp definition and symmetrical pattern of coloration characteristic of the western species. One specimen (No. 31049, Washington, D. C.) is wonderfully similar, in the darkness and distribution of tints, to the Q. agileus, Bd., but resembles this in these respects only.

Wilson's figure conveys a good idea of this species; Audubon represents the western style, although his description is of the eastern.

The exact name of this species is a matter of some question. It is undoubtedly the Gracula quiscalus of Linnaeus, as based on the purple jackdaw of Catesby, which, although generally considered as the same with the common crow blackbird of the northern States, is more like major. The Gracula purpurea of Bartram from Florida, again, though excluding major, may include agileus. Q. versicolor, of Vieillot, embraces various West Indian species, though essentially belonging to the crow blackbird. On the whole, for the present, at least, I will follow Mr. Cassin in retaining Bartram's name of purpureus.

Quiscalus agileus, Ridgway.

Quiscalus versicolor, Aud., Orn. Biog. pl. vii; Birds Amer. iv, pl. 221, (figure but not description).

Fig. 2.

Sp. ch. Length 12-50 to 13-50, wing 6-00, tail 6-00, culmen 1-26, tarsus 1-32. Third and fourth quills longest and equal; first shorter than fifth; projection of primaries beyond secondaries 1-28; graduation of tail 1-48. Metallic tints rich, deep and uniform. Head and neck all round rich silky steel blue, this strictly confined to these portions, and abruptly defined behind, varying in shade from an intense Prussian blue to brassy greenish, the latter tint always, when present, most apparent on the neck, the head always more violaceous; lores velvety black. Entire body, above and below, uniform continuous metallic brassy olive, varying to burnished golden olivaceous bronze, becoming gradually uniform metallic purplish or reddish violet on wings and tail, the last most purplish; primaries violet black; bill, tarsi and toes pure black; iris sulphur yellow.

Habitat.—Mississippi region of U. S., east to Alleghany Mts., west to Ft. Bridger; Saskatchewan Country, Hudson's Bay Territory, Labrador and Maine (52382, Oulnis, Mc. G. A. Boardman).

This species may be readily distinguished from the preceding by the color alone, independently of the differences of proportions.

The impression received from a casual notice of a specimen of the Q. purpureus is that of a uniformly glossy black bird, the metallic tints being much broken or irregularly distributed, being frequently or generally arranged in
successive bands on the feathers over the whole body, producing a peculiar iridescent effect. In the *Q. xenus* nothing of this character is seen; for, among a large series of western specimens, not one has the body other than continuous bronze, the head and neck alone being green or blue, and this sharply and abruptly defined against the very different tint of the other portions. These colors of course have there extremes of variation, but the change is only in the shade of the metallic tints, the precise pattern being strictly retained. In the present species the colors are more vivid and silky than in the eastern, and the bird is in fact a much handsomer one.

**Quiscalus aegleus**, Baird.


**Fig. 3.**

*Sp. ch*—Length 11-00, wing 5-20, tail 5-12, culmen 1-24, tarsus 1-28. Second and third quills equal and longest; first shorter than fourth; projection of primaries beyond secondaries 1-12; graduation of tail 1-00.

Bill very slender and elongated, the tip of upper mandible abruptly decurved; commissure very regular.

Metallic tints very dark. Head and neck all round well defined violaceous steel blue, the head most blueish; body soft dull bronzy greenish black, scarcely lustrous; wings, upper tail coverts and tail blackish steel blue, the wing coverts tipped with vivid violet bronze; belly and crissum glossed with blue.

**Hab.**—South Florida.

This species is quite well marked, differing from the two preceding in much smaller size, with more slender and more decurved bill.

The arrangement of the colors is much as in the larger western species, while the tints are most like those of the eastern. All the colors are, however, darker, but at the same time softer than in either of the others.

In form this species approaches nearest the western, agreeing with it in the primaries, slender bill, and more graduated tail, and, indeed, its relations, in every respect, appear to be with this rather than the eastern.

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**July 6th.**

The President, Dr. Hayes, in the Chair.

Ten members present.

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**July 13th.**

Dr. Bridges in the Chair.

Twelve members present.

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Mr. Meehan presented leaves of the Peach and Cherry, and said it had fallen to him to point out that the leaf blades of plants were developed in proportion as vigorous vitality was relaxed, and that they were adherent or decurrent in proportion as vigor or vitality was thoroughly developed in the central axis or stem. By following out the same line of observation he had discovered the law which governed the production of sexes in plants, and he now wished to call attention to the operation of the same cause in the production of glands on the leaf stalks of the Peach and Cherry.

A careful examination of a gland-bearing variety of either of these would show that these glands were simply germs of the cellular matter which formed the leaf blade. They may be seen in every stage of development from dense full globes on the petioles to very small dots on the apex of the tolerably well expanded matter, and it will be further seen that in proportion as vitality is weak are these germs and glands developed. Leaves from the shaded center of the tree, or from shoots weak or enfeebled from any other cause, produce glandless leaves, while the stronger the shoot, the stronger and more numerous are the glands or undeveloped parts. Remembering that these glands are but undeveloped leaf blades, and that I have proved in former pages that plants develop these less freely in proportion to a vigorous axial or stem growth, it should necessarily follow that a weakened vitality would be indicated by an absence of glands. That this is so in the cases before us, these weak and glandless leaves show. But I have had a very remarkable confirmation of this by the observations of Peach growers who have had no knowledge of these recent physiological discoveries. Many varieties of Peaches have no glands, and these have been found by the growers of southern Illinois, as I am informed by Dr. Hall, of Alton, in all cases to be the first to succumb to diseases or unfavorable circumstances. It is very seldom that the developments of science, and untutored observation, go along together and so thoroughly accord. To me it is one of the most interesting facts I have met with in support of my theory—that the degree of separation of the leaf-blade from the main stems is wholly a question of vitality.

Mr. Meehan exhibited some fibre obtained from Mr. Roæzel, of Vera Cruz, which was fewer and stronger than that furnished by the “Ramie.” Mr. Roæzel obtained it from a plant which he had found in the Alleghanies, and which he believed to be a new species of Botneria. Mr. M. had, however, since found it abundantly along the Missouri River, and it proves to be only Urtica purpurascens, Nutall.

July 20th.

The President, Dr. Hays, in the Chair.

The publication of the Proceedings for January, February and March, was announced.

July 27th.

DR. RUSCHENBERGER, Vice-President, in the Chair.

Dr. Chas. L. Cassin, U.S. N., was elected a member.

On favorable report of the Committee, the following paper was ordered to be printed:

[July]
Descriptions of New Carboniferous Fossils from the Western States.

BY F. B. MEEK AND A. H. WORTHEN,
Of the Illinois State Geological Survey.

ECHINODERMATA.

Genus POTERIOCRINITES, Miller.

The typical forms of this genus have a more or less obconical body, with a protuberant base, strong rounded column, and generally long, stout, bifurcating arms, always composed each of a single series of pieces. The body is composed of five basal pieces, alternating with five subradials, and five first radials, all alternating with the latter, excepting one on the anal side, which rests directly upon the upper truncated edge of one of the subradials.

The anal series consists, normally, of two alternating vertical ranges of pieces, the lowest piece of which rests between the upper sloping sides of two of the subradials, partly under one side of the first radial on the right, and connects above its middle, on the left, with another resting on the upper truncated edge of one of the subradials, and joining the first radial on the left, while usually one or two more above these connect with others belonging more properly to the base of the so-called proboscis. The primary radials above the first are free, and generally smaller, and vary in number in the different rays of the same individual, from about two to eight, ten, twelve or more, below the first bifurcation. The ventral part of the body is produced upward in the form of a cylindrical, or more or less expanded proboscis (so called), generally as wide as the whole space between the arms below, and composed of regular hexagonal pieces, often with pores passing through the sutures between. The opening is said to be near the top of the proboscis, though we have never seen it in any of the numerous specimens we have examined.

In addition to the species agreeing in all respects with the characters above given, there are numerous others which, although conforming in general structure with the typical forms, still depart so widely in some of their characters, that when the extremes are compared, it seems difficult to believe that they can all belong to one genus. And yet they are all linked together by so many intermediate gradations that, in the present state of our knowledge of these fossils, we are at a loss to see how they can be separated more than subgenerically. For some of these types the names Scaphiocrinus, Zearcrinus, Cylindricrinus, etc., have been proposed, either as subgenera or as distinct genera from Poteriocrinites. Adopting the former view, these groups may, in order to facilitate their study, be arranged as follows, commencing with Poteriocrinites proper:

1.—Genus Poteriocrinites, Miller.
Represented by such forms as P. crassus, Miller, P. conicus, Phillips, P. Missouriensis, Shumard, and P. Seelovii, M. and W.

2.—Subgenus Scaphiocrinus, Hall; or Graphiocrinus, de Koninck and Le Houën."

The characters distinguishing this group, as it is generally understood, from Poteriocrinites proper, may be stated as follows: Species generally of smaller size and less robust habit, with only two (or rarely three) primary radial pieces

* It seems highly probable, as has been suggested by Mr. Lyon and Dr. Shumard, that the type on which de Koninck and Le Houën founded their name Graphiocrinus, may have five minute basal pieces hidden by the column in the concavity of the under side, within the range apparently belonging to the basal series, as is the case with many American forms. If so, the typical form of Scaphiocrinus would present no difference of even subgeneric importance, and the name Scaphiocrinus would have to be abandoned; in which case the American species would have to be called Graphiocrinus simplex, G. spinobrochias
tus, G. tortuosus, &c.

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to each ray, excepting sometimes in the anterior ray. Second radial pieces generally contracted in the middle, and usually separated from the first radials by gaping sutures. Arms generally shorter and sometimes simple, often with the pieces so arranged as to present a zigzag appearance. Body short and rounded or concave below, or varying to an inverse bell shape or obconic outline.* Anal pieces sometimes with only a single one included as a part of the wall of the body.


Poteriocrinites dactyloides, P. latifrons, of Austin, and P. tenuius, of Miller, would also fall into this section, giving it the limits usually admitted.

3.—Subgenus Zeacrinus, Troost.

Differs from Scaphiocrinus in having the body more generally rounded and concave below, and always with more than one anal piece included as a part of the walls of the body. Also in having the arms generally more frequently bifurcating and the inner divisions all simple, as well as in having the free radials generally wider.


4.—Subgenus Celiacrinus, White.

Differs from Scaphiocrinus in having the ventral prolongation much inflated or balloon shaped, instead of nearly cylindrical.

Includes Poteriocrinus dilatatus, and P. ventricosus, Hall.

Poteriocrinites? perplexus, M. and W.

Body small, somewhat cup shaped, with sides a little expanding above and rounding to the column below; height to top of first radial pieces more than half the breadth at the same point. Base small, much depressed, or nearly flat, with a pentagonal outline. Subradial pieces each nearly as large as the whole base, about as wide as long, three hexagonal and two heptagonal (counting a very obtuse angle at the middle of the base of each). First radials nearly twice as large as the subradial pieces, and proportionally wider, pentagonal in form, and each with a moderately deep rounded sinus, rather more than half the breadth of its upper margin, for the reception of the suc-

* It is worthy of note that the original typical species of Scaphiocrinus (S. simplex, Hall), has its body much depressed and rounded, but not concave, below, with but one anal piece only, included as part of the walls of the body. It also has but two radials to each ray, with all the arms simple, and two from each ray, excepting in the anterior ray, which supports only one arm. [This species is wrongly described, and illustrated by the cut, in the text of the Iowa Report, part ii, vol. 1, p. 550—52, as having the arms double from their origin on the second radials all around, there being but one arm in the anterior ray in the type specimen now before us.] The group, however, has been extended by Prof. Hall and others, so as to include species presenting all the characters given above, and might be divided into several sections distinguished from each other and from the typical form, on quite as good characters as those distinguishing the latter from Zeacrinus.

† This is our Poteriocrinus carinatus, (Illinois Report, vol. iii, pl. 17, fig. 1). As Prof. Hall had previously used the name carinatus for a Scaphiocrinus, it becomes necessary to give our species a new name. At the time we referred it to Poteriocrinites proper we were not aware that there is a little group of species having the other characters of Scaphiocrinus, and yet with three radial pieces to each ray.

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ceeding radials. Anal pieces presenting the usual arrangement of a double alternating series, the lowest being partly under one side of the first radial on the right, while the next on the left of this rests on the truncated upper edge of one of the subradials, and these connect with others above, that form the base of the proboscisidiform ventral extension. Second radials very small and short, or scarcely more than filling the sinuses in the first. Third radials nearly as wide as long, quadrangular and only about half as wide as the first radials. Fourth radials a little larger than the third, pentagonal in form, and supporting the arms on their superior sloping sides.

Arms slender, rounded and proportionally long, bifurcating first above the last radial, generally on the third or fourth piece, above which each of the subdivisions bifurcates again several times. Arm pieces generally about as wide as long, and not wedge shaped.

Proboscisidiform extension at least half (and perhaps more than half) as long as the arms, entirely lateral, and not more than half as wide as the body, below; apparently somewhat thicker above. Body plates not convex, but merely granular, and joined by close fitting sutures. Column slender, round, and composed of nearly equal moderately thick pieces, near the base.

Height to top of first radial pieces, about 0.15 inch; breadth, 0.24 inch; length of arms, about 0.95 inch.

This is one of those few intermediate types such as we occasionally meet with in various departments of Natural History, when extensive collections can be studied, connecting or standing, as it were, intermediate between two genera. That is to say, it combines some of the characters usually regarded as belonging especially to Poteriocrinites with others equally characteristic of Cyathocrinites. Its body has much the usual form of Cyathocrinites, with the double alternating series of anal pieces precisely as we see in Poteriocrinites. On the other hand, it has the narrow, decidedly lateral proboscisidiform ventral extension of Cyathocrinites, and might, with almost equal propriety, as far as we yet know, be called Cyathocrinites? perplexus. The existence of such a type would, in the estimation of some naturalists, be regarded as a sufficient reason for uniting the genera Poteriocrinites and Cyathocrinites. In this opinion, however, we cannot concur, for we believe that if all the genera thus connected by a few obscure forms were united, it would be found impossible to fix any limits whatever to such groups, with all the extinct types before us. Possibly characters may be found, however, warranting the establishment of a new genus for such forms.

Specifically this little Crinoid seems to be most nearly allied to our Cyathocrinites? enormis, but it differs in the number and arrangement of its anal pieces, as well as in having its arm pieces scarcely one-half as long in proportion to thickness.

Locality and position.—Lower part Burlington group of the Lower Carboniferous, Burlington, Iowa. No. 264 of Mr. Wachsmuth’s collection.

Subgenus SCAPHIOCRRINUS, or GRAPHIOCRRINUS.

SCAPHIOCRRINUS RUDIS, M. and W.*

Body much depressed, about four times as wide as high, flat or a little concave below, the flattened part including the basal, subradial, and about half the length of the first radial pieces. Base very small, a little impressed, and entirely hidden by the column. Subradial pieces of moderate size, extending out horizontally from the column; the one on the anal side, however, curving up distinctly, and the others slightly, at the ends; all flat, excepting the curvature mentioned, and pentagonal in outline (the superior angle being rather salient), excepting the one on the anal side, which is hexagonal, being trun-

*Although we write the names Scaphiocrinus and Zonocrinus in this paper for the sake of brevity, as if they were regarded as distinct genera, we really use them as subgeneric names under Poteriocrinites, as already explained.

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cated above for the reception of the anal piece. First radial pieces three or four times as large as the subradials, twice as wide as long, very tumid in the middle, and pentagonal in form, the lateral margins being longer than the inferior, and the superior one straight, and equaling the entire breadth. Second radial pieces of about the same size as the first, which they equal in breadth below, though they are a little longer, and proportionally narrower above, and have each a strong angle down the middle of the outer side; all pentagonal in outline (excepting the anterior one, which is quadrangular), the superior angle being salient; each supporting two arms on the superior sloping sides, excepting the anterior one, which bears but a single arm.

Of anal pieces one only is included as a part of the walls of the body, and this one rests upon the upper truncated edge of the largest, curved subradial, and connects on each side with a first radial. Succeeding anal pieces unknown.

Arms moderately strong, simple, angular on the dorsal side, and composed of short wedge shape pieces, alternately projecting out laterally on each side, in the form of spine-like processes. Column small, round, and composed near the base of pieces of moderate thickness, with each a projecting ridge around its middle, and perforated by a minute round canal. Sutures between the first and second radial pieces widely gaping when the arms are folded up vertically.

Height of body, 0.08 inch to the top of first radials; breadth, 0.33 inch; length of remaining portions of arms, about 0.85 inch; thickness of column at base, 0.17 inch.

This belongs to the typical section of Scaphiocrinus, as it has but a single anal piece included as a part of the body, and all its arms are simple. Specifically it appears to be most nearly allied to S. spinobrachiatus, Hall (Bost. Jour. Nat. Hist. vol. vii, p. 306), but differs in having its body much depressed, more flattened below, and its base is so much smaller as to be entirely hidden by the column, instead of projecting out around it. Its subradial pieces also differ in not being more elevated than the others, nor impressed at the angles. The arms in the specimen from which our description was drawn up, are not quite complete at their ends, though from a slight tapering and appearance of a tendency to curve together toward their extremities, it seems to be quite probable that they were not more than an inch in length, while those of the species spinobrachiatus are said to be about three inches in length, in the original specimen, and still imperfect at the ends.

Locality and position. Upper division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 275 of Mr. Wachsmuth's collection.

Scaphiocrinus macrodactylus, M. and W.

Body obconical, or tapering rather gradually from the top of the first radials to the column. Base about twice as wide at the top as long, truncated below, the breadth of the column; basal pieces a little longer than wide, pentagonal in form, with the lateral margins longer than the upper sloping sides. Subradial pieces once and a half to twice the size of the basals, hexagonal in form, excepting one (or possibly two) on the anal side, which is larger than the others and heptagonal, being truncated above for the reception of an anal piece.

First radial pieces wider and a little shorter than the subradials, and all wider than long. Second radials distinctly longer than wide, rounded and constricted in the middle, with a pentagonal outline (excepting the one in the anterior ray, which is truncated above), and supporting the arms on their superior sloping sides. Arms nine or ten, simple from their origin, very long, slender, rounded and composed of wedge form pieces, which have their longer side about twice the length of the shorter and equaling their breadth, but not projecting so as to give the arms a zigzag appearance. Pinnules long, moderately stout, and composed of joints about twice as long as wide. Anal pieces unknown.

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Surface finely granular. Column round, moderately stout and composed of rather thin pieces, of uniform size near the base, with a rather small, round or subpentagonal central canal.

Length of body below the summit of the first radial pieces, 0.40 inch, breadth about 0.50 inch. Diameter of column at base, 0.18 inch. Entire length of arms unknown, as they are all broken at the extremity, with the remaining portion measuring 3.40 inches in length, with thickness of about 0.10 inch throughout.

This species has the long straight arms, obconic body, protuberant base, and general physiognomy of the typical forms of *Poteriocrinites*, but differs in having but two primary radial pieces to each ray, with the sutures between them somewhat gaping, as in *Scaphiocrinus*. Specifically it is not closely allied to any of the other known species. In the form of its body it is most nearly allied to our *Pot. subimpressus*, which Mr. Wachsmuth has ascertained probably has only two primary radial pieces to each ray, and hence seems to fall into *Scaphiocrinus*, giving that group the wide limits usually admitted. The species here under consideration, however, will be readily distinguished from the *Pot. (Scaph.) subimpressus*, by not having its body plates impressed at the corners, and all distinctly thinner, as well as by its less robust general habit.

**Locality and position.** Lower beds of the Burlington group, Burlington, Iowa. Lower Carboniferous. {No. 277 of Mr. Wachsmuth's collection.}

*Scaphiocrinus nanus*, M. and W.

Body very small, expanding rapidly from the column to the top of the first radials, where it is about once and a half as wide as high. Base small, slightly projecting, pentagonal in outline, and nearly covered by the round, flat facet for the attachment of the column. Basal pieces showing a very short, minute pentagonal facet above the column. Subradial pieces a little wider than long, three with a pentagonal outline, and two on the anal side hexagonal, there being no well defined angle visible at the middle of the under side of any of them. First radials of about the size of the subradial pieces, a little wider than long, pentagonal in form, and somewhat rounded on their outer sides, in consequence of the sutures between them being impressed. Second radials longer than wide, or nearly twice as long as the first, all pentagonal in outline and rounded and more or less constricted in the middle, each supporting two arms on its upper sloping side.

Anal pieces consisting of a double alternating series, the lowest one of which rests between the upper sloping sides of two of the subradials, and supports one side of the first radial on the right, while on its left it connects, above the middle, with another anal resting upon the truncated upper side of one of the subradials, and connecting on its left with the first radial on that side; above these three or four other pieces are seen between the arms extending up and joining with the base of the so-called probosces.

Arms somewhat rounded on the dorsal side, each bifurcating on the sixth or seventh piece above the second primary radials, and composed of wedge form pieces that are a little longer than wide on the longer side. Above the bifurcations these pieces are somewhat constricted and each one projecting laterally above, on its longer side, for the reception of the pinnula, so as to present a rather zigzag appearance. Pinnulae moderately stout, and rather distantly separated from each other; composed of joints a little more than twice as long as wide.

Surface of body plates even, and finely granular.

Height of body, 0.10 inch to top of first radial pieces, where it measures about 0.20 inch in breadth. Arms about 0.75 inch in length.

In size and general appearance this species is quite similar to *S. dichotomus*, of Hall, with which it also agrees in having its arms bifurcating but once above their origin on the second radials. It differs, however, in having its second radial pieces rounded instead of angular, and distinctly longer in proportion to 1869.]
breadth, as is also the case with all the arm joints. It also differs in having two arms to each ray; all around, instead of only one in the anterior ray, as well as in the number of pieces in each arm below the bifurcations. Its arms are likewise proportionally more slender.

**Locality and position.** Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. Mr. Wachsmuth's collection.

**Scaphiocrinus striatus, M. and W.**

Body below the top of the first radial pieces subhemispherical, being regularly rounded below; composed of thick plates, which are ornamented with distinct, somewhat broken striae, running vertically, so as to radiate from the base, but all parallel with each other on each individual plate. Basal pieces hidden by the column externally. Subradials about as wide as long, five of them showing a pentagonal outline (there being no visible angle at the middle of their bases on the outside), and one on the anal side hexagonal, the latter being a little larger than the others. First radial pieces slightly shorter than the subradials, but about once and a half as wide, all having a general pentagonal form, being broadly truncated their entire breadth above, and having the articulating surfaces each marked with two very distinct transverse furrows. First anal piece a little longer than wide, hexagonal in form, and resting upon the truncated upper end of the odd subradial between two of the first radials, beyond which it projects nearly half its length; truncated above for the reception of a second anal. Other parts unknown.

Sutures distinctly channelled, so as to impart a moderate convexity to the plates.

Height to top of first radials, 0·20 inch; breadth, 0·46 inch.

This is a typical Scaphiocrinus, as far as its parts are known, and seems to be most nearly related to S. simplex, of Hall, from which it may be at once distinguished, however, by its channelled sutures, convex plates and peculiar sculpturing.

**Locality and position.** Lower Burlington beds, of the Lower Carboniferous, at Burlington, Iowa. No. 274 of Mr. Wachsmuth's collection.

**Scaphiocrinus penicillus, M. and W.**

Body small, somewhat basin shaped, or about three times as wide as the height to the top of the first radial pieces, truncated and a little concave below. Base very small, and nearly or quite hidden by the column in the shallow concavity of the under side. Subradials generally wider than long; with a pentagonal outline, excepting one on the anal side, which has the upper angle a little truncated, so as to make a sixth angle; there is doubtless also another obtuse angle at the middle of the lower side of each, covered by the column. First radial pieces wider than high and pentagonal in form. Second radial pieces nearly twice as long as wide, expanded at each end, and distinctly constricted along the middle, where they are each somewhat carinated on the dorsal side; all pentagonal in form and supporting each two arms on their superior sloping sides, excepting in the anterior ray, where this piece is quadrangular and supports but one arm.

First anal piece wedged obliquely down in between two of the subradials, under one side of the first radial, on its right, and connecting by its left side, above the middle, with another anal resting on a very short truncated side of one of the subradials, and connecting on the left with the first radial of that side. Above these one or two other pieces are seen between the arms, connecting with the base of the proboscis.

Arms somewhat rounded, and bifurcating on the fifth or sixth piece above the second radials; and in all but the anterior ray, one of the divisions (the inner one) remains simple, and the other subdivides again on the sixth, seventh or eighth piece, while the anterior arm bifurcates first on the sixth piece, and each of its subdivisions again on the eighth or tenth piece above. First, and
sometimes also the second arm pieces a little longer than wide, and slightly constricted; other arm pieces generally wider than long and wedge shaped, but not arranged so as to impart a zigzag appearance to the arms. Column small, nearly or quite round, and composed near the base of alternately thin and thick pieces.

Height of body to top of first radial pieces, 0·07 inch; breadth, 0·20 inch; length of arms, about 0·70 inch.

This little species seems to be nearest like *S. dichotomus*, Hall (Iowa Report, p. 553), with which it agrees in size and general appearance. It will be readily distinguished, however, by the more frequent bifurcations of its arms, which also differ in being more rounded and composed of proportionally longer pieces, not arranged so as to present a slightly zigzag appearance, as in the species *dichotomus*. It will also be distinguished from the last by having two arms to each ray all around, as well as by its concave base.

**Locality and position.** Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 286 of Mr. Wachsmuth's collection.

*Scaphocrinus* Tethys, M. and W.

Body under medium size, expanding rather rapidly from the column to the top of the first radials, where it is about one-fourth wider than high. Base small, twice to three times as wide as high. Basal pieces very small, wider than high, and pentagonal in form. Subradial pieces slightly wider than long, pentagonal, excepting two on the anal side, which are hexagonal, there being no well defined angle at the middle of the base of any of them. First radials larger than the subradials, a little wider than long, and all pentagonal. Second radial pieces rather more than twice as wide as long; rounded and a little constricted in the middle, and somewhat expanded at the ends; all pentagonal in outline, and each supporting two arms on its superior sloping sides.

Anal series consisting of two alternating vertical ranges of pieces, the first of which rests between the two upper sloping sides of two of the subradials, and supports an inferior sloping side of the first radial on the right, while its left side above the middle connects with another anal resting upon the truncated upper side of one of the subradials, and connecting with the first radial on the right. Above these one or two ranges of similar pieces join with those forming the base of the so-called proboscis.

Arms not positively known to bifurcate after their origin on the second radial pieces; composed of joints, the lower of which are twice to three times as long as wide, and rounded or subangular, and narrower in the middle than at the ends. Above these the pieces gradually become shorter, and more distinctly expanded at the ends, with the upper lateral extremity of each somewhat projecting alternately on opposite sides, so as to present a distinct zigzag arrangement, the projection being for the support of the pinnule, which are comparatively rather stout, and composed of joints two or three times as long as wide, and provided with deep ambulacral furrows within.

Column comparatively rather stout; subpentagonal near the base, but soon tapering and becoming rounded below; composed below of uniform pieces; about one-third as thick as wide, but gradually becoming thinner near the base of the body.

Length of body to top of first radial pieces, 0·17 inch; breadth about 0·22 inch; length of arms, about 1·10 inch.

This species is related to that we have here described under the name *S. natus*, but not only differs in having longer arms, but in having its second radial pieces and all of its arm joints much longer in proportion, as well as presenting a more strongly zigzag arrangement. Its base is also more protuberant, and the sutures between its body plates slightly impressed instead of even.

**Locality and position.** Upper division Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 298 of Mr. Wachsmuth's collection.

1869.]
Scaphiocrinus delicatus, M. and W.

Body very small, somewhat cup-shaped, once and a half as wide as the height to the top of the first radials; sides expanding rapidly upward from about the middle of the subradials to the top of the first radial pieces, and rounding under to the column below. Base very small, and nearly hidden by the column, pentagonal in general outline. Basal pieces merely appearing as minute trigonal facets around the top of the column, and curving upward a little at the extremity. Subradial pieces of comparatively rather large size, three or four of them hexagonal (counting a very obtuse angle at the middle of the under side), and one or two heptagonal. First radial pieces of about the size of the subradials, but shorter and wider, and all pentagonal in form; facet of each for the reception of the second radials not occupying the entire breadth above, and sloping outward. Second radials full twice as long as wide, measuring the breadth at the widest part of the lower end; slender and rounded in the middle, and enlarged at the ends, particularly below; each supporting two arms on their upper sloping sides.

Anal plates arranged in a double alternating series, exactly as in the last described species. Arms slender, rounded, and composed of joints, the lower of which are about twice as long as wide, but those above gradually growing shorter, until they become scarcely longer than wide, on the longer side; and owing to their oblique arrangement and projections for the support of the pinnules, presenting a zigzag appearance. At least one of the posterior arms seen to bifurcate on the seventh piece. Pinnules rounded, comparatively rather stout, composed of joints two or three times as long as wide, and owing to the length of the arm-pieces, widely separated from each other. Column of moderate thickness, and apparently showing a tendency to assume a pentagonal outline near the base.

Height of body to the top of first radial pieces, 0.10 inch; breadth of do. 0.15 inch; length of arms about 0.75 inch.

This very delicate little species is nearest like that we have already described under the name Scaphiocrinus nanus, but will be readily distinguished by its much more slender second radial pieces and arms. This narrowness of the second radials causes the intervening spaces to be wider than the second radial pieces themselves; while in the Scaphiocrinus nanus these pieces are so wide as to be in contact with each other all around, excepting on the anal side. These differences give to each of these two forms more strongly marked distinctive features than would probably be apparent from merely reading the descriptions without seeing the fossils themselves.


Scaphiocrinus Clia, M. and W.

Body inversely subcampanulate, somewhat truncated or more or less rounded to the column below, and a little expanded at the top of the first radials, where it is nearly twice as wide as high. Base very small, or almost entirely hidden by the column, not projecting below the horizon of the next range of pieces. Sabradial pieces slightly tumid, and owing to the small size of the base forming most of the under side, as well as half of the height of the body, a little longer than wide, and all (excepting probably one or two not seen on the anal side) presenting a general pentagonal outline, there being no visible angle at the middle of the under side in any of them. First radials larger than the subradials, wider than long, pentagonal in form, and rounded or convex on the outer side above. Second radials short, transversely oblong, or about twice as wide as long, and all rounded on the outer side. Third radials (in four of the rays seen) somewhat longer than the second, pentagonal in form, but with their lateral margins so short as to appear nearly trigonal; supporting the arms on their superior sloping sides. Anal pieces unknown.

[July,
Arms round, rather slender, and after their origin on the third primary radials, bifurcating on the seventh, ninth or eleventh pieces in the different arms seen, and beyond this, one arm is observed to bifurcate on the nineteenth piece above; all composed of slightly wedge-formed pieces, a little wider than long.

Proboscis (so called), as observed nearly flattened by pressure, two-thirds as wide as the body, and about four-fifths as long as the arms; not expanded at the summit; composed of moderate sized hexagonal pieces indented (and probably perforated) at the corners. Column subpentagonal near the base, where it is composed of alternately thicker and thinner pieces, with a small apparently pentagonal canal.

Height of body to top of first radials, 0·20 inch; breadth, about 0·40 inch; length of arms, about 2·10 inches. Length of proboscis above first radials, 1·70 inches; thickness of column at its connection with the base, 0·15 inch.

This species is related to such forms as *N. carinatus* and *S. dichotomus*, Hall; *S. rusticus*, White, and *S. Wachsmuthi*, M. and W., but differs from them all too clearly to render a comparison necessary.

**Locality and position.**—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 295 of Mr. Wachsmuth's collection.

**Scaphiocrinus scalaris**, M. and W.

Body small, somewhat cup-shaped, being broad below, and a little expanded above; about twice as wide as high at the top of the first radials. Base small and hidden by the column in the concavity of the under side. Subradial pieces tumid, wider than high, and arranged so that the body rests upon them, when placed on a plane surface with the column removed; all appearing as if pentagonal, excepting the two on the anal side, which seem to be hexagonal, but they must all have each an additional obtuse angle at the middle of the under side. First radials about of the same size as the subradials, wider than long and pentagonal in form, though one on the anal side has one side so short as to appear as if quadrangular; each a little expanded above, so as to present, with the broad excavations at their inferior lateral angles, a more or less constricted appearance. Second radials smaller than the first, rounded on the outer side, and a little constricted on the lateral margins, all wider than long, with a quadrangular outline. Third radial pieces in all but the anterior ray nearly as long as the first, but proportionally longer, rounded on the outer side, constricted in the middle, and pentagonal in form; the superior lateral sloping sides of each supporting an arm. In the anterior ray the third piece is narrow and long, truncated above, and merely supports a single arm.

First anal piece smaller than the subradials, pentagonal in form, and resting between the upper sloping sides of the two hexagonal subradials; connecting on the left with the second anal, and on the right with a first radial, while it supports one side of another anal above. Second anal of nearly the same size as the first, and resting upon the superior truncated side of the subradial below. Above these, two alternating series of anal pieces are seen extending upward, to connect with the base of the so-called proboscis.

Arms nine, simple from their origin on the third radials, rather angular on the back, and each composed of short wedge-formed pieces, arranged somewhat in zigzag, with their longer ends alternating on opposite sides, and projecting so as to support stout, rounded pinnule, composed of joints sometimes nearly as long as wide. Pinnule very regularly arranged, so as to leave intervening spaces scarcely of their own breadth, and so stony as to present rather the appearance of armlets, than what are usually called tentacles, in the descriptions of fossil Crinoïds; all like the arms with the ambulacral furrows comparatively deep and large.

Vault unknown; proboscis (so-called) about half as long as the arms, comparatively rather slender until at the upper extremity, where it is suddenly expanded to nearly twice its breadth below, and somewhat flattened on top. The 1869.
expansion, however, seems to be mainly due to the greater thickness of the plates here, than to a corresponding increase in the size of the cavity within. Plates of the proboscis of moderate size, and all indented at their corners.

Height of body to the top of first radial pieces, 0'18 inch; breadth about 0'32 inch; length of arms beyond the top of the third radials, 1'68 inches; length of proboscis above the first radials, 0'95 inch.

This species is so distinct from all others known to us, that it is scarcely necessary to compare it with any of them. It seems to be most like S. Halli, Hall, but differs in having its subradials so timid as to give the body a truncated appearance below, instead of an inversely campanulate outline. Its pinnule are also much stouter and less oblique, while its arms are entirely without the little flattened spine-like projections along their backs seen in that species. The stout pinnule as seen extending between the arms present, with the latter; a peculiar scalariform appearance, that suggests the specific name.

**Locality and position.** Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 282 of Mr. Wachsmuth's collection.

**Scaphiocrinus piscellus**, M. and W.

Body very small, somewhat cup-shaped, about once and a half as wide as high, rather broad and subtruncated below, with moderately expanded sides. Base very small, flat, and hidden by the column, when the latter is attached. Subradial pieces convex, curving under to connect with the base and extending about half way up the sides; three of them presenting a pentagonal outline, and two hexagonal, (that is without counting a very obtuse angle double existing at the middle of the under side of each, but hidden by the column). First radials about the size of the subradial pieces, and pentagonal in form, the upper side always truncated the full breadth. Second radials quadrangular, constricted in the middle, and expanded at the ends; separated from each other by spaces nearly half their own breadth, measuring at the middle. Third radial pieces a little longer and narrower than the second, abruptly dilated at the ends, and strongly contracted in the middle; each, with apparently the exception of one in the anterior ray (which seems to bear only one arm), supporting two arms on their superior strongly sloping sides.

Anal plates forming a double alternately arranged series, exactly as in the last. Arms apparently simple from their origin on the third radials; composed of pieces as long as wide, or a little longer, and angular on the dorsal side; each piece always contracted in the middle, and expanded at the ends, particularly at one of the upper lateral corners alternately on each side of the arm, for the reception of the pinnule, thus giving the arms a zigzag appearance. Pinnule rather stout, and composed of pieces about as long as wide.

Surface of the body with deep indentations at the corners of all the plates, so as to form a comparatively strong ridge radiating to each side of the subradial pieces, to connect with a similar one on each of the adjacent pieces.

Height of body about 0'11 inch to the top of the first radial pieces, where it measures about 0'17 inch in breadth; length of arms, about 0'95 inch.

This species is nearly related to the last, but in addition to being much smaller, it differs in the strong radiating costa of its body plates, as well as in having its subradial plates merely convex, instead of timid. Its arm joints also differ in being proportionally longer, and contracted in the middle.

**Locality and position.**—Lower division of the Burlington group; Burlington, Iowa. Lower Carboniferous. No. 283 of Mr. Wachsmuth's collection.

**Scaphiocrinus juvenis**, M. and W.

Body small, expanding rather rapidly from the column, or presenting a short, obconic form, with rather distinct sinuses between the radial series; nearly twice as wide at the top of the first radials, as the height to the same point. Base small and short, or several times wider than high, but projecting [July,
below the subradials, truncated about three-fourths its breadth by the facet for the attachment of the column. Basal pieces nearly twice as wide as long, and pentagonal in form, but owing to the shortness of the lateral margins appearing nearly trigonal. Subradial pieces a little wider than long, three pentagonal, and two on the anal side hexagonal (without counting a scarcely defined angle at the middle of the under side of each). First radial pieces of about the size of the subradials, generally wider than long, and pentagonal in form. Second radials about as long as wide, distinctly rounded on the dorsal side, and quadrangular in outline. Third radials somewhat larger than the second, more or less expanded at the upper end, and rounded and contracted in the middle; each bearing two arms on its superior sloping sides.

Anal plates forming a double alternating series of five or six pieces, as in the last; the lowest piece resting between the upper sloping sides of two of the subradials, partly under the first radial on the right, and connecting on the left above the middle, with another piece resting upon the upper truncated edge of one of the subradials, and joining the first radial on the left.

Arms tuft, simple from their origin on the third radials, composed of somewhat wedge-formed pieces, about as long as wide on the longer side, which projects above, alternately on opposite sides of the arms, for the reception of the pinnule, so as to present a somewhat zigzag appearance. Pinnule stout, arranged at intervals of near their own breadth apart, and composed of joints that are about as long as wide. Surface granular; body plates even, and merely separated by linear sutures. Column of comparatively moderate size, faintly subpentagonal, near the base, and composed of rather thin, nearly equal plates, with a very small central perforation.

Height of body to the top of first radial pieces, about 0.12 inch; breadth, 0.20 inch; length of arms, about 0.75 inch; thickness of column at base, near 0.07 inch.

This species is related to the last two, but is readily distinguished by the more conical form of its body, produced by the protuberance of its base, as well as by having two arms to each ray all around, instead of only one in the anterior ray. It also differs from both in having its body plates even, instead of very convex, or tumid, as in S. scalaris, or costate, as in S. fisellus.

Locality and position.—Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 284 of Mr. Wachsmuth’s collection.

**Scaphiocrinus notabilis**, M. and W.

Body large, obconic, or expanding gradually from the column to the middle of the first radials, at which point these pieces are protuberant, so as to give the general outline, (as seen in a side view) a tendency towards an inverted bell-shape. Base of a deep cup form, less than twice as wide at the top as the height, or about one-third as high as the body to the top of the first radials. Basal pieces higher than wide, and pentagonal in form, the lateral margins being longest. Subradial pieces nearly twice as long as the basal, hexagonal in form, excepting the two on the anal side, which are heptagonal. First radials somewhat larger than the subradial pieces, slightly wider than long, pentagonal in form, and each provided with a very profound sinus for the reception of the second radials, more than one-third as wide as its upper edge, and extending about half way down its outer side. Second radial pieces comparatively very small, or about one-third as large as the first; pentagonal in form, about as wide as long, rounded on the outer side, and so deeply inserted in the sinus of the first radials on a kind of shoulder-like projection, that their mesial angle above scarcely rises beyond the upper margins of the first radials, each supporting two arms on its superior sloping sides, and separated from that of the next ray on each side, by an interradial space of about one and a half its own breadth. Anal plates two and about half of the third, included as a part of the walls of the body, hexagonal in form, and having the usual arrangement of those of Poteriocrinites, in a double, vertical, alternating series.

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Arms very long, slender and rounded; one of them seen to bifurcate first on the sixth, two others on the eighth, and another on the tenth piece, above the second radials. Beyond these bifurcations it is evident from the number of slender branches seen, that there must be other subdivisions, but the specimen is not in a condition to show the details of the bifurcations. Arm pieces generally longer on the longer side than wide, but not arranged in zigzag; the first two of each arm twice as long as wide, and somewhat contracted around the middle. Proboscisidiform extension very long, or nearly or quite equaling the length of the arms, and somewhat narrowed at the extremity.

Surface of the first radial plates strengthened by prominent, rounded, radiating costae, two of which diverge downward from the mesial prominence under the sinus for the second radials, to connect with others on the subradials, so as to inclose profound triangular pits at the upper corners of the latter; while two similar ridges run laterally on each side of the sinus, parallel to the upper margin, to connect with those similarly situated on each adjacent first radial. On each subradial, the ridge extending down the middle widens and becomes nearly obsolete at the base, where it connects with several slender lines that continue on down converging toward the lower part of each basal piece; there being no pits or impressions at the meeting of the corners of the basal and subradial pieces.

Height of body to the top of the first radial, 0.96 inch; breadth across at the most protuberant part of the first radials, about one inch. Length of arms from their origin on the second radials, about four inches. Length of proboscisidiform ventral extension, 3.85 inches.

This fine species departs very widely from the typical forms of Scaphiocrinus in its large size, obconic body, strongly costate body plates, long bifurcating arms, and particularly in having its second radial pieces so narrow in proportion to the first, as to be separated from each other by interradial spaces, wider than the second radial pieces themselves. Its anal series, although including more pieces than we see in the typical Scaphiocrinus (being like that of Poteriocrinus proper), does not differ from that of a large proportion of the species usually included in Scaphiocrinus, with which the species agrees in having only two radial pieces to each ray.

Specifically it is related to such forms as Cyathocrinus macropleurus, Hall, and Poteriocrinus obnexus, White; but it differs too widely from these and all the other similar forms known to us, to render a comparison necessary. Cyathocrinus macropleurus was described from a specimen not showing either the anal pieces or second radials, or the arms; Mr. Wachsmuth has specimens, however, showing that it has several anal pieces, and two radials to each ray. He also has specimens of the P. obnexus (which was also described from a specimen not showing the arms and second radials), indicating that it agrees in these characters with Scaphiocrinus. It is possible such species should form a separate section, or subordinate group.

Locality and position.—Lower division of the Burlington group. Burlington, Iowa. Lower Carboniferous. No. 303 of Mr. Wachsmuth's collection.

Scaphiocrinus Coreyi, M. and W.

Body of medium size, hasin-shaped, or about twice as wide as high, rounded and distinctly concave below. Base small, and nearly or quite hidden by the column in the concavity of the under side. Subradial pieces comparatively rather large, curving under to connect with the base, all presenting a general hexagonal outline, excepting two on the anal side, which are heptagonal; they must each, however, have another obscure angle below. First radial pieces about equaling in size the subradial, but proportionally wider, being sometimes slightly more than twice as wide as long, all pentagonal in form, the upper side being much the longest, and the lateral margins short. Second radials a little longer than the first, but narrower above, and more or less con-
stricted around the middle; pentagonal in form, the upper angle being rather salient, and each supporting an arm on each of their superior sloping sides. First anal piece about one-third as large as one of the subradials, hexagonal in form, and resting between the upper sloping sides of two of the subradials, and partly under one side of one of the first radials on the right; while it supports another anal piece above, and connects with a third on the left, which rests upon the upper truncated side of one of the subradials.

Arms moderately long, carinated along the middle of the outer side, and after the first division on the second radials dividing again on the sixth or eighth piece, beyond which they are all simple, each composed of alternating wedge-shaped pieces, which are a little wider than long, and each projecting on alternate sides above for the reception of tentacles, which are stout, angular, and composed of pieces nearly twice as long as wide.

Breadth of body, 0.55 inch; height to top of first radials, about 0.20 inch.

This species is remarkable for the curious rough appearance of the arms, produced by the projection of the pieces alternately on each side, and the interruption of the carina along the dorsal side, which is not continuous, but looks as if the pieces had been slipped a little alternately to opposite sides.

 Locality and position.—Crawfordsville, Indiana. Keokuk division of the Lower Carboniferous.

Subgenus ZEACRINUS.

ZEACRINUS SCORINA, M. and W.

Body very much depressed, or about four times as wide as high, to the top of the first radial pieces, and concave in the middle below. Base small, and hidden by the column in the concavity of the under side. Subradial pieces curving in to the concavity of the under side, and extending outward around the column; all presenting a nearly pentagonal general outline, with short lateral edges, excepting the one on the anal side, which seems to be hexagonal, (each being without a visible angle at the middle of the under side). First radials three or four times as large as the subradials, near twice as wide as long, pentagonal in form, with lateral and inferior margins of nearly equal length, and upper edge equaling the entire breadth. Second radials as wide as the first and nearly twice as long, all pentagonal in form, the superior angle being salient, and also projecting outward, while a strongly defined mesial angle extends down the middle of the dorsal or outer side to the base of each, the surface on each side of this angle being distinctly concave.

Anal pieces small, and owing to the rough surface of the plates, and the indistinctness of the sutures, without very clearly defined outlines. As near as can be made out, the first one seems to be somewhat cuneiform, and wedged in obliquely under one side of the first radial on the right; on its left it connects above the middle, apparently with another resting upon a very short upper side of one of the subradials. Above these other anal pieces are seen between the arms, but their exact arrangement cannot be made out from the specimen studied.

Arms, after their origin on the second radials, each bifurcating on the sixth piece (excepting those of the anterior ray, which divide first on the eleventh piece), the inner division of each being smaller than the other, and remaining simple; while the outer or main arm gives off another division on the inner side on the eighth piece above the first bifurcation, and still another on the ninth or tenth piece above the latter, which is as far as the arms can be clearly traced in the specimen, though there is some appearance of a fourth bifurcation in one of the arms. Arm pieces short, or from twice to three times as wide as long, and not in the slightest degree wedge-shaped; each with lateral edges sharp and a little projecting, and provided with a little pointed process on the middle of the dorsal side. These little asperities, and the beveled character of the sutures between the arm joints, give the arms a rough, 1869.]
ramp-like appearance, which has suggested the specific name. The body plates are also rendered very rough by a ridge extending from the middle of the upper edge of each first radial to connect with others on the subradials, and the presence of other irregular asperities. Sutures between the first and second radials widely gaping when the arms are folded together. Column of moderate size, and composed of thin, nearly round pieces, with projecting rough edges, and a rather small subpentagonal central perforation.

Height of body to the top of the first radials, 0·10 inch; breadth, about 0·42 inch; length of arms, about 1·70 inch.

This species is related to Zeacrinus perangulatus, of Dr. White, but differs in having its arms longer and less tapering, as well as bifurcating more frequently; also in having each inner division of each arm smaller than the outer. The bifurcating pieces of its arms are likewise proportionally smaller, and not protuberant as in that species. In the species perangulatus the arm pieces are also merely angular along the middle, while in that under consideration there is, instead of a continuous angle, a row of little pointed isolated protuberances, presenting a crenate appearance as seen in outline.

**Locality and position.** Upper division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 321 of Mr. Wachsmuth's collection.

*Zeacrinus asper* M. and W.

Body small, much depressed, or twice and a half as wide as high, broadly truncated and concave below, the concavity including the base and about half the length of each subradial piece. Base small and nearly or quite hidden by the column. Subradial pieces very abruptly ganiculated in the middle, the lower or inner half forming a part of the concavity of the under side, and the upper a part of the outer wall of the body, while their prominent middle forms the margin of the concavity below, each presenting a pentagonal outline, excepting one on the anal side, which is hexagonal. First radial pieces about twice as long as the subradial, and twice as wide as long, all pentagonal in form, with the upper truncated side equaling the full breadth. Second radial pieces as wide and once and a half as long as the first, pentagonal in form (unless the anterior one, which has not been seen, may be an exception), and supporting the arms on their superior sloping sides, each with a very prominent sharp carina extending up the middle, while the surface on each side of the carina is deeply concave, excepting at the lower margin, along which there is also a transverse ridge or carina.

Anal plates arranged as in the last described species, in a double alternating series, the lower one being placed obliquely under one side of the first radial on the right, while the next rests upon a short end of one of the subradials, the two connecting together and supporting the others above.

Arms, after their origin on the second radial pieces, each bifurcating on the sixth piece, the two divisions of each being of equal size, but the inner one is simple, while the outer bifurcates again on the sixth, seventh, eighth or ninth piece above the first division, beyond which the two equal divisions are simple as far as they can be traced in the specimens examined. Arm pieces short, or nearly twice as wide as long, wedge form, and each strongly projecting on the longer side, alternately, so as to present a zigzag appearance; bifurcating pieces all larger than the others, and extending out, on the dorsal side of the arms, into pointed prominences, sometimes assuming the character of short spines, which, with the lateral processes of the other pieces, give the arms a very rough, harsh appearance.

Surface of the body plates with deep excavations at the corners, and strong ridges or carinae between the excavations. Of these carinae, two descend diverging from the middle of the upper side of the first radials (along which there is also a transverse ridge), to connect with others on the subradial pieces. Sutures between the first and second radial pieces very widely gaping. Column round and very slender near the base, where it is composed of pieces
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of moderate thickness, every alternate or third one of which projects out distinctly beyond the others. Central canal minute and apparently round.

Height of body to the top of the first radial pieces, 0·10 inch; breadth, 0·31 inch; length of arms, about 1 inch.

This is another species related to Zeacrinus spinobrachiatus, of Dr. White, but it differs in having decidedly more slender arms below the bifurcations, with the arm pieces, particularly above the first bifurcation, arranged much more in zigzag, and their thicker ends more projecting on each side. It is one of the forms combining some of the characters of Zeacrinus and Scaphiocrinus.


Zeacrinus serratus, M. and W.

Body small, much depressed, or about three times as wide as high, broadly truncated and concave below. Base very small, and nearly or quite concealed by the column in the concavity of the under side. Subradials a little tumid, curving abruptly into the concavity of the under side, and extending about half way up the lateral walls of the body; three or four pentagonal and one or two on the anal side hexagonal (not counting a very obtuse angle doubtless existing at the middle of the under side of each). First radials somewhat larger than the subradials, nearly twice as wide as high, and all pentagonal in form, with the upper side equaling the entire breadth. Second radials as wide at the base as the first, and nearly twice as long, each pentagonal in form and supporting two arms, excepting that of the anterior ray, which is quadrangular and supports but a single arm; each with a prominent, well defined, sharp carina extending up the middle, and the dorsal surface on each side of this carina is distinctly concave. Anal pieces arranged in a double alternating series almost exactly as in the last.

Arms (excepting in the anterior ray) bifurcating first on the sixth piece above their origin on the second radials, the inner division being slightly smaller than the other, and simple to the end, while the outer division bifurcates again on the seventh piece above, and a third time on the eighth piece above the latter, the inner divisions being all simple. Arm pieces very short, or two or three times as wide as long, and scarcely showing any tendency to assume a wedge shaped outline; each one with a small pinched or angular projection on the middle of the dorsal side, giving the arms a subcarinated appearance; but these projections are not continuous, being separated by notches at the sutures between the pieces, and a little inclined upward, so as to impart to the dorsal side of the arms a serrated appearance, as seen in an outline lateral view. Axillary pieces at all the bifurcations of the arms larger than the other arm pieces, and more prominent and angular.

Surface of body plates merely convex, or somewhat tumid, and without costae or carinae. Column very small, round or subpentagonal, and composed, near the base, of nearly equal rather thin pieces, with a very minute central perforation. Sutures between the first and second radial pieces widely gaping.

Height of body, 0·07 inch; breadth, about 0·22 inch; length of arms, about 0·60 inch.

In several respects this species agrees almost exactly with Z. ramous, of Hall, which has the same proportions, with its arms bifurcating in exactly the same way, and composed of similar short pieces, showing no tendency to a wedge formed outline. On comparison with the original typical specimen of that species, however, now before us, the species under consideration is found to differ in having its second radial pieces each provided with a sharp, strongly defined mesial carina, and the surface on each side of the carina distinctly concave, instead of having these pieces merely obtusely rounded. The same or a similar difference is also seen in the arm pieces, each of which is provided with one or more little projections on the dorsal side, instead of being smoothly 1869.]
rounded or somewhat flattened, as in *Z. ramosus*. If it were not for the fact that the typical specimen of *Z. ramosus* has the surface well preserved, we would be led to think it might possibly have possessed the sharp carina of the second radials, and the projecting points of the arm pieces, seen in the species under consideration, and that they might have been removed by accidental abrasion. The fact, however, that it has the surface of its arms, second radials and other parts so well preserved as to show the original fine, delicate granulations over the whole, demonstrates that it could never have possessed the characters mentioned in the species we have here described; and as we have never seen varieties of a species, in this or any of the allied groups, differing to this extent in such characters, we can but regard the differences as being specific.

It will be observed that the character of the arm and second radial pieces, mentioned as distinguishing this species from *Z. ramosus*, also occur in the species described in this paper under the name *Z. scobina*. That species, however, differs from this in having its first radials and subradial plates strongly costate, while its arms are proportionally longer and differ in being somewhat serrated on each side. It also differs in having two arms, instead of only one, from the anterior ray, as in this, and more divisions in its arms, which divisions are given off at greater intervals.

**Locality and position.** Burlington group, at Burlington, Iowa. Lower Carboniferous. Mr. Wachsmuth's collection.

*Z. Eachinus lyra*, M. and W.

Body short obconical, or expanding very rapidly from the column to the top of the first radial pieces, where it is about twice as wide as high. Base not concave but somewhat projecting, and about one-third as high as wide; truncated near three fourths its breadth by the slightly concave facet for the attachment of the column. Basal pieces presenting a small pentagonal facet above the column, two or three times as wide as long, with lateral margins so short as to appear nearly triangular. Subradial pieces of moderate size, about as wide as long, three hexagonal and two on the anal side heptagonal. First radial pieces generally about twice as large as the subradials, near once and a half as wide as long, and all pentagonal, with the upper side equaling the entire breadth. Second radial pieces of very nearly the same size and form as the first, though the fifth angle and sloping sides are of course above instead of below; each supporting two arms, all around. Anal plates nearly all hexagonal, and, as usual, arranged in a double alternating series, the first resting between the superior sloping sides of two of the subradials, under one side of the first radial on the right, and connecting above the middle on the left, with another resting on the superior truncated side of one of the heptagonal subradial, and joining the first radial on the left. Above these the others extend up to connect with the proboscis (so called).

Arms all distinctly rounded, and after their origin on the second radial pieces each bifurcating first on the fifth, sixth, seventh or eighth piece, above which the outer division bifurcates (or gives off an arm on the inner side) twice or three times at more or less nearly equal distances, all the inner arms continuing simple throughout their entire length, and equaling the outer divisions in thickness. Arm pieces short and very distinctly wedge formed, each having a moderately stout tentacle at its larger end, along the inner lateral margins of the arms; axillary or bifurcating pieces a little larger than the others, but not more convex. Tentacles composed of joints about twice as long as wide.

Body plates not convex, and merely separated by linear sutures, which are not gaping even between the first and second radials; entire surface more or less granular.

Height of body to top of first radials, about 0.25 inch; breadth, about 0.50 inch; length of arms, apparently nearly 2 inches.

[July,
This species is related to *Poteriocrinus burriformis*, of White, which has its body formed exactly as in *Poteriocrinus*, with its arms and primary radials presenting all the characters of *Zeocrinus*, as was noticed by Dr. White; thus showing, with the species under consideration and some others, that *Zeocrinus* can scarcely be regarded as more than a subgenus under *Poteriocrinites*. The form that we have here described differs, however, specifically from Dr. White's species, in having its body proportionally shorter and smaller. Its arms also differ in being very distinctly rounded instead of flat, while its anterior ray supports two arms directly on the second radial piece, as in all the other rays, instead of having the first bifurcation in that ray on the fourth piece.

The specimens are not in a condition to show much of the ventral prolongation, but one of them shows that it is very nearly as long as the arms, and somewhat expanded and crowned with short spines at the upper extremity.

**Locality and position.** Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 319 of Mr. Wachsmuth's collection.

**Genus ACTINOOCRINITES, Miller.**

In the second volume of the Illinois Reports, published in 1866, after admitting as distinct genera from *Actinocrinites* the groups *Megistocrinus*, *Agaricocrinus*, *Amphorocrinus* and some others, we also separated under the name *Strotocrinus* a group of remarkable American Carboniferous species, of which *Actinocrinites*, *Perambrus*, Hall, was regarded as the type. At the same time that we made this separation there were amongst the collections before us specimens of another allied type, in regard to the proper disposition of which we were in considerable doubt. These belong to the group of which *A. ventricosus*, Hall, may be regarded as an example. We readily observed that while in some of their characters they agree most nearly with *Strotocrinus*, that in others they seemed to be more closely allied to *Actinocrinites*, and at one time we were very much inclined to the opinion that a strictly systematic definition of all the different genera of the *Crinoidea* would require their separation as a distinct intermediate genus. Wishing to avoid disturbing the existing nomenclature, however, as much as possible, we finally concluded to place this group provisionally as a section under *Actinocrinites*.

Since that time we have had an opportunity to study an extensive series of these and the allied groups, in Mr. Wachsmuth's collection, and have been led to the conclusion that if this type does not form a separate genus, holding an intermediate position between *Strotocrinus* and *Actinocrinites*, that it should be placed as a distinct subgenus under the former. Adopting this view, and admitting, as we have elsewhere done, that the *Batoeocrinus* and *Doryocrinus* groups should stand as distinct genera, the genus *Actinocrinites* would be left to include two sections;* that is, the typical forms, such as Miller's *A. tricontaclubratus* and *A. polydaetulys*, and de Koninck's *A. stellaris*, *A. diversus*, *A. deornatus* and *A. armatus*, with various others; and the group including *A. multibrachialis* and its allies.

The typical forms of *Actinocrinites*, which agree almost exactly with all the other genera mentioned, as well as with the *A. multibrachialis* group, in the number and arrangement of the pieces composing the walls of the body below the bifurcations of the rays, are distinguished by the following characters, never found all combined in any one of the other groups:

In the first place, they have the arm bases, or brachial pieces, and adjacent parts (sometimes as far in as the third primary radials) grouped together so as to form five more or less protuberant lobes,† and so far as yet known to us, at

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* There are doubtless other sections, but we allude here to the forms we have had an opportunity to study.
† Since these remarks were in type, we observe, on consulting Miller's Nat. Hist. of the *Crinoidea*, to which we had not previously had access for many years past, that he seems to have confounded two very distinct forms under the one name of his typical species, *Actinocrinites tricontaclubratus*. One of these, if correctly represented on plate 4 of his work, 1869.]
least a part of the arms bifurcating after becoming free, and always each composed of a single series of pieces below each bifurcation, as well as generally for some little distance above. They also combine with these characters a more or less produced central or subcentral tube or proboscis, and have the second primary radial pieces nearly always normally hexagonal.

The other group represented by *A. multibrachiatus* differs from the typical forms of *Actinocrinites* in having the arm bases arranged in a nearly or quite continuous series all around, and the arms never bifurcating after becoming free, as well as in nearly always having the same number of arms in each ray. The species of this group also more generally have the vault higher in proportion to the body below the arms, but there are a few exceptions to this in both groups. In a few species of typical *Actinocrinites* the arm bases are less distinctly grouped, and not so protuberant as in others, but so far as we have yet seen they can readily be distinguished by the structure and bifurcations of their arms, where specimens retaining them can be seen, and nearly always, even where the arms are broken away, by their wider interradial and anal sinuses and other peculiarities of general physiognomy, apparent enough to the eye but difficult to express in words.

In having the arm bases arranged in a nearly or quite continuous series all around, and the arms never bifurcating after becoming free, the *A. multibrachiatus* group agrees with *Batocrinus*, but it differs from that group in having longer arms in proportion to the length of the proboscis, which in *Batocrinus*, when entire, protrudes from one-fourth to one-half its entire length beyond the extreme length of the arms. They also differ from *Batocrinus* and agree with *Actinocrinites* in nearly always (perhaps always normally) having the second radial pieces hexagonal instead of quadrangular, while their body plates are more or less sculptured (generally strongly so) into radiating costae, usually consisting of a single rib for each side of each plate, instead of having the plates even and smooth, merely convex or tumid. In short, the species of these two groups can be distinguished at a glance from specimens even showing the body only.

As thus limited, the genus *Actinocrinites* would include, along with a number of foreign species, the following American Carboniferous forms:

1. **Actinocrinites**, Miller. *Section (a).*

   *A. verrucosus* (= *A. asterius*, McO.), *A. chloris* (= *A. tenusculptus*, McO.), *A. lobatus*, *A. Humboldtianus*, *A. jugosus*, *A. pernodosus*, *A. unicosatus*, *A. lowei*, *A. brontes*, &c., of Hall. Also, A. *Tandelli* and *A. multitubularia*, Shumard; A. *Wachsmuth*, White; and *A. scutulus*, M. and W. (= *A. rusticus*, Hall, and A. *Stellimani*, M. and W.); as well as our *A. penicillus* and *A. delicatus*, of this paper, and *A. Indianensis*, L. and C., with perhaps several others with which we are not very well acquainted.

2. **Section (b).*

   *A. multibrachiatus*, *A. proboscidialis,*| *A. culatus*, *A. clavus*, *A. limbrochiatius*,

* must belong to an entirely different species from that figured under the same name on his plate 11, as it is represented as having its arm-bases and contiguous parts, not forming five widely separated protuberant lobes, but arranged more like those in the American section represented by such forms as *A. multibrachiatus*, though its arms clearly bifurcate after becoming free.

* See figs. 1 and 2, pl. 11, Iowa Geol. Report, vol. 1, pt. ii.
* See pl. x, fig. 10, Iowa Geol. Report, vol. 1, pt. ii. For other examples of this group see figs. 13 & 14 same plate, where they may be compared with figs. 7 & 9 of the same plate, representing two species of true *Actinocrinites*, with arm bases grouped into 5 protuberant lobes.
* There are some other described American species not mentioned in this list, which is only intended to include such species as we have had an opportunity to study.
* Dr. Shumard's *A. concinna* belongs here, if not a *Stegocrinites*. We have not yet seen a specimen of it showing the rays far enough out to decide positively to which of these groups it belongs.

1. *A. quadrernarius*, *A. quadrernarius var. spiniferus* and *A. Themis*, Hall, are believed to be varieties of his *A. proboscidialis*. [July,
A. ovatus, A. securus, A. opusculus, A. excerptus, A. infrequens, A. thelit, A. thoa, A. loceillus, A. securatus, A. reticulatus, all described under Actinocrinus by Prof. Hall. Also, A. Fosteri and A. Hurdianus, McChesney, and our A. longus of this paper.

It is worthy of note that all the known Burlington species of this group came from the Lower Burlington beds, as has been determined by Mr. Wachsmuth, by careful observations continued through many years.

**ACTINOCRINITES. Section (a).**

**Actinocrinites penicillus, M. & W.**

Body small, inversely campanulate, or with sides expanding rapidly from the truncated base to the secondary radius, which with the brachial pieces curve a little outward. Base much depressed, or about four times as wide as high, broadly truncated and but slightly concave below; margin more or less expanded horizontally, and deeply notched at the sutures. First radial plates comparatively rather large, and about twice as wide as high. Second radials near half as large as the first, about twice as wide as high. Third radials a little larger than the second, wider than long, and pentagonal in form, the lateral margins being short, each supporting on each of its superior sloping sides a secondary radial of about its own size, which in its turn supports two free arms.

Anal pieces unknown above the second range; first one smaller (particularly narrower) than the first radials, and supporting two others of its own size in the next range. Interradial pieces three to five in each space; first one as large as the second radials, hexagonal in form, and bearing upon its upper sloping sides two smaller pieces, above which there is generally one or two minute pieces.

Arms free from their origin on the secondary radials, and composed below of slender rounded pieces, the first of which is about twice as long as wide, and more or less constricted in the middle; beyond this the lateral arm on each side of each ray is simple, with its second piece like the first, and followed by two or three other shorter wedge formed pieces before passing into a double series of small, alternately arranged pieces. Inner arms of each ray bifurcating on the first piece, and one of the subdivisions in one or both bifurcating again on the first piece, thus making from seven to eight arms to each ray, or from thirty-five to forty in the entire series. The single piece below and the first above each division, is slender, rounded, and more or less constricted, and generally two or three wedge formed pieces follow the latter before the commencement of the double series of alternating pieces, above which the arms are a little wider and of moderate length. Vault unknown; probosics very slender at the upper end, and apparently of about the same length as the arms.

Surface of all the body plates deeply excavated at the corners, and prominent in the middle, the prominence of the first radials usually forming a transverse ridge, from which a single more or less defined vertical ridge ascends the secondary radials to the middle of the third, from which it bifurcates and continues to the secondary radials.

Height of body to the top of secondary radials, about 0.22 inch; breadth at the top of secondary radials, 0.40 inch; length of arms if straightened out, about 0.70 inch; breadth of do. at the widest part near the middle, 0.06 inch.

This little species is allied to A. lucina, Hall, which, before seeing specimens showing the arms, we had supposed to belong to the A. multibrachiatus group, but which is a true Actinocrinites. Our species differs, however, in having the arms more frequently and differently bifurcating, so as to make from thirteen to fifteen more in the entire series. Its arms also differ in not being subspinous on their margins.

1869.]
**Locality and position.** Lower Burlington beds of Lower Carboniferous, Burlington, Iowa. No. 38 of Mr. Wachsmuth's collection.

**Actinocrinites delicatus, M. and W.**

Body small, subturbinate, or widening rather rapidly from the somewhat truncated base to the top of the third radials. Base depressed, or about four or five times as wide as high, with slightly expanded margins notched at the sutures. First radial pieces of moderate size, a little wider than long, and, as usual, two heptagonal and three hexagonal. Second radial pieces a little smaller than the first, more or less regularly hexagonal, the superior lateral sides, however, being sometimes very short. Third radials about as large as the second, normally pentagonal, but sometimes with the lateral angles truncated so as to give them an irregular heptagonal outline. Secondary radials resting one upon each superior sloping side of each third primary radial, which they exceed in length; more or less prominent, curving outward, and generally constricted and rounded in the middle, though not entirely free from the walls of the body, excepting on the upper side; supporting on each of their superior (free) sloping sides the first divisions of the arms. First interradial pieces about as large as the first radials, hexagonal, and supporting two smaller pieces in the next range, which connect with others above, belonging apparently more properly to the vault. First anal piece nearly as large as the first radials, heptagonal in form, and supporting in the second range two pieces, one of which (in the typical specimen) is as large as the first; above these there are four or five smaller irregular pieces in the third range, and above the latter others belonging apparently to the vault.

Arms slender, rounded, and composed below of distinctly constricted pieces longer than wide, and, after the first division on the secondary radials, the inner ones bifurcating on the second piece, and one or both of these subdivisions divide again on the second piece, above which they still continue to be composed of a single range of rounded pieces for a short distance, and then pass gradually through a few wedge-formed pieces into a double series of alternating pieces; above this they are all a little stouter than below, and show a very slight tendency to become somewhat flatter toward their upper extremities. So far as can be seen, the two outer arms of each ray are simple from their origin on the secondary radials, and composed of a single series of rounded and constricted pieces as far up as the last bifurcations of the other arms; consequently there appear to be eight ultimate divisions, or arms, to each ray. (Vault unknown.)

Surface apparently minutely granular, and with a small, more or less defined ridge extending from the base up the primary radials to the third radial, on which it bifurcates and sends a branch to the base of each of the two main arms. On the first radials, as well as the anals, there is also some tendency to send off an obscure ridge across from one to another, on each side. None of the body plates are tumid, though they are generally very slightly convex.

Height of body from bottom of base to the top of secondary radials, 0.16; breadth, about 0.30 inch.

This species is related to A. chloris, Hall, but is much smaller, and differs in having its body, below the arms, merely rather rapidly expanding, with nearly straight sides, instead of being hemispherical. Its arms also bifurcate differently. In the choris, for instance, they all (or at any rate, the inner ones), after their origin on the secondary radials, bifurcate once on the first piece beyond, while in our species the inner arms bifurcate on the second piece, and the outer of those subdivisions again on the second piece.

**Locality and position.**—Upper division of the Burlington member of the Lower Carboniferous at Burlington, Iowa. Mr. Wachsmuth's collection. [July,
ACTINOCRINITES. Section (b).

ACTINOCRINITES LONGUS, M. and W.

Body rather elongate-obconic below the arms, the sides expanding gradually, with a moderately convex outline, from the base to the tertiary radial pieces, which, with the brachial pieces, curve very slightly outward. Base about twice and a half as wide as high, not thickened or expanded below, and but very slightly notched at the sutures; facet for the reception of the column large and moderately concave, with a rather large central perforation. First radials comparatively large, very nearly or quite as long as wide. Second radials scarcely half as large as the first, about as wide as long, quadrangular, pentagonal or unequally six-sided. Third radials of about the same size as the second, pentagonal, hexagonal, or heptagonal, and each bearing on its superior sloping sides two secondary radials of near its own size, each of which supports, on its outer sloping upper side, brachial pieces, leading to an arm, and on its inner side, above, a small tertiary radial giving origin to two arms, thus making three arms to each main division, and six to each ray, or thirty to the entire series. (Arms unknown.)

Anal plates five or six, the first being of the same size as the smaller first radials, hexagonal in form, and a little longer than wide; second analis two, about two-thirds as large as the first, and irregularly heptagonal or octagonal; above these there are two smaller pieces in the third range, and one or two still smaller pieces above the latter, the upper one being barely large enough to separate the posterior lateral brachial pieces of the two posterior rays. First interradial pieces about half as large as the first radials, heptagonal, and supporting two smaller pieces in the second range, above which there are one or two still smaller pieces in the third, and a minute piece over the latter, wedged in between the brachial pieces. In each interaxillary space there are usually two intercalated pieces, the lower of which is sometimes as large as one of the tertiary radials, while the upper is very small, and wedged in between the brachial pieces.

Vault conical, and nearly three-fourths as high as the body below the arms; composed of irregular pieces of moderate size, some of which project in the form of small pointed nodes or short spines, passing gradually into a rather large subcentral proboscis.

Surface of all the body plates rather distinctly convex, but not properly tumid, and showing but the faintest traces of an effort to form, on some of the smaller pieces, an obscure radiating ridge near each side. In most cases, however, these are entirely obsolete, and the plate seems to be merely evenly convex.

Height of body to arm bases, 1·2½ inch; breadth of do. at arm bases, 1·40 inch; height of vault, about 0·80 inch.

In the structure of its body, as well as in its arm formula, this species agrees with Actinocrinus clausus, of Hall. It differs, however, greatly in form, as well as in the surface characters of its body plates, being rather elongate obconical below the arms, instead of "very broadly subturbinated, and spreading more rapidly above the third radial plates," while its body plates are merely convex, instead of being "elevated into strong angular nodes, some sometimes marked by low ridges on the lower part," and by "strong angular ridges" on the upper part.

Its elevated conical vault, passing gradually into the nearly central proboscis, and narrow obconic body below the arms, give it a peculiar fusiform outline. In the nature of its vault it resembles quite nearly A. costatus of Hall, from which, however, it differs widely in other respects.

Locality and position.—Lower beds Burlington group of Lower Carboniferous, Burlington, Iowa. Mr. Wachsmuth’s collection.

1869.]
Extending the genus Strotoocrinus so as to include, as already suggested, the Act. ventricosus group as a subgenus, we will have, first, the typical urn-shaped species, such as S. perumbrosus and S. luratus, with the structure of Actinocrinites up to the divisions of the rays, but with the body comparatively long and narrow below, and the secondary and other succeeding supplementary radials, branchial and intermediate pieces, connected laterally all around, and spreading out horizontally far beyond the limits of the body, so as to form, with the flatter or much depressed vault, a broad, more or less distinctly ten-angled disc, from the margins of which the numerous long, slender arms arise, without bifurcating after becoming free.† Indeed, with rare exceptions, the rays can scarcely be said to bifurcate, properly, after the division on the third primary radials, though each main division continues on out, throwing off alternately on each side branchial pieces in close contact with each other, until, at last, it terminates in a single free arm. Each of the arms commences abruptly as a double series of small alternating pieces immediately on the last fixed branchial piece, without an intermediate series of free single pieces extending entirely across. Some of the species, such as S. perumbrosus, have but a very small simple opening situated subcentrally, or more or less eccentrically towards the anal side, and penetrating the flattened vault obliquely, so as to be directed forward or away from the anal side; while others, like S. luratus, have a long erect, subcentral tube, or so-called proboscis, sometimes recurved at the end. The column is known, at least in the species provided with a proboscis, to be peculiar in being composed of very thin segments, a part of which, at regular intervals, project out beyond the others, and send up and down, at equal distances all around, five external, thickened processes or ribs, apparently as a natural provision to give it strength, without destroying its flexibility.

Then we have the Act. ventricosus group, which not only agrees with the S. perumbrosus section of Strotoocrinus in having merely a very small subcentral or excentric opening in the vault, without any traces of a proboscis, but also, to a considerable extent, in the manner in which the subdivisions of the rays are given off; but differs in having these subdivisions not in contact so as to form a disc, but divided by narrow interradial, anal, axillary, and sometimes interbranchial sinuses, the former of which often extend quite in to the body. The species of this group also differ from the typical forms of Strotoocrinus in having the body shorter below the arms, and the vault generally more ventricose, and provided with external furrows radiating from the middle to the anal and interradial sinuses. So far as yet known, the species of this type have rather stouter and less numerous arms than we see in Strotoocrinus proper, but generally more than we see in Actinocrinites. In both groups of Strotoocrinus the arms are, as in Actinocrinites, provided with numerous pin-nule, or so-called tentacles, but here they seem to be always armed with minute spines directed more or less obliquely upward from their upper margins. From Actinocrinites the A. ventricosus group not only differs in being without any traces of a proboscis, but in having its ventricose, furrowed vault composed of numerous minute pieces; and the divisions of its rays, although not forming a continuous disc as in Strotoocrinus proper, not grouped into five lobes. Its arms also differ in never bifurcating after becoming free. For this group we propose the name Physetocrinus (φύστος, puffed up; κρέας, a lily), in allusion to the ventricose vault of the typical species, Act. ventricosus, Hall.)†

The genus Strotoocrinus, as here defined, would include the following species, all peculiar to the lower Carboniferous rocks of America:

†Some of the species have as many as seventy to eighty arms.
‡Iowa Geological Report, vol. 1, part Palaeont., pl. 11, fig. 6, a b.
1.—Strotocrinus, M. and W. (proper.)

Section (a). Species without a proboscis.—S. perumbrosus, S. regalis and S. glyptus, all described under Actinocrinus by Prof. Hall.

Section (b). Species with a proboscis.—S. agilops, S. rudis, S. lianus, S. umbrosus,† S. tenuriradiatus, S. tholus and S. insculptus, all described by Prof. Hall under Actinocrinus. It may also probably include his Act. glans. His A. clavis is believed to be synonymous with his S. agilops (sp.), and his Act. subumbrosus a variety of his S. lianus (sp.)

2. Subgenus Physetocrinus, M. and W.

P. ventricosus, P. cancellatus, P. ornatus and P. reticulatus, all described by Prof. Hall under Actinocrinus; also P. subventricosus, described by Professor McChesney under Actinocrinus. The proposed species senarius, Hall, is believed to be a variety of his A. ornatus.

In the single character of having only a simple opening in the vault, without the slightest indications of a proboscis, the Physetocrinus group would agree more nearly with the typical section (a) of Strotocrinus than the section (b) does, but in all other characters it is more distinct.

Section (C).

Strotocrinus ectypus, M. and W.

Body depressed, very rapidly expanding to the third radials, above which the secondary and tertiary radials and brachial pieces curve out horizontally. Base about twice and a half as wide as high, truncated, slightly concave, and not expanded or thickened below, but with small nodes around the margin of the under side, placed one at the termination of each of the costae. First radial pieces wider than high, two heptagonal and three hexagonal. Second radials one-half to two-thirds as large as the first, wider than high, hexagonal, or in part (sometimes) pentagonal, the superior lateral sides being short. Third radials wider than long, pentagonal, hexagonal, or irregularly heptagonal, and supporting on each superior sloping side a secondary radial, each of which gives origin to brachial pieces leading to an arm on the outer side, and supports on its inner sloping side a tertiary radial, which gives origin to two arms, thus making three arms to each main division, or six to each ray, and thirty to the entire series.

First anal piece a little longer than wide, hexagonal, and supporting two pieces of about half its own size in the next range; between the superior sloping inner sides of these there is one small piece, and above these three or four other small pieces, one or two of which extend up so as to separate slightly the outer brachial pieces of the adjacent rays. Interradial pieces four or five to each area, the upper of which is narrow and extends up so as to separate slightly the brachial pieces above. In each interaxillary space there is usually an elongated intercalated piece, sometimes large enough to truncate slightly the upper margin of the third primary radial, while it continues upward so as to separate the brachial pieces above.

Vault much depressed, and composed of numerous, irregular, slightly convex pieces of moderate size, and provided with a rather stout subcentral proboscis, composed near the base of unequal pieces, some of which are distinctly protuberant.

Surface of all the body plates moderately convex, or sometimes a little angular in the centre, and ornamented with distinct radiating costae, extending from the middle to the sides of each piece, so as to divide the whole into numerous triangles. These costae are also more or less compound, so as to form a secondary or (below the middle of the first radials) a tertiary series of smaller, less defined triangles within those formed by the principal costae.

*See vol. ii, Geological Report Illinois, p. 188, 1866.
† Iowa Report, part 11, pl. ii, fig. 3, a b.

1869.
Height of body to horizon of arm openings, 0·70 inch; breadth at same, 1·60 inches.

This species resembles in the sculpturing of its body plates S. glyptus, Hall (sp.), but has a more depressed body, and is also at once distinguished by having a proboscis, while the S. glyptus belongs to the section of the genus with merely a simple opening in the vault. From S. cyclops it will readily be distinguished by its shorter, more rapidly expanding body and less numerous arms, as well as by its different sculpturing. Although its brachial pieces are a little separated over the anal, interradial, and axillary spaces, there are no distinct sinuses at these points in the margins of the disc, as the little intercalated pieces separating the brachial pieces at these places extend out as far as the latter, so that when the arms are removed the outline of the disc presents only an obscurely subpentagonal outline.

Locality and position. Lower division Burlington beds of Lower Carboniferous, at Burlington, Iowa. No. 59 of Mr. Wachsmuth's collection.

Stroctocinus ? asperrimus, M. and W.

Body under medium size, urn-shaped, being a little wider at the top of the third radials than high, with the secondary radials and succeeding parts spreading out horizontally, but divided by narrow anal and interradial sinuses quite in to the body; sides ascending with a gradual expansion to the top of the third radials, with a moderately convex outline below the middle. Base about twice and a half as wide as high, not thickened or spreading below, but projecting downward a little around the column, in the form of little nodes, formed by deep notches at the sutures and smaller ones between. First radials generally wider than long. Second radial pieces somewhat smaller than the first, wider than long, some hexagonal and others pentagonal. Third radials a little smaller than the second, generally pentagonal and bearing on each superior sloping side a secondary radial, each of which supports one or more brachial pieces, leading to an arm on its outer sloping side, and a small tertiary radial on its inner, each of which evidently supported two other pieces above, one or both of which were probably brachials. If both sides bore brachials it would make six arms to the ray, but if one side bore an axillary piece it would make eight to the ray or forty in the whole series.

First anal piece of about the same size as the smaller first radials, slightly longer than wide, hexagonal in form, and succeeded by two smaller hexagonal or heptagonal pieces in the second range, above which there seems to be about four other smaller pieces. Subradials three or four to an area, the first one about as large as the second radials, hexagonal or heptagonal in form, and supporting two smaller pieces in the next range; above this there seems to be one, or possibly sometimes two other smaller pieces. Axillary spaces sometimes occupied by one or two small pieces.

Vault much depressed, or rising little above the horizon of the arms, composed of irregular small and moderate sized pieces, and provided with a nearly central proboscis, which in the typical specimen is composed of very small pieces at the base, and a little inclined to one side.

Surface of body plates all prominent and angular in the middle, and provided with well defined, sharp radiating costae, which are compound on the first radial and first anal pieces, but generally consist of a single rib, extending from the middle to each of the sides of the others. The mesial prominence on each of the first and second radials is pinched out so as to form a prominent sharp, transversely arranged ridge, while on each of the smaller plates it is a rounded, rather pointed node, the whole presenting a very rough appearance.

Height of body to the horizon of the arms, 0·74 inch; do. to top of vault, 0·88 inch; greatest breadth at the top of third radials, 0·80 inch.

In general form and surface markings this species resembles the following,
but its body is more spreading above and it has ten or more arms less, while its vault is much more depressed and provided with a proboscis. It seems to bear much the same relations to the section (b) of the genus Strolocrinus that the subgenus Physetocrinus bears to the typical forms of Strolocrinus.

**Locality and position.** Burlington Limestone of the Lower Carboniferous at Quincy, Illinois.

**Subgenus PHYSETOCRINUS, M. and W.**

**STROTOCRINUS (PHYSETOCRINUS ?) ASPER, M. and W.**

Body somewhat urn-shaped, being obconical below, with nearly straight, gradually expanding sides, and rather ventricose vault. Base about three times as wide as high, truncated below and angular, though not thickened or properly expanded around the lower margin, which is so broadly and deeply notched at the sutures as to present a trifoliate appearance as seen from beneath. First radials wider than high, and as usual two heptagonal and three hexagonal. Third radials of the same size as the second, and bearing on each of their superior sloping sides a somewhat smaller secondary radial, each of which bears on its outer sloping side a series of brachial pieces, leading to an arm, while on its inner sloping side it supports a small tertiary radial, bearing on its inner side brachial pieces leading to an arm, and on its outer a small quaternary radial, bearing on its outer side a brachial piece, and on its inner another axillary piece, giving origin to two arms, thus making, as far as can be determined, ten arms to each ray, or fifty to the entire series.

First anal piece as long as the first radials, but narrower, heptagonal in form, and supporting one small piece over its middle and a larger one on each upper sloping side in the second range; in the third range there are three, in the fourth two pieces, and above these, three smaller pieces extending up so as to connect with the vault. First interradial pieces of about the size of the third radials, hexagonal in form, and bearing two smaller pieces in the second range, above which there are some five or six very small, irregular pieces, some of the upper of which extend up and connect with the vault.

Vault rather ventricose, or more than one-third as high, near the middle, as the body below the horizon of the arms; composed of irregular nearly flat pieces of moderate size; opening apparently simple, at the highest point about one-third of the distance from the middle towards the posterior side.

All the body plates are protuberant and sharply angular in the middle, the angular part, especially on the larger plates, forming a sharp transverse ridge. From the under side of this transverse ridge two or three others extend downward on the first radial and first anal pieces, so as to connect with others on the basal pieces. The second and third radials pieces have each about three small pointed nodes, arranged transversely, while from the third radial's narrow ridges extend up to the secondary radials, thence up all the branches to each arm base. All the smaller body plates also have a more or less projecting angular point in the middle.

Notwithstanding the number of arms, the narrow anal and interradial sinuses extend in so as to divide the disc quite in to the body, while even the interbrachial sinuses extend nearly in to the body. The column is of moderate thickness near the base, where it is round and composed of thin pieces with sharp projecting edges, pierced by a nearly round central canal.

Height to horizon of arms, 0.75 inch; breadth across at the interradial sinuses, 0.90 inch; height of vault, 0.40 inch.

This species has its plates sculptured in nearly the same way, and presenting much the same roughened appearance seen in S. glyptus, Hall (sp.), but it differs materially from that and all of the other species known to us, that resemble it in other respects, in having deep interradial and anal sinuses in its disc, as in the subgenus Physetocrinus, with which it also appears to agree in its ventricose vault. It is the only species known to us, however, appa
recently belonging to that group, that has its body so narrow and produced below, and its body plates presenting the style of angularly sculpturing. If the interradial and anal sinuses of its disc were filled with interrelated pieces it would present nearly all the characters of a typical Strotoocrinus. Consequently it may be regarded as a connecting link between these groups, and with a few others shows that they cannot be properly separated more than subgenerically.

**Locality and position.** Upper beds Burlington group of Lower Carboniferous, at Burlington, Iowa. No. 67 of Mr. Wachsmuth's collection.

**Strotoocrinus (Physococrinus) dilatatus, M. and W.**

Body rapidly expanding, with nearly straight sides, from the base to the secondary radials, thence spreading more abruptly to the brachial pieces, which are directed out nearly horizontally, and so closely crowded all around as to come very nearly, or sometimes quite, in contact over the anal and interradial areas. Base about three times as wide as high, not thickened or expanded below, but provided with a large round perforation. First radial pieces comparatively large, generally wider than high, two heptagonal and three hexagonal. Second radials only about half as large as the first, some of them quadrangular, and others with one or both of the upper lateral angles a little truncated, so as to make them properly pentagonal or hexagonal. Third radials larger than the second, wider than long, pentagonal, hexagonal or heptagonal, and supporting on each superior sloping side a secondary radial, each of which gives origin on its outer side to brachial pieces leading to an arm, while on its inner side a tertiary radial gives origin to two arms in all but the two posterior rays, where one or sometimes both bear on one side another axillary piece, making seven or eight arms in each of these rays, or, in the latter cases, thirty-four arms to the entire series.

First anal piece as large as the largest first radial pieces, and bearing above two heptagonal or octagonal pieces of near its own size in the second range, with three smaller pieces in the third range, and two or three minute pieces over these, one of which is wedged in between the brachial pieces above. First interradial pieces generally larger than the second radials, heptagonal or octagonal, and surmounted by two smaller pieces in the second range, over which we usually see one or two small pieces wedged up between the outer brachial pieces of the rays on each side. There is also usually a small interaxillary piece between the secondary radials of each ray, but it seems never large enough to extend down so far as to truncate the upper angle of any of the third primary radials.

Arms stout, increasing a little upward for a distance of two and a half inches (as far as they can be seen in the specimen), each passing directly into a double series of very short pieces, from their origin on the last brachial piece.

Surface of body plates merely finely granular where not worn, slightly convex, with shallow indentations at their corners. Vault unknown.

Height of body to the top of tertiary radials, 0·75 inch; breadth, about 1·33 inch; breadth of arms two inches above their bases, 0·20 inch.

This species is related to S. (Physococr.) subventricosus, McChesney (sp.), but differs in having its body much more rapidly expanding, and proportionately wider above, while its tertiary and brachial pieces curve much more strongly outward. It also differs in the relative size and form of its second radial pieces, which are proportionately smaller, and generally quadrangular, or only with the upper lateral angles slightly truncated, instead of being larger and regularly hexagonal. Its arms are likewise stouter than those of McChesney's species, judging from the brachial pieces seen in specimens of the latter, while it has one or two arms more in each of the posterior rays. Its surface markings are also different, but this is a very variable character in this group.
Locality and position. Lower beds of the Burlington group. Lower Carboniferous. No. 58 of Mr. Wachsmuth's collection.

Genus MEGISTOCRINUS, O. and S., 1850.

The type upon which this genus was founded (M. Evansii, O. and S.*) has a short, broad, cup-shaped body, with a depressed vault, and sides moderately expanded above, and rounded under below to the flat ancyloyosed base, which is usually a little impressed, or less prominent than the first radial and first anal pieces extending horizontally outward all around it so as to form a part of the under side. In some species the base is not properly impressed, though it can rarely be said to project beyond the surrounding next range of pieces. The body plates are moderately thick, and separated by well defined, or rather deep sutures, so as to present a more or less convex surface, without sculpturing or radiating costae, though there are rarely small indentations at the corners of some of the plates.

The nearly or quite flat vault is composed of unequal, irregular, more or less tumid or convex pieces, of moderate size, the middle one sometimes rising into a prominent, rather pointed node, that may be, in certain cases, even developed into a short spine. The opening is decidedly lateral, often penetrating the anal side below the horizon of the arm bases; sometimes it is on the same horizon as the arm openings, or rarely slightly above them. It is never situated in a thickened protuberance, however, as in Dorycrinus and Agaricocrinus, but always shows thin, broken, abruptly projecting edges, as if, when entire, it had been produced into a short, slender tube, or so-called proboscis, projecting out horizontally backward.

In the number and arrangement of the pieces composing the walls of the body, up to the third radial pieces inclusive, this genus presents no essential differences from Actinocrinus, with which it also agrees in having the arm bases more or less grouped, or separated by interradial and anal spaces, and never forming a continuous series all around, as in Batocrinus;† nor an expanded disc, as in Strotocrinus. It not only differs from Actinocrinus proper, however, in general physiognomy and the nature and position of the opening, but particularly in having its arms each composed of a double series of alternating pieces below all the bifurcations, as in Amphoracrinus, from which, however, it differs widely in other respects. This peculiarity of having the arms each composed of a double series of alternating pieces below as well as above the bifurcations, is not only continued down to the body, but in some species each division of the rays included as a part of the walls of the body, has the same structure nearly one-fourth of the way down the side, to within one or two pieces of the third primary radials.

The six or seven known true typical species of this genus form so natural a group that they can be readily distinguished at a glance from the allied genera such as Amphoracrinus, Agaricocrinus, Dorycrinus, Celocrinus, Strotocrinus, &c. There is, however, at least one, and probably two, known Carboniferous species, standing as it were between Megistocrinus and Sacocrinus, and combining the characters of both to such an extent that one of them (Act. (Megist.) Whitei, Hall) was referred by Prof. Hall to Megistocrinus (which he seems to regard as a section or subgenus of Actinocrinus), while the name of the other was written by us, Actinocrinus (Sacocrinus ?) amplius,‡ because we were con-

* Owen's Geol. Report, Wisconsin, Iowa and Minnesota, pl. V, A, fig. 3.
† We cannot believe that those remarkable truncated forms, with arm bases in contact all around, and an erect subcentral proboscis, such as M. spinosus, of Lyon (Proc. Philad. Acad. N.S. Decr. 1861, pl. iv, fig. 7), really belong to Megistocrinus.
‡ It is possible, as already intimated, that this may not be distinct from Prof. Hall's species Whitei; but as it is larger and more robust, however, and has its body plates more convex, and without the ridge seen extending up the radial series of the species Whitei, which also differs in some other details, and came from the upper part of the Burlington beds, and ours from the lower, while scarcely any species of Crinoids are believed to be common 1869.]
vinced that it is not a true Actinoocrinus, and believed it related to Saccocrinus. From direct comparisons with Prof. Hall's typical specimens of the species M. Whitei, in the Museum of the University of Michigan, Professors Winchell and Marcy were also led to refer Silurian species of Saccocrinus to Megistocrinus.

The Silurian typical forms of Saccocrinus have the same arm structure, as well as essentially the same arrangement of body plates, as Megistocrinus, but differ in having a much more elongated narrow body, composed of thin even plates (without excavated sutures) and a protuberant obconic, instead of a flat or impressed base, also a subcentral opening (or proboscis?) instead of a decidedly lateral proboscisiform opening in the vault, thus presenting a decidedly different general physiognomy from the typical Carboniferous forms of Megistocrinus. If we had only the typical forms of these two groups to deal with, there would be no difficulty in separating them. The two species, or varieties, Whitei and amplus, however, are not so easily disposed of, since they have the same thin smooth plates, without impressed sutures, seen in Saccocrinus, and nearly as protuberant a base, while their body is exactly intermediate in form,* and their arm structure the same as in both of these groups, with which they also equally agree in the number and arrangement of the body plates. We have never seen a specimen of any of the Silurian species of Saccocrinus showing the vault, but all the casts we have examined seem to show that it was nearly flat, and had either a subcentral opening or proboscis, and no traces of a decidedly lateral opening as in typical forms of Megistocrinus. A specimen figured by Dr. Roemer in his work on the Silurian fossils of Tennessee, shows the vault to be protuberant in the middle and provided with an opening there, with some appearance of being surrounded by the remains of the base of a proboscis, though it may possibly be only a simple opening in a prominence. In the Carboniferous species Whitei, as already stated, there is a small subcentral opening in the depressed vault, without any traces of a proboscis, and we can now scarcely doubt that this is the case with the amplus, and the vault of both these species also differs from that of the typical Megistocrinus in being composed of innumerable minute pieces.

Although there are a few points in regard to the relations between these groups that we have not yet been able entirely to clear up, we are, from all the facts now known to us, inclined to believe that Saccocrinus should be ranged as a subgenus under Megistocrinus. At any rate, if the species Whitei and amplus are to be included under Megistocrinus at all, we think they should certainly be at least placed in a separate subgenus from the typical forms, and until these questions can be more definitely settled from the study of more extensive collections we prefer to retain for this subgenus the name Saccocrinus. With these limits the genus Megistocrinus would include the following American Carboniferous forms:

1. Megistocrinus, Owen and Shumard, 1850.

Body short, broad and composed of rather thick convex pieces; base flat,

to these two horizons, we are not entirely convinced that they are identical. All the specimens of the species, or variety, amplus we have seen are in a more or less crushed condition, which in some instances caused the vault to protrude in such a way as to lead us to believe it provided with a central or subcentral proboscis, especially as several of the specimens clearly show that it certainly has no traces of a lateral opening anywhere near the anal side, as in the typical forms of Megistocrinus. Mr. Waehsmuth informs us, however, that he has recently found a specimen of the species Whitei showing that it has a small subcentral simple opening, much as in Strolocrinus, section (a), and from the close relations of our amplus to that species, it is highly probable that it also has a similar opening, without a proboscis.

* It is proper that we should also state here that there are consideralbe differences of form among the Silurian species of Saccocrinus: for instance, we have now before us, from the Niagara beds of Chicago, rude natural casts, having all the characters apparently of undescribed species of this group, that are as short and broad as even the typical Carboniferous forms of Megistocrinus; while specimens of Saccocrinus Christyi, Hall, now before us, from the Niagara beds of Walbronn, Indiana, have the body presenting almost exactly the form of the typical specimens of the Carboniferous species Whitei, with which, through the politeness of Prof. Winchell, we have been able to compare them.
impressed, or scarcely more prominent than the first anal and first radial pieces; vault composed of moderate sized convex pieces; opening decidedly lateral, produced in the form of a small short proboscis? and directed posteriorly.\footnote{This diagnosis is not intended as a full description of the genus, but merely to give the characters distinguishing the typical section of the genus. If such Devonian species as M. fatus, Hall, and Actinocrinus subornatus, Lyc., belong to this genus, they could not be properly included in the typical section with the Carboniferous species. They have the broad depressed form of Megistocrinus proper, but differ in having thin even body plates, without impressed sutures, and the first, at least, in having a subcentral opening in the vault, while the plates of the species subornatus are, when well preserved, ornamented, even on the vault, with delicate radiating striae. From the appearance of its arm bases, in the specimens we have seen, they would seem to have also been constructed differently from those of the Carboniferous species, while the arm openings present the curious character of being each divided by a transverse horizontal septum into two distinct openings, one directly over the other. The anal opening in this species, however, is lateral, and much like that of the typical Megistocrinus. In each of the four specimens of this species we have seen, from the original locality, there are only five series of radials (three each) instead of six, as in that from which Mr. Lyon's description was drawn up.} 

Megistocrinus Eecamii, Owen and Shumard; \( M. \) plenus, \( M. \) crassus, White; and \( M. \) brevicomis and \( M. \) superbus, described by Prof. Hall under Actinocrinus.\footnote{\textit{Act.} minor, Hall, is believed to be the same as his \textit{A. brevicomis}.} Also our \textit{M. parvirostris} of this paper. All of which are from the Lower Carboniferous.


Body usually more elongated, with a protuberant base; body plates thin, even, or not convex; vault composed of small or minute pieces, and provided with a small subcentral simple opening, or possibly sometimes with a proboscis.

Actinocrinus (\textit{Megistocrinus}) Whitei, Hall, and \textit{Act. (Saccocrinus?) amplus}, M. and W.

Megistocrinus parvirostris, M. and W.

Body rather small, of the usual short cup shape, about one-fourth wider than high. Base nearly even with the surrounding first radial and first anal pieces. First radials near one-third wider than long. Second radials a little smaller than the first, hexagonal in form. Third radials as wide as the first, but shorter, pentagonal or hexagonal, and each supporting on each superior slipping side two brachial pieces in direct succession, upon the last of which rest two or three series of double alternating pieces before the commencement of the free arms, making two arm openings to each ray, or ten to the entire series. First anal piece wider and a little shorter than the first radials, supporting three smaller pieces in the next range, above which there are four or five in the third, and five in the fourth ranges, which latter connect with numerous very small pieces forming and surrounding the little short proboscidiform opening. First interradials about as large as the second radials, and bearing two smaller pieces in the second range, three in the third and two or three in the fourth, with a few minute pieces in the latter.

Vault a little convex, composed of moderate sized, convex or tuberculiform pieces, the largest and most prominent of which is in the middle, and the others surrounding it, while a few minute pieces are intercalated between and around the latter, particularly on the anal side. Anal opening in a short, little proboscidiform protuberance, placed entirely below the horizon of the arm bases, and directed a little obliquely downward. Body plates, excepting the small ones, connected with the opening, all rather tumid, and separated by excavated sutures, somewhat indented at the corners of the plates. Arms and column unknown.

Height of body to top of central node of the vault, 0-80 inch; breadth, 0-96 inch; height to arm openings, 0-58 inch; do. to anal opening, 0-33 inch.
This species is apparently most nearly allied to *M. brevicornis*, Hall (sp.), but differs in having a greater number of ranges of brachial pieces included as a part of the walls of the body, and these pieces wider and commencing as double series farther down. Its opening is also placed decidedly lower even than the proposed species *Aet. minor*, of Hall, being distinctly below the horizon of the lower edge of the arm openings, and nearly halfway down the side, measuring from the highest part of the vault. Its larger vault pieces, excepting the middle ones, are also more prominent and pointed. Its body and vault plates are all much more convex, its arm bases stouter, its vault less depressed, and its opening decidedly lower than in *M. superlatus*, Hall (sp.).

**Locality and position.** Upper Burlington beds of the Lower Carboniferous at Burlington, Iowa. No. 161 of Mr. Wachsmuth's collection.

**Genus DORYCRINUS, Roemer.**

**Dorycrinus canaliculatus, M. and W.**

Body under medium size, cup-shaped below the arms, rather rapidly expanding from the lower margins of the first radials to the arm bases. Base extremely short, its entire height merely consisting of the thickness of the plates, subhexagonal in outline, with small lateral notches at the sutures, scarcely projecting below the first radial and first anal piece; facet for the attachment of the column occupying about half the breadth of the base, round and rather deeply impressed. First radial plates about once and a half as wide as high, all very nearly hexagonal, there being scarcely any perceptible angle at the middle of those over the sutures of the base. Second radials scarcely half as large as the first, about once and a half as wide as long, and presenting the usual quadrangular outline. Third radials a little wider and shorter than the second, pentagonal in form, and bearing on their upper upper sloping sides, in the posterior rays, two slightly smaller secondary radials, each of which supports two brachial pieces, thus giving origin to four arm openings to each of these two rays; while in the anterior ray one side of the third radial merely bears a series of branchial pieces leading to an arm, and its other side a tertiary radial, supporting two brachial pieces, thus making three arms to this ray. In both anterior lateral rays each third radial bears on each side two brachial pieces in direct succession, making only two arm openings to each of these rays, or fifteen to the entire series.*

Anal pieces about eight, below the horizon of the arm openings; first one as wide as the first radials, and a little longer, heptagonal in form, and bearing three smaller pieces in the second range, above which there are five smaller pieces in the third range, connecting with others extending up to the opening of the vault. First interradials nearly half as large as the first radials, heptagonal in form, and bearing two smaller pieces in the second range, above which one or two small pieces intervene to separate the brachial pieces, and connect with the vault.

Vault about two-thirds as high above the arm openings as the height of the body below, provided with a single rather pointed and prominent central node that may be in some instances developed into a short spine. Opening with margins a little projecting and situated in a slightly impressed area above the horizon of the arm openings.

Body plates convex, separated by deeply canaliculated sutures, and roughened by a peculiar shallow pitting over the entire surface, but which is larger and deeper at the edges of the larger plates, to which it imparts a slightly crenate appearance. The plates of the vault are also defined by the same deeply canaliculate sutures, and roughened by similar pitting to that on the body plates, though they are not convex like the latter.

As we have not seen the arms of this species it is barely possible that it may

* Sixteen is probably the normal number.
be more properly an aberrant *Agaricocrinus* than a true *Dorycrinus*. Its arm bases, however, or rather the brachial pieces, have not the breadth and stoutness seen even in the most aberrant species of the former group, such as *Agaricocrinus* (= *Act. corniculatus*, Hall), and from their appearance there is little room for doubting that it had two slender arms from each arm opening, instead of a single stout one as in *Agaricocrinus*, which, so far as we are aware, never has more than three arm openings to each posterior ray and two or three to each of the others. It is the only species we have ever seen of the *Dorycrinus* group with the peculiar sculpturing of its body plates already mentioned. This sculpturing, however, is very different from that seen on *Agaricocrinus corniculatus*, which the species most nearly resembles in several respects, being a peculiar pitting of the whole surface of each individual plate, with a few larger marginal indentations. Its greater number of arm openings (four to each posterior ray, and three to the anterior one, instead of two to each all around) would alone at once distinguish it from that species, even in specimens without the arms.

**Locality and position.** Lower bed of Burlington Limestone, Burlington, Iowa. Lower Carboniferous. No. 156 of Mr. Wachsmuth’s collection.

**Genus AGARICOCRINUS, Troost.**

*Agaricocrinus nodosus*, M. and W.

Body, without the arms, having a truncate-suborbicular general outline, being convex above and broadly truncated below; under side moderately concave out to the second radial pieces inclusive. Base small, impressed deeper than the general concavity of the under side, and entirely hidden by the column. First radial pieces extending out horizontally from the end of the column, and exposing a flat hexagonal surface nearly twice as wide as long. Second radials nearly as large as the first, a little wider than long, and presenting the usual quadrangular form. Third radials tumid, or projecting distinctly beyond the surface of the second and first; wider than long, larger than the second, and pentagonal or hexagonal in form; each bearing on its outer sloping sides two series of tumid, stout alternating brachial pieces, directed horizontally outward, and in all but the two posterior rays, forming the base of two stout arms. In the posterior rays, intermediate brachial pieces are intercalated between the others so as to give origin in each of these rays to three arms, thus making twelve arms to the entire series.

First anal piece about as wide as long, heptagonal in form, with a flat surface entirely included within the concavity of the under side, supporting in the next range three pieces, which are longer than wide, and curve up so as to form a part of the outer wall, but are not included within the concavity of the under surface. Of these the lateral two have a general oval outline, with eight or nine sides and a tumid surface, while the middle one is hexagonal, moderately convex, and much narrower at the inner than the outer end. Above these are three other smaller pieces, connecting with the vault. First interradial pieces about once and a half as long as wide, with nine sides, the inner half being flat and included within the concavity of the lower side, and the outer tumid. Connecting with the outer end of each of these are two elongated narrow pieces in the second range, which are usually tumid at the lower end, and extend up between the brachial pieces, to connect with the vault. Arms unknown.

Vault composed of irregular, unequal, tumid larger and smaller pieces. Of the larger, more prominent pieces, one is situated over each ray, and another at the middle; while a series of four or five somewhat smaller pieces immediately surround the anterior and lateral margins of the middle one. The intermediate spaces are occupied by much smaller and less prominent pieces. Opening nearly over the posterior side and penetrating a very prominent thickened ridge, which extends from the middle to the anal side, and is composed of comparatively large pieces for this part.

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Surface of all the plates, including those of the vault, regularly granular. Column of moderate size, round, and composed near the base of alternately thicker and thinner pieces, with radiately striated surfaces, and perforated by a very small nearly rounded central canal.

Height of body to top of vault, 0.88 inch; breadth, including three brachial pieces on each side, 1.13 inches; breadth of concavity of under side, 0.57 inch; thickness of column 0.40 inch from base, 0.12 inch.

This species differs from all the others yet known from the Burlington group, in having three arms to each posterior ray. It is most nearly allied to A. bul-latus, Hall, a single individual of which, out of a considerable number in Mr. Wachsmuth's collection, has abnormally three arms in one of the posterior rays, all the others having two to each ray all around. It differs also from all of these, however, as well as from the original type now before us, in having the concavity of the under side less deep, and all the pieces surrounding it more tumid, while the form and proportions of its body pieces are different, its anal region much more protuberant, and its vault pieces less rounded and swelled. Its surface is also more coarsely granular.

Locality and position. Highest part of the upper bed of the Burlington group at Burlington, Iowa. Lower Carboniferous. No. 148 of Mr. Wachsmuth's collection.

**Genus PLATYCRINITES, Miller.**

**PLATYCRINITES TENUIBRACHITUS, M. and W.**

Body rather small, subglobose, being somewhat wider than high. Base shallow, or dish shaped, with a subpentagonal outline and a rather broad shallow concavity below, nearly twice as wide as the rather small round facet for the attachment of the column. First radial pieces a little wider than high, having a general quadrangular form, but with the superior lateral angles slightly truncated for the reception of the interradial pieces, and the lower sides a little convex in outline; sinus in the upper side of each equaling about half its breadth, and extending down on the outer side about one-third to one-fourth its length. Sutures channeled by the beveling of the edges of the plates. Second radial pieces very small, wider than long, triangular in form, and wedgeing out on each side so as to allow the first brachial pieces to come in contact with the first radials at the lateral edges of the sinuses in the same.

First divisions of the rays, from their origin on the second radial pieces, each round and composed of a single series of somewhat wedge shaped pieces to the fourth piece, which has a pentagonal outline and gives origin to two divisions, the inner one of which is smaller than the other and without farther bifurcations, being a simple arm, composed below, for some little distance, of a single series of wedge formed pieces, beyond which it passes gradually into a double series of alternating pieces, while the outer division bifurcates on the second piece, its outer subdivision remaining simple like the inner of the first divisions, already described, and its inner division bifurcates again on the fourth pieces, forming two arms like the others, thus making four arms to each of the two main divisions of each ray, or forty arms to the entire series, all of which are long, slender, and without spines or other asperities. Pinnule, or so-called tentacles, slender, rather crowded, and composed of joints that are longer than wide and deeply furrowed within.

Surface of body plates marked with small rough ridges, which on the first radial pieces run parallel to the lower and lateral margins, with more or less irregularly disposed granules on the central region, sometimes showing a tendency to radiate from the sinuses for the second radial pieces.

Height of body, 0.30 inch; breadth of same, 0.50 inch; length of arms, measuring from the first divisions on the second primary radials, about 1.50 inch; do. to first bifurcation above, 0.22 inch; breadth of each individual arm above all the bifurcations, 0.05 inch.

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This species is related to Platycrinus Americanus, of Owen and Shumard, with which it agrees in the size and form of its body. Its surface sculpturing, however, is somewhat different, that species having merely a nodular ridge running along the lower and lateral margins of the first radial plates, and two others starting from the lower lateral angles and converging to the sinuses in the middle of the upper edge, with little isolated nodes on the intermediate spaces; while in the species under consideration there are merely three somewhat nodular ridges, parallel to the basal and lateral margins of these plates, with more or less granules in the central region. As such markings, however, are subject to some variation in individuals of the same species of this group, we should not have regarded the differences mentioned of sufficient importance to warrant the establishment of another species, if it were not for the additional fact that Mr. Wachsmuth finds specimens agreeing exactly with Owen and Shumard's species in the ornamentation of the body, and yet having only six arms to each ray, or thirty in the entire series, instead of eight to each ray, as in that under consideration.

P. Wortheni, Hall, agrees with this in having eight arms to the ray, but they are much stouter, and differ in being roughened by numerous small asperities, while its second radial pieces are much smaller, and each supports on each side above only two very short pieces between it and the first bifurcations above, instead of four. Similar differences are also seen in the details of the other divisions, while the surface ornamentation of the two species is entirely different, and the base of the Wortheni is flat or broadly concave, instead of being moderately convex with merely a central concavity.

Locality and position. Upper beds of Burlington Limestone, Burlington, Iowa. No. 218 of Mr. Wachsmuth's collection.

Genus PROTASTER, Forbes.

Protaster? gregarius, M. and W.

The disc of this species is circular in outline, slightly convex above, and measures from 0·20 to 0·30 inch in diameter. In most cases it looks as if merely covered by a smooth membranaceous integument. Some casts of its external surface, however, seem to show traces of flat, nearly smooth, imbricating scales above. The five arms are slender, flexible, and rather long in proportion to breadth. In a specimen with a disc measuring 0·25 inch in breadth, the diameter of the arms near the disc is only 0·05 inch. None of the specimens show the entire length of the arms, though some fragments of them were seen lying detached in the matrix, about 0·55 inch in length, without being complete at either end. From the breadth and gradual taper of these it would seem probable that when entire they may have been 0·75 to 1 inch in length. Their impressions in the matrix give no indications of a longitudinal furrow along the under side, but show that there were about six pairs of arm pieces in a length of 0·16 inch. These pieces appear to be nearly though not exactly opposite, and each one provided below with a comparatively large, round, deep pit or pore, near the middle of its anterior side. Along their lateral margins there appear to be impressions in the matrix of very small spines (one to each arm piece), though if such they must have been extremely short. Impressions of the upper side of the slender arms show them to have been somewhat rounded above, with the nearly square arm pieces slightly alternating. Some of the impressions seem to show traces of central pores or pits, one at the middle of each pair of pieces, though in others no traces of these are visible.

We have numerous specimens of this little species before us, but as they are all merely in the condition of casts and moulds in a very fine, somewhat granular matrix, they do not show the details of its structure very clearly. As far as its structure can be made out, however, it seems to agree well with the general features of the genus Protaster, as illustrated by Prof. Hall in the Twentieth Report of the Regents of the University of N. Y., on the State Cab.
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net of Nat. Hist., though not with Mr. Salter’s figures of *P. Miltoni*. It will probably be found to be generically distinct from the Silurian typical forms of *Protaster*, but we prefer to place it provisionally in that genus for the present. We are not aware that any well defined species of the genus *Protaster*, however, have been found in Carboniferous rocks.

**Locality and position.** Crawfordsville, Indiana. Keokuk division of the Lower Carboniferous series.

**MOLLUSCA.**

Genus CHÆNOCARDIA, M. and W.

(CHÆNOCARDIA, to gape; καθαρσία, the heart; in allusion to its gaping front and general form).

Shell equiva]ve? rather thin, very inequilateral, more or less oval, beaks small, depressed and nearly terminal; valves strongly gaping in front, and closed behind; hinge unknown, but short and without cardinal area; surface with concentric stripes, crossed on the posterior dorsal region by faintly marked radiating costae, and on the gaping front by radiating lines and costae.

Although we have not seen the hinge of this type and know very little of its muscular* and pallial impressions, it differs so decidedly in its external characters from all the established genera known to us, that we cannot doubt the propriety of proposing a new genus for its reception. In the single character of having the valves distinctly gaping anteriorly, it resembles the Silurian genus *Hippomorpha* of Salter, to which it may bear some relations. It differs, however, in having the gaping part of the valves terminal, instead of occupying the anterior ventral region. When placed with the hinge line in a horizontal position, the margins of the gaping part (which are not thickened and reflected as in Mr. Salter’s genus), are found to slope slightly forward, as if truncated, in that direction from immediately in front of the beaks, instead of sloping posteriorly to the middle of the basal margin. Our type also differs in the possession of radiating markings, and much smaller umbones, as well as in being less gibbous. It is true that some of these characters might be merely specific, but we cannot believe they all are; while the general physiognomy of the two forms is so different as strongly to impress the mind with the idea of their belonging to entirely distinct genera.

Without a knowledge of its hinge and interior, it is not possible to arrive at very satisfactory conclusions in regard to the family relations of this shell, though we are inclined to believe it related to the *Mytilus*. The gape of the front was doubtless for the passage of a byssus, as it is too high up from the antero-ventral margin to have been for the protrusion of a foot to be used in crawling about.

The description is made out from left valves only.

**CHÆNOCARDIA ovata, M. and W.**

Shell obliquely ovate, more than two-thirds as wide as long, moderately gibbous, the greatest convexity being a little in front of the middle. Posterior outline rounding into the cardinal margin above, and into the base with a broad subsemicircular curve; deepest part of the base behind the middle, from near which the anterior ventral margin ascends very abruptly and a little obliquely forward, with a slightly convex outline, to the lower part of the anterior hiatus. Anterior gaping edge truncated, with a slightly convex outline and forward slope from immediately in front of the beaks, and defined, or separated from the body of the shell by a faint sulcus, starting from the immediate front of the beak, and curving downward so as to intersect the margin at the base of the hiatus, which (supposing it to be equally developed in the

* One internal cast appears to show trace of a long narrow, anterior adductor muscular scar near the edge of the gaping part of the valve.

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right valve) is about twice as long as wide, and of a broad lance-ovate form, most angular at the base. Hinge line scarcely more than one-fourth the greatest length of the shell, measuring obliquely from the anterior extremity to the posterior basal margin, and ranging at an angle of about 45° to the longer axis of the valves. Beaks very small, incurved, and depressed almost to the cardinal margin; located nearly over the anterior edge. Surface with concentric striæ obscure; radiating costæ of the posterior dorsal region very faintly marked, and broader than the slight furrows between, while very obscure traces of fine longitudinal striæ may be seen on some of them; radiating costæ of the anterior, fine, and rather sharply defined on the gaping edge, back of which a few larger obscure ribs may be seen, the posterior one of which is larger than the others, and curves down from the anterior side of the beak so as to intersect the margin of the valve a little below the lower end of the hiatus.

Length, 2 inches; height, measuring at right angles to the greatest length, 1 1/48 inch; convexity of the left valve, 0.50 inch; length of anterior hiatus, 0.63 inch; breadth of do. in same, 0.16 inch.

This shell differs so widely from all others known to us from our Carboniferous rocks, that a comparison is unnecessary. Indeed we know of no other form liable to be confounded with it, from rocks of any age.

Locality and position.—West Pecan Creek, Grundy County, from the lower part of the Coal Measures.

Genus ALLORISMA, King.

ALLORISMA COSTATA, M. and W.

Shell under medium size, longitudinally oblong, the length being more than twice the height, very thin, rather convex in the central and umbonal regions; anterior margin rather short, closed and narrowly rounded; basal margin forming a long nearly semi-elliptic curve, with a very slight sinuosity in front of the middle; posterior side compressed; but apparently a little gaping and distinctly truncated, nearly vertically, from the base about half way up, and thence a little obliquely forward and upward to the dorsal margin; posterior dorsal region compressed above the umbonal ridge; cardinal margin equaling about two-thirds the entire length of the shell, very nearly straight, and inflected so as to form a narrow or lance-linear corselet, extending its whole length; beaks convex, rising a little above the cardinal margin, and placed slightly more than one-sixth the length of the valves behind the anterior extremity; lunule well defined and lance-ovate in form. Surface ornamented by about twenty-five very regularly arranged, distinctly elevated concentric costæ, which commence near the lunule, and extend backward parallel to the base, to the well defined, angular umbonal ridge, leading from the beaks to the posterior basal extremity, at which ridge they become suddenly obsolete, or very nearly so, being mainly represented on the more compress posterior dorsal region by distinct lines of growth, which are crossed on the middle of this area by a second oblique linear ridge extending from the beaks to the middle of the posterior margin. Some indications of the usual minute surface granules appear to be visible in some of the moulds left in the matrix.

Length, about 1 20 inch; height, 0.53 inch; convexity, 0.44 inch.

This is a very neat, elegant species, of the type A. elegans, King, and A. Geinitzii, Meek, (= E. elegans, Geinitz,* not King). It is a more slender species, however, with much more sharply elevated, and more regularly disposed costæ than the former; while it will also be readily distinguished from the latter by its costæ, and much more depressed umbones. wider (higher) posterior extremity, &c. The regularity and prominence of its concentric costæ, and their very abrupt termination along the umbonal ridge or carina, are remarkable.

* Carbon f. und Dyas in Nebraska.

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characters that give the posterior half of the valves much the appearance of some types of Trigonia.

Locality and position.—Found by Mr. Green, of the Illinois Survey, in Warren County, Illinois, in a black bituminous limestone near the base of the Coal-measure, associated with Lima retifera, and Cardiomorpha Missouriensis, Shumard, Aviculopecten ? carbonarius, Stevens, sp., (=Pecten Broadheadii, Swallow, =P. Swallowi, Gein.), Spiriferina Kentuckensis, Shumard, Chonetes mesoloba, N. & P., Schizodus curtus, M. & W., and various other species, many of which have been generally, until recently, supposed to be mainly confined to the upper part of the Coal-measures.* Mr. Broadhead also found it associated with many of the same fossils near the upper part of the Coal-measures in Fayette county, Illinois.

August 3d.

The President, Dr. HAYS, in the Chair.

Twelve members present.

August 10th.

The President, Dr. HAYS, in the Chair.

Eighteen members present.

August 17th.

The President, Dr. HAYS, in the Chair.

Sixteen members present.

On motion, it was resolved, that the Academy take part in the Centennial Anniversary of Humboldt’s Birthday, to be held on the 13th and 14th of September. Dr. H. C. Wood, Jr., was appointed by the Academy as orator, to deliver an address on the occasion.

The following paper was offered for publication: “On Brevoortia,” by Alphonzo Wood.

August 31st.

Dr. MAYBURY, in the Chair.

Eighteen members present.

* I have also been interested to see amongst the Illinois State Collections from the shale associated with the coal-bed at Danville, in that State, a new type of bivalves I had never before seen from any other locality than Nebraska City, Nebraska, where it occurs in the Upper Coal-measure beds referred by Prof. Marcou to the horizon of the Permian. It is a small, smooth, compressed, elongated, equivale bivalve, with nearly parallel, straight upper and lower margins, and a distinct, rather large rectangular notch in the anterior ventral margin, forming a hiatus similar to that seen in the genus Elyothyris, though it evidently has no relations to that group, but seems to be allied to the Solenidae. In Dr. Hayden’s report on the Geology of Nebraska, I have proposed for this genus the name Prophyris.

From the same bed at Danville, Ill., I have likewise seen in the State Collection, specimens of Prof. Geinitz’s Nebraska species Gerrevilla longa, one of which shows the hinge to have none of the characters of Gerrevilla or Bakaevelia, since it has no trace of the row of cartilage pits characterizing those genera. On the contrary, it seems to agree well in its hinge characters with the genus Arcaea.

P. B. Meek.
The following gentlemen were elected members:
Dr. John C. Spear, U. S. N.; Jas. Lanman Harmar; Dr. Fausto E. Rendon.

The following were elected Correspondents:
Prof. A. Kolliker, of Wurzburg, and N. H. Bishop.

The Committee to which was referred the paper by Alphonzo Wood, entitled “On Brevoortia,” reported in favor of its publication in the Journal.

On favorable report of the Committee, the following papers were ordered to be published:

The Auroral Display of April 15, 1869.

BY J. ENNIS.

This auroral display was the brightest that has appeared at Philadelphia since the memorable one on the evening of August 28, 1859. On both these occasions the light was most beautiful and striking, and during the interval between the two no display occurred at all to be compared to these in brightness, in beauty, in variety of coloring, and in general grandeur and magnificence of view. They both began just as the twilight was dying away. The former slightly exceeded in gorgeous coloring, and the latter in duration, for it continued to be still strikingly grand until after midnight. On both occasions the chief colors were pale rose and pale green, but though pale in tint they were very bright, clear and impressive.

The cause of the aurora borealis is generally admitted to be the passage of electricity from the northern region of the globe toward the south. This passage I suppose to be constant, and in three different paths: the lower, through the surface of the earth; the middle, along the top of the atmosphere; and the higher, along what are called the magnetic curves; the earth being considered as a great magnet, with the poles north and south.

The lower path becomes evident by studying the disturbances of the magnetic needle. Mr. Charles V. Walker came to the conclusion, from magnetic irregularities, that over the south-eastern portion of the New England States there is a stream of electricity of indefinite width drifting across the country, moving to and fro in a line from N. 42 E. to S. 42 W.* Professor Loomis, of Yale College, in discussing the great auroral display of 1859, says he found similar magnetic disturbances over the continent of Europe, and that they are propagated in a direction from N. 28 E. to S. 28 W. He intimates that perhaps more observations would show the directions in Europe and America to be the same.† Probably the electric currents on both continents would be found floating more nearly north and south. All the facts of these magnetic disturbances coincide with the idea that the electric stream is through the earth’s surface, the actual position of the magnets irregularly deflected.

The necessity for such a current through the earth’s surface southwardly becomes evident from the fact that the solid portion of the globe is constantly robbing the atmosphere of its electricity. We behold the tendency of this fluid to come down in a thunder shower; and sometimes, though rarely, the thunder and lightning will fall from a cloud without any rain. I know an instance, witnessed by several credible persons in the north-eastern part of New Jersey, where a lightning stroke, with a loud report, and without any rain, fell from a small summer cloud and struck one of the cattle in the field, which had a bell at its neck. The soder of the bell was partly melted, and the animal was killed. In all ordinary good weather, the higher we ascend in the air the more strongly do we find it charged with electricity. The under

† Ibid, p. 334.

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side of any stratum, say two hundred feet thick, is always negative to the upper side; and at the same time it is positive to the upper side of a stratum directly below. The lower side of this lower stratum is positive to the solid earth below, which is negative to the air above. From this condition in the air, and the relative condition between the air and the ground, there must be a constant passage of electricity more or less from the atmosphere to the earth. As the extra accumulation is at the north, it must go south through the earth for the equilibrium. This extra accumulation in the north is proved by the visible aurora borealis.

The second path southward of the superabundant electricity at the north is along the top, or through the exceedingly rare upper regions of the atmosphere. The auroral arch has in some cases been found to be about forty miles above the earth's surface. We may say it is at or near the top of the atmosphere possessing an appreciable density. This arch always moves towards the south. While it moves it seems to part with portions of itself in the form of "streamers."—far extending lines upward,—in the directions of the magnetic curves. The "streamers" cease to be visible before they reach low southern latitudes, and so does the arch; but the want of visibility, either in the streamers or in the arch, is no reason why the electric fluid does not continue to flow in both cases towards the equator. Streamers cannot be supposed to rise from the arch in the lower latitudes, because there the magnetic curves coincide so nearly with the horizon; and the parting of the streamers may perhaps cause the visibility of the arch.

Nearly twenty years ago I had a very distinct view of the electric fluid flashing along the top of the atmosphere. It consisted of sheets of flame, thin and broken, darting from north to south. I was standing on the back platform of the last car of a train travelling from New York to Newark, N. J., where I then resided. The sky was perfectly clear, and I think, though I am not certain, it was bright moonlight. I remember very distinctly that no aurora borealis was seen,—at least such as the aurora generally appears. But in looking towards the east I saw at intervals bright patches of flame shooting from north to south. These fiery patches were not the mild faint glow of the ordinary aurora, but bright like flame, though very much broken and ragged, evidently very thin, and about eight or ten degrees in diameter. Their course before disappearance ran through an arc a little longer. It was as though something was passing rapidly through the atmosphere along its top, and by friction was grating fire now and then as it passed. A few others saw the display, and I believed then, as I believe now, that I saw the frictional effect of the electric fluid against the atmosphere while flowing from the polar toward the equatorial regions. The direction of the passage was not towards the zenith to form a corona, but from north to south, while appearing in the eastern sky at an elevation of from 30 to 40 degrees.

During the display of April 15, 1869, one of the most remarkable features was the quick passage of flakes of the light glowing aurora from the northern horizon to the zenith, and sometimes fifteen or twenty degrees beyond. The transfer of the electric matter through this entire space occupied only the fraction of a second. For distinctness of appearance I could not help comparing these passages with those of breezes of wind across the surface of the water, or over a wheat field when seen from a neighboring elevation. As there are successive flaws of wind, one chasing another, so there were successive and frequent flaws or discharges of electricity. The next day an observer, quite a young man, remarked to me that it was wonderful to see the white clouds rise up from the north and fly swiftly overhead. This very rapidity, moving through such an arc in a fraction of a second, shows these clouds to have been electric. It was impossible for me then to conceive how they could have been mere flashes of light. They were not intense in brightness like those I saw twenty years ago, but the pale auroral glow as seen in the artificial auroral tube. I gazed at them long and often, with the profound

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conviction that I actually saw electricity, whatever that may be, transferred bodily from north to south. But did these mild but swift electric clouds take the path along the top of the atmosphere, or along the magnetic curves? They were certainly quite distinct from the tall continuous streamers. I incline to believe that they ran along the top of the atmosphere, and that they were nearer than the streamers. But by mere vision the relative nearness of such objects cannot well be distinguished; we cannot tell the relative nearness of a planet and a fixed star by simple inspection, although the one may be several hundred thousand times farther off than the other.

In Prof. Loomis’s description of the great auroral display of Aug. 28, 1859, he records some very remarkable observations, and reproduces the diagrams showing the deflected course pursued by some streams and flashes of electricity.* Such tortuous streams would be impossible in the magnetic curves. But they are what should be occasionally looked for when the electric fluid passes through and over the upper regions of the atmosphere. That atmosphere we know is composed of various strata and various currents, some dry and some moist, some moving one way and some another, and some charged with electricity more than others. Therefore a stream of electricity floating through or over the rare upper regions of the atmosphere, and meeting these various strata and currents, must be affected differently, and sometimes made to produce just such curved phenomena as are presented in those descriptions.

Lightening down the side of a tree takes a tortuous path from the grain of the wood, or even of the bark.

The upper path, the magnetic curves far away above the atmosphere, pursued by the electric fluid in passing from the north to the south, I do not now discuss. Like many other kindred auroral topics, it is not within the scope of this short paper. That path has been ably treated by B. V. Mersi, Esq., of this city, and by Prof. Loomis of Yale College, when describing the great auroral display of 1859 in the American Journal of Science and Arts, where both those gentlemen have given references to other authors.

The constant passage of the electric fluid from north to south is indicated by the frequent irregular deflections of the magnetic needle, and by the frequent auroral displays in high northern latitudes. Prof. Loomis portrays a zone around the northern region of the globe, where the aurora is seen eighty times in a year, as the highest maximum average. But this number seems to me to be too small. Many observers speak of their appearance almost nightly. In latitude 70° N., at Bosskop, in Finmark, M. Lottin observed one hundred and forty-three auroras during an interval of two hundred and six days, between September, 1838, and April, 1839. During the long night of seventy times twenty-four hours, from Nov. 17 to Jan. 25, the aurora was visible sixty-four times. On other occasions within that same period, when the sight of the aurora was impossible on account of thick clouds, it was proved to exist by disturbances of the magnetic needle. At Fort York, in 1789, Umfreville says, “there were very few nights without an aurora.” Chapell in 1814, when giving his experience, says, “the nights were constantly illuminated by the aurora.” Henderson says he saw the auroras in Iceland in 1814-15 almost every clear night. Such is the testimony of others, but in this short paper I cannot quote. In Prof. Loomis’s collections about the great display in 1859, several similar expressions may be found, and also in the collection of Mr. Peter Force in the 8th volume of the Smithsonian Contributions. During the summer of 1868 I spent six weeks on the Saguenay river or its near vicinity in Canada, being part of the time at Grand Bay and Chicoutimi, more than a hundred miles due north of Quebec. There the aurora appeared almost every evening; indeed, its appearance was the rule and its absence the exception. But the displays were not strikingly grand. I remarked that on the Saguenay they were much more frequent than when 1


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was at Montreal, either the same summer or in that of 1858, when I spent more than a month in or near that city. That difference of latitude, about three degrees, made what appeared to me a disproportionate difference in the frequency of auroral displays,—a difference, however, not as great as that between Montreal and Philadelphia, which is again a difference of latitude about five and a half degrees.

In high northern latitudes the auroral phenomena are rendered invisible a very large part of the year by twilight. At Montreal the twilight lasts until 10 o'clock and begins at 2; and on the Saguenay it ends at 11 o'clock and begins at 1. In latitude near 60° N. many years ago, in the month of June, I could read very easily at midnight by the light of the sun, which luminary seemed, by his bright rosy reflections against the clouds, to be but very little below the northern horizon. Plainly there can be but little chance for the electric aurora to shine among the rosy fingers of the due northern solar aurora. As in those regions the electric process causing the aurora occurs almost every night when there is little or no twilight, so we may presume the same process continues when a strong twilight hides the boreal aurora, especially since we know that auroras may be indicated by the magnetic needle when they are not actually visible to the eye. Our present reports from the far north lead to the supposition that the auroral process is more frequent on some meridians of longitude than on others, and that it is effected by geographical causes. Probably also many reporters, being exploring travellers and not scientific observers, have thought the fainter and less conspicuous auroras unworthy of record; and hence Prof. Loomis' small number of eighty per annum for the maximum average in any zone.

Both Capt. Franklin and Dr. Richardson testify that "the auroral phenomena are frequently seated within the region of the clouds." Hood states that he saw the aurora several times only six or seven miles above the earth's surface; among others, on Oct. 23, 1819, and June 13, 1820. I have observed similar cases. All the facts agree best with the idea that the liberation of the electricity causing the aurora takes place daily within the atmosphere, and that thence it escapes southerly by the three paths I have mentioned. The constant flow of electricity from the north requires in that region a constant supply. This supply must be afforded by the constant flow of the atmosphere to the north from the equatorial regions, where at its very start it is charged with electricity by simple evaporation from the saline waters of the oceans. For it is a well known fact that positive electricity abounds in all vapors from waters only slightly saline. It has long been remarked that terrestrial magnetism and atmospheric electricity seem intimately connected. They cannot depend on geological causes, for we see nothing in the mineral constitution of the globe to produce such variable phenomena. They must depend on the radiations from the sun, either directly in part by changes of temperature, as Faraday thought, or indirectly by some other means, such as evaporation, condensation, friction of atmospheric strata, and the like. Mysterious as the whole subject now appears, it is nevertheless plainly a soluble question, and awaits only the coming man armed fully with physical and meteorological science and having patience to give the problem a few years of undivided attention.

On the production of BRACTEA in LARIX.

BY THOMAS MEEHAN.

I have no desire to press with undue force on my fellow-students in Botany the importance of the discovery I made last year, that many of the great differences we see in varieties, species or even genera in Coniferae, are resolvable into the simple question of axial vigor; but the key it furnished enables me frequently to unlock some heretofore secret and mysterious...
cabinet of nature, and I have, therefore, to keep referring to it as the means to still more important ends.

Last year I had progressed only so far as to learn that foliage was governed by this law. I have since been able to show that the production of the sexes is governed in the same way. I can now show that the same law prevails in determining the form of the parts of fructification.

Larix Europaea, as in these cones exhibited, has the bracteae scarcely as long as the scales, but I also exhibit other cones from the same tree in which the bracteae are double the length of the scales, and some of them inclined to recurve in such manner that they much more nearly resemble the cones of Larix Grigorii of the Himalayas than they do those of the species to which they belong. In order more clearly to explain the law of their production, I will go over again part of the ground I have before explored, in order to make more clear the connection between past discoveries and the present one.

In the first year of infant life, vitality is not strong. The Larix is no exception. As a consequence of this light hold on life, the leaves are all entirely free from cohesion with the main stem or axis. The next year life is more powerful,—the axis thickens, and the leaves become mostly adherent, having only the foliaceous awns free. The Larch, of all trees, devotes the most of its strength to its main axis or stem. Year by year it accumulates strength in it, until by ten or twelve years of age it will frequently be able to make a growth of five or six feet in height of a single season. At this—the height of its vigor,—the reproductive age commences.

The greatest stream of vitality flowing through the main axis, the side branches have a very weak development. In many cases the buds cannot push forth into shoots at all, but in such cases that law which gives corresponding strength to the leaves in proportion as it is abstracted from the axis, causes the leaves—true leaves—to grow in tufts or verticils, on small woody spurs. The axis in these spurs elongates every year; by slitting them, the annual gains of growth can be readily seen. Occasionally, by the accidental breaking of the point of the branchlet along which these verticils are situated, or from some other cause, the stream of vitality along that line is checked, it will flow again into these verticils or arrested axes, and though they may have been in the condition of spurs for ten or twenty years, they will again develop into branchlets, with adherent leaves, as in the regular course of things.

Coming now to the bearing age, we find along a branchlet of the preceding year's growth, before the growing season commences, numerous buds at irregular distances along its length. The stoutest of these buds branch out into new branchlets; the rest remain as spurs. None of these produce flowers on this, the shoot of the preceding year; but the next year a few of the strongest again develop into branchlets, a few more into verticils of true leaves on the spurs, more into female, and the balance into male flowers. All these different grades of vigor, and the consequences of the various grades are apparent in these specimens (exhibited). The highest grade, the development of the axis with adnate leaves,—the next spurs with free leaves,—the third with fruiting cones,—the fourth with a vitality so weak that, after the production of the pollen, the flower and whole woody axis immediately dies altogether.

Let us now pass from the Larch to a law of vigor recognized by every observer as common to all trees. If two branches push out together, and the one happen to get a little the start of the other in vigor, the stream of vitality in that will be continually getting wider and stronger; and just in proportion will the other lose. The strong branch in time will often take all, absorbing all the feeders into itself, leaving the other side stream dry. Thus the inside branches of trees, deprived of light and air, get weaker; and the more fortunate ones thrive in proportion. In the Larch this is beautifully illustrated.
The inside branchlets get gradually weaker, until spur after spur in successive years loses the power of forming verticillate leaves, produces male flowers, the last effort of life, and then expires. Clear as I think the illustrations in my previous paper were to show that the production of male and female flowers in Conifera was a mere question of a relative flow of vital force, nothing can better illustrate it than this one of the Larch.

I now come to the chief point of the present paper—the influence of these laws of vigor in the modification of the parts of fructification. You will see in some of these weaker shoots, which in the production of male flowers most of the spurs have performed the last sad offices of life, a few have had just enough extra vigor vouch-safed to them to produce female cones, and it is just these weak cones which produce the lengthened bracts. I have compared with those of Larix Griffithii.

I have said in my paper on "Taxodium and Penus," in reply to an objection that my point as regards Glyptostrobus sinensis and Taxodium distichum being the same thing, is probably wrong, because the parts of fructification differ in each,—that as these parts of fructification are but modified leaves, the same law of change ought to operate on them as well. This instance of Larix proves it to be so. The bracts in Conifera are modified leaves, and the carpellary scales modifications of the woody axis. According to our now fully demonstrated theory, the leaves of Conifera are free, and become fully developed just in proportion to the weakness of the woody or axillary parts. This law might be expected to show itself in force in the bracts of the cone, as it is seen it really does in the specimens before us.

I am often asked what influence this law of vigor, as modifying form, is to have on our ideas of specific character? To me it seems the tendency will be to make our recognition of distinct things clearer, rather than to confuse them. As it is now, science on its present basis contradicts our senses. Every one knows a larch, a spruce, a fir, or a cedar, almost instinctively at sight; but no sooner were the rules of our best botanists applied to them, than no one knows which is which, and they are all thrown together in one genus. By pointing out the directions of change on one unvarying law, applicable equally to a whole genus or natural order, certainly affinities must be brought clearer and closer together, than by the present system of conjoining a few special points, many of which have no physiological relation to one another.

September 7th.

Dr. Ruschenberger, Vice-President, in the Chair.

Twenty-one members present.

Thomas Meehan said it was well known that all vegetable physiologists taught there were two classes of buds in plants, one called adventitious buds which had a kind of nomadic existence, springing anywhere from root or branch in apparent defiance of law or order,—the other axillary buds which were supposed to owe their origin to the leaf from the base of which they spring. It was customary to speak of these as the "parent leaves of the axillary buds." He would show that the leaf not only did not aid the axillary bud formation, but was rather a foe to bud development. He exhibited vigorous shoots of the Kentucky Coffee Tree, Honey Locust, Virginia Itea, Hickories and Walnuts, showing what had either been entirely overlooked by other botanists or passed over as of no importance, that there were in these two or three buds instead of the usual single axillary bud, one above another in a direct line, and that in all these instances the one the farthest removed from the base of the leaf, and of course the one the least under its influence, was the largest and best developed. These facts he had already incorporated in a paper read before the American Association at Salem last month. He [August,
had since extended the observations so as to get proofs of the same principle from single bud cases. He exhibited specimens of some maple shoots of the present season's growth and showed that there was a gradual diminution of strength in the leaves from the early spring to the present time; but just in proportion as the leaf lost in vigor the axillary buds gained in strength. The upper buds were large and plump, the lower scarcely discernible. The inference was made clear, from these illustrations, that whatever may be the cause of the simultaneous appearance of leaves and axillary buds, they were not in harmony together.

He further suggested how very important it was that botanists should note well the most trivial phenomenon. These facts, which bid fair to revolutionize one of the most popular dogmas in vegetable physiology, had all originated from the single observation that the glands on the leaf stalks of the common wild senna weed, *Cassia marilandica*, were not always in one fixed position, and could not, therefore, be an elementary part of the regular leaf system. They were afterwards found to be buds which had been devoured, as it were, by the leaf, and actually absorbed into its structure.

Mr. Redfield noticed the finding of *Aspidium aculeatum* in the Catskill Mountains, two degrees farther south than it had heretofore been observed.

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**September 14th.**

DR. LECONTE in the Chair.

Nine members present.

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**September 21st.**

DR. RUSCHENBERGER, Vice-President, in the Chair.

Sixteen members present.

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**September 28th.**

DR. BRIDGES in the Chair.

Twenty members present.

The following gentlemen were elected Members:
Jas. Cummisky, M. D.; T. H. Struts; Nathaniel E. Macomber; Wm. H. Fynn.

Prof. Geo. H. Cook, of Princeton, N. J., was elected a Correspondent.

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**Oct. 5th.**

DR. RUSCHENBERGER, Vice-President, in the Chair.

Eighteen members present.

The following papers were presented for publication:

"Meteors, their composition and the cause of their ignition and of their white trails." By Jacob Ennis.

"On the variations of the Genus *Ægiothus*." By Elliott Coues, A. M.

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The publication of No. 2 of the Proceedings for 1869 was announced.

Oct. 12th.

The President Dr. Hayes, in the Chair.

Twenty-eight members present.

The following paper was presented for publication: "On the Law of Development in the flowers of Ambrosia artemisiifolia." By Thomas Meehan.

The death of Mr. Frederick Klett was announced.

Oct. 19th.

Dr. Bridges in the Chair.

Fifteen members present.

Oct. 26th.

The President, Dr. Hayes, in the Chair.

Twenty-six members present.

The monthly report of the Biological and Microscopical Section was presented.

On favorable report of the Committees, the following papers were ordered to be published:

On variation in the Genus *Egiolithus* *

BY ELLIOTT COUES, A.M., PH.D.

Study of this genus will show a series of facts apparently of some general application, on the question of the mutual relations, if not actually of the origin, of the various forms, usually held to be species, that compose associations of corresponding grade. It is not to be supposed that this genus has labored under any peculiar or isolated conditions, or been subject to any special laws of development that have resulted in the state of things that is found to obtain. Whatever these conditions and laws may have been, they are presumably—in fact, almost certainly—equally operative upon more or less allied groups. Though it seemed to the writer, at one time, that there was something peculiar in the kind of variation to which Red-polls are subject, later investigations render it probable that such is not the case. Analysis, therefore, of the phenomena of this one group, carried into details, may be the means of deducing some generalizations not wanting in import.

It is not proposed to consider how the genus *Egiolithus* became what it is,—that is, by what means it secured individual existence as an entity distinct from all surrounds, differentiated by certain characters from the most nearly and most remotely allied types; that is a question of the origin of genera, foreign to the present subject. We are to take the genus as it now is, and study characters of the grade next below generic, in the hope of tracing some of the laws that have been effective in sorting out, among the birds of the group, the precise features they are found to possess.

* See these Proceedings, Nov. 1861, p. 373, et seq.; and Feb. 1862, p. 40.

[Oct.]
It is immaterial what name is given to the several assemblages of individuals that make up the genus. Some authorities admit but one, or at most two, "species"; others six or eight. With a common standard of reference, both parties cannot be right. If there be such a standard in nature, not dependent upon the minds of ornithologists, the difference clearly results from the fluctuating position that the latter have assigned to it; and a human fallacy, one way or the other, is implied. If, on the contrary, no such standard exists, one of the above mentioned views is as true as the other. As will be seen in the sequel, the probability is that the latter proposition comes nearest the truth. At any rate, during this discussion, until some conclusions are reached, the terms "variety," "race," and "species" will be used interchangeably, as may be most convenient for the designation of such groups as it may be necessary to speak of,—not in the conventional sense that these words have gained. And by the term "Egiothis" I wish to be understood as referring, not to the abstract idea of the genus so designated, but collectively to the million or more individual birds that are to day dwelling upon the earth, as the concrete expression of the genus they constitute.

It is demonstrable, I believe, that these birds constitute a genus; that is, that they are separable from all other birds whatsoever, by a set of characters of higher grade than those by which they have up to this time been differentiated among themselves. There is no break or flaw in the bird by which it is possible to circumscribe them. There is no shading into or graduating towards this or that allied generic group. No bird has yet been discovered of which it cannot be predicated, without qualification, that it either is, or is not, one of the *Egiothi*. If it is, it will be found to exhibit the following combination of characters; and no bird, not presenting just this combination, is an *Egiothi*:

The culmen barely or not curved, as long as the middle toe without its claw, and not over four-tenths of an inch long; the upper mandible beset at base with retrorse plumules, more or less concealing the nostrils; the lower mandible without ridges; the point of the wing formed by four primaries, of nearly or absolutely equal length; the length of the wing from carpus to tip barely exceeding one-half the total length from tip of bill to end of tail; the tail four-fifths to five-sixths of the length, forked, with broad, rounded feathers; the middle toe without its claw not over two-thirds as long as the tarsus; the hind claw longer than its digit; the crown of the head some shade of crimson; the colors of the back not in well-defined areas; the rump lighter colored than the rest of the upper parts; the adult male with the breast of some shade of red, and the throat unstreaked.

It is common to speak of the "type of a genus," and in this instance *A. linarius* is generally held to be such. But it is evident that if the above characters of the genus were to be drawn exclusively from this species, they would be rather specific than generic, and would require qualification. A diagnosis drawn as closely from *linarius* alone as the foregoing is drawn from the six or eight forms together, would exclude at least two,—*rostratus* and *cornecens*. In fact, if such expression be allowable, it may be said that *linarius* rather exaggerates than typifies *Egiothi*; that is, makes *Egiothi* out to be more different from other birds than it really is; for *rostratus*, for instance, in the features of size and shape of bill, more nearly resemble *Linota* or *Leucosticta* than *linarius* does. It is only by weighing all the phases of the genus together, taking an average, and weighing this against other averages, that a diagnosis of the genus can be obtained. Upon this method I have framed the foregoing definition, which I believe applies to *Egiothi* alone; and, as has been promised, it is highly satisfactory to find that the subject in hand may be so definitely limited. I see no "type" of this genus, except in an ideal—certainly no known existing—bird, that combines the attributes of all, without presenting exclusively the special characters of any, of the species.

If there was ever a time when all the then existing *Egiothi* resembled each other as closely as those now called "*linarius*" do,—in other words, if the ge-1869.]
nus was ever unspecific, and has since by whatever causes been made otherwise by differentiation of several phases, then linarius was perhaps the actual type of the genus. But as at such time the genus was then rather forming than formed, it is more probable that the characters of linarius (i.e., of Ejiotus in its entirety) were then specific only in relation to such types as Linota, Leucosticta, Chrysomitra, &c. So at any given moment in bird-life, a generic type or plan is an ideal induction of ours, rather than a material existence.

It is true, nevertheless, that at present linarius is the most common and widely distributed aspect of Ejiotus, and that it comprehends a larger per centum of Ejiotus than any other form. Were it the only phase of Ejiotus now living, we could handle the genus in much the same manner as we shall have occasion to with consideration of other forms. I shall for the present assume that linarius is Ejiotus, and see if it is possible, upon this hypothesis, to account for the balance of Ejiotus that are now living more rationally and naturally than they can be accounted for upon any other premise.

It is specifically characteristic of the "typical" (i.e., normal, or most usual and general) linarius to be, 1, under six and not under five inches long; 2, with a wing 2.75—3.00 inches long; 3, a tail 2.25—2.65 inches long; 4, a tarsus equal to the middle toe and its claw; 5, a bill compressed-conic, very acute, with not appreciably curved culmen, and never wholly yellow or wholly blackish; 6, the light and dark streaks of the back about equal in amount, and mingled with an intermediate color; 7, the rump never wholly unstreaked, yet always lighter than the back; 8, the male sex indicated by a bright color on the breast and rump that is between deep crimson and pale rose, yet not reaching, under mature conditions, either of these extremes.

It is to be observed, in the first place, that a large per cent.—perhaps 50 or more—of Ejiotus have preserved these special conditions inviolate. Upon these birds neither geographical regions, latitude, longitude, climate, or any other perturbing influences have exercised the slightest appreciable effect. Specimens from all parts of Europe, from Hudson's Bay, New York, Southern States, Kansas, Oregon, Sitka (and Asia?), may be found as closely resembling each other as birds from the same nest ever do. In short, there are no differences. As similar Ejiotus as I ever compared were from, respectively, Germany and the Rocky Mountains; and probably more than half the specimens at present existing in all the collections in the world will be found thus correlated. So it is a fact that, whatever influences have been brought to bear upon Ejiotus, tending to produce, or producing its differentiation or forking into several recognizable channels, such influences have been nil in effect upon most individuals.

This is the first broad fact to be remembered. It is not an isolated one. On the contrary, it is one of a parallel series of large extent. In the cases of a number of boreal and arctic types, as Nyctea, Surnia, Pinicola, Ampelia sp., and Plectrophanes sp., among land birds, and still more among natatories, as the glacial Lariote, Anaitide, Alcide, &c., we find the Nearctic the same as the Palearctic; and generally, the more nearly circum-polar types are, the more likely it is, ceteris paribus, that distinctions between these two regions will be reduced to zero. It is to be observed, further, that linarius, besides being in longitude the most widely dispersed phase of Ejiotus, is at the same time the most restless element of its genus. It has properly no special abiding place; its movements are irregular, almost spasmodic; it is found as far north as most, if not any, other forms; and, at least in the United States, ranges further south than any. I think it probable that the clue to its singular constancy is to be found in this fact: individuals not being subjected through series of generations to precisely the same climatic and other influences, in consequence of which the equilibrium, so to speak, is preserved, and variation in this or that special direction opposed. This inference seems just, and is corroborated by the fact, about to appear, that the more geographically re-

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restricted a certain per cent. of *Ergiothus* is, the more decidedly and extremely
does such per cent. differ from the rest.

1. To take up this point next: A certain part of *Ergiothus*—perhaps only one
or two per cent., now live, and probably always have lived, in Greenland. A
few years ago this fraction of the genus received from Mr. Gould the name of
"canescens," in reference to a certain condition of plumage. By this word we
may summarily imply the fact that these birds differ from *Linarius* in the fol-
lowing particulars: 1, larger size, averaging six inches in length, with wings
and tail to correspond: 2, a less compressed, less acute, more regularly conic
bill, differently colored, with heavier nasal plumules; 3, not correspondingly
enlarged feet, the toes, especially, being relatively shorter; 4, marked de-
ficiency in coloring matter of the feathers, which makes the whole plumage a
more hoary-whitish, leaves the rump pure white, reduces the streaking of the
under parts, and lightens the red of the adult *Ergiothus* to a pale rosy. These are simply
observed facts, not open to cavil. It is also a fact that these physical condi-
tions of Greenland *Ergiothus* represent the extreme of differentiation that *Ergio-
thus* has yet attained; for no known bird of the genus differs so much from the
common standard, *Linarius* as *canescens* does. These facts are to be reasoned
upon in connection with the following considerations:

As just stated, *canescens* is the most local, as well as the most boreal, demon-
stration of the genus. It is confined to Greenland; at least, it only reaches
its characteristic manifestation in that country. Though quoted from North
America, the citation is held, upon the best of grounds, to be erroneous. It is
recorded from Northern Europe; I have seen no typical specimens from such
localities; if really occurring, they can scarcely be regarded as more than ad-
vventitious. All other styles of *Ergiothus* range over more ground than this one:
if then, according to any laws whatsoever, extraneous influences effect permutation of individual characters after a sufficient number of genera-
tions, we should expect such causes to be more efficiently operative in the case
of the Greenland birds than in any other. Such is found to have been the
case. *Canescens* has for an indefinite time been subjected to certain spe-
cial, if not exceptional, conditions, with the witnessed result as above detailed;
which is tantamount to a demonstration of the assertion already made, that
the most local *Ergiothus* are the most specialized ones.

The fact of this greatest differentiation settled, we have next to inquire how
far the particular kind of modification that has been brought about is amenable
to certain laws that have been found of extensive applicability. I think that,
with perhaps one exception, all the distinctive features that *canescens* presents
are explainable by reference to some of these known laws.

An increase of size, coincidently with increase of latitude, has been shown
by Baird* and others to be of wide application in the cases of species ranging
over many degrees of latitude. It is unnecessary to cite examples. The case
of *canescens* vs. *Linarius* is a parallel one. If it be objected that in this case we
are dealing with two distinct "species," instead of variations in a single spe-
cies, it is to be replied that the "specific" distinctness of *canescens* is precisely
the point at issue, not a proven theorem. Moreover, it is to be observed that
this distinction in size is one especially marking, not birds that migrate over
a great extent of country, but those resident species, individuals of which are
comparatively stationary, some living north, others south. It is here that the
law comes most clearly into play, and *canescens* is the only set of individuals
that conforms to this requirement; the others (with possibly one exception)
are more or less migratory. So we can see why *Linarius* taken at Hudson's
Bay and in Carolina should be of the same size, while *canescens* surpasses their
dimensions.

Whether as effect of climate, adaptative modification, or pure incidence (but
more reasonably the former), the fact remains that a large number of genera


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more or less arctic present white forms. Among mammals it is only necessary to allude to Ursus, Canis, Lepus, &c. Among birds may be cited the Lagopus from the Tetraonine, Hieraftes and Nyette among raptors, and in the present family of the Fringillide certain species of Plectrophanes. Looking to water-birds, it is observed that in the large cosmopolitan genus Larus, nearly if not all the tropical and temperate zone species of which have the back black or blue, and the primaries crossed with black, the glacial species (e. g., glaucus, leucopterus, &c.) have not this color on the wings, and the mantle is very pale, or even white, as in the case of L. hutchinsi; the exclusively boreal Larue genus Pagophila is all white. It is the same with the most boreal geese, as hyperboreus, rossii, &c. Among Procellariide the most glacial genus, Fulmarus, is the palest; and an antarctic species, Thalassoica antarctica, is similarly paler than most of its allies. The modifications of color that the Greenland Aegothi have sustained are exactly homologous. This is too evident to call for argument. Moreover, besides the whitening of color, it is a matter of common observation that pelage of mammals and plumage of birds is likely to be increased or otherwise modified in cold regions, or even at colder seasons of the year, for an evident purpose. The covering of the skin is increased in two ways: by thickening over parts already covered, and by extension over parts ordinarily naked. The feet of the Ptarmigan, of the Snowy Owl, of the Northern Hare, are good illustrations of the last. Now in canescens we see both these methods in play. There is a peculiar soft thick molliposite condition of the plumage, not seen in other species, and the little modified feathers that surround the base of the upper mandible are lengthened and thickened till they form a dense ruff concealing the nostrils. It may be also remarked, by the way, that this ruff is one of the diagnostic characters of a large group, although a true subfamily, of Fringillide, many if not most of the species of which are more or less boreal birds. One other feature of canescens,—the want of enlargement of the feet in correspondence with increase in other dimensions,—I shall revert to in another connection.

As the case stands with canescens, few if any ornithologists would deny this fraction of Aegothus "specific" rank. But if the laws that we have just been noticing have any meaning,—if they are not mere word-formulas, shadowy and insubstantial,—there is no reason to suppose that canescens was not at one time linarius; nor that, if the physical barriers—the geographical restrictions—that now hedge it about were taken away, and it were permitted free migration and unrestrained commingling with other Aegothus, it would not revert to linarius in the same length of time, or less, that was required for its aberration.

It seems to me that the special conditions and relations of Aegothus canescens give it forcible bearing upon the generic question of the origin of species; and it is evident on which side it stands as witness.

II. A correlation of species in the matter of size, other than that just spoken of as dependent upon latitude, is frequent among birds. It may be accompanied by apparently unimportant, and certainly not very noticeable, differences in color, proportions of parts, &c.; a correspondent variation of the bill being among the more common. This law, so to speak, reaches a maximum, as the writer has shown, in certain pygopodous birds. In the families Columbide and Podicipide, in fact, it is possible to range the species in two parallel series, one of which is the counterpart of the other in case of almost every species, in nearly everything but size. Thus there is a larger (C. Adamsii) and smaller (C. torquatus) Loon; a larger (urticuus) and smaller (pacificus) Black-throated Diver; a larger (holboilii) and smaller (griseigama) Red-necked Grebe, and so on. The three North American species, so called, of Accipiter, are admirable illustrations. Examples without number could be advanced, but

these will suffice. In all these instances the foregoing law of increase in size with latitude has no part; for these birds always may be, and, as a matter of fact, usually are, more or less associated. The genus *Euripithus* is also obnoxious to this special kind of variation, which remains as yet unexplained.

There are in Europe, and probably also in America, two races, or varieties, of Redpolls, that differ from the ordinary style of *Euripithus* in little except size. One is smaller, the other larger. The latter has, in addition, a somewhat (but barely appreciably) larger and more yellowish bill than average *linarius*; but none of these points, even that of size, are sufficiently marked to be obvious and unmistakable except in the extreme they have as yet reached; that is, intermediate individuals now living complete a gradation back to *linarius*. This form is called *Euripithus holboelli*, after Brehm; it has been on record but a few years. It is found in northern and western Europe, associated with *linarius*; and I have seen identical samples from Canada. The smaller race has been longer known. Though usually credited, as Fringilla rufescens, to Vieillot, somewhere about 1817, it was an old entry in the books at that date. Brisson describes it with his usual accuracy; Müller has it in his Supplement, of 1776, as *F. cabaret*. Although authors speak of a notable amount of rufous in the plumage, over and above that commonly exhibited by *linarius*, there is reason to suspect that this is exaggerated. Very young *linarius* is largely rufous; and it is credible that, age for age, and season for season, the difference in the colors of *rufescens* and *linarius* is not very tangible. Difference in size, then, is the main if not the only point in this, as in the former case; and *rufescens*, as surely as *holboelli*, grades in this respect with *linarius*.

Were these larger and smaller birds separated from each other and from *linarius* by geographical range, and particularly by a difference in latitude, we could argue more plausibly concerning them. In such case, even the slight difference that exists might be traced to some cause, and be really of more consequence, in a classificatory point of view, than it now appears to be. In the larger bill of *holboelli* we might see the operation of the same class of causes (however obscure their special determination may be) as those that, e. g., have sharpened the bills of all the White-bellied Nuthatches west of a certain meridian, enlarged the Florida Crows' bills, turned the California Magpies' bills yellow, strengthened the claws of the Arizona black Pipilos, drawn out the tails of western Mocking Thrushes, put warts on the bill of *Anser rossii*, and produced a thousand modifications corresponding in degree, though so different in kind. As the case stands, we are totally in the dark. We had best, perhaps, content ourselves with bare statement of the fact that a certain per cent. of *Euripithi* have proven susceptible to some special unknown influences, and have consequently undergone certain modifications that the rest, though similarly exposed, have successfully resisted. If we go further, it must be upon speculative grounds. We may conjecture that these two races are forming species; that they began to be differentiated within the last few thousand years, more or less; and that in the process of time they will either become permanently distinct, the differences that they have become possessed of being of advantage to them; or that they will eventually revert to an original standard, such differences proving useless. A supposition as little likely to be substantiated as refuted, except by analogical reasoning.

At present, ornithologists are very properly indisposed to look upon *rufescens* and *holboelli* as anything more than "varieties" of *linarius*, and as not even very satisfactorily defined varieties. But I hold it to be demonstrable that the characters that separate these birds from *linarius* are of the same kind (though of different degree, or intensity, so to speak) as those distinguishing the Greenland Red-polls from *linarius*. The characters of all the *Euripithi*, once reduced, as they can be, to the same level, and shown to differ only by varying force of expression, I see no means of distinguishing any set of the birds from the rest, as species. Intermediate links of the chain are easily found,—links that bind the whole so firmly that there is no break in the series between the
The smallest and darkest, and largest and lightest sets of individuals as yet discovered. To prove this I must bring forward the curious variations that *Ejiolthus* has sustained in northern North America.

III. I discovered in Labrador, in 1860, and soon after published a description of, a small Red-poll that I called *fuscescens* on account of its color. Specimens had before, however, been collected, and I am inclined to think this form is the one figured by Audubon for the common species; but *fuscescens* is, as far as known, its earliest designation. These Red-polls have since been traced quite across the continent, in British America, to Sitka; specimens are contained in nearly all the collections from the interior. With this extensive range in longitude, the birds' latitudinal dispersion is rather unusually limited. They appear to be mostly confined to boreal America, rarely entering the United States, and then only along its northern border; at least, I have seen no good examples taken further south. Throughout British and Russian America they are liable to be associated with true *linarius* at any point. In Labrador, however, they are the prevailing, if not the only form. They are also associated in the interior and on the west coast with another "species," to be noticed presently. It is difficult to estimate their numbers relative to those of the two other species; perhaps they are one for ten or twenty, or even in less proportion. These birds differ from *linarius* in, 1, smaller size, though this is not very evident except on striking averages; 2, in relatively and absolutely larger, heavier, and wholly blackish bill, furnished with unusually short and sparse plumules; 3, in color, which is above dusky, scarcely relieved by lighter streaks, the rump only a trifle lighter than the rest of the upper parts, the sides very heavily streaked with dusky, and the red of the male breast intense crimson.

The form is not to my knowledge found in Europe. Whatever causes have operated to produce this special modification in *linarius*, they have not been effective in Europe, and have moreover in America only affected a small per cent. of the total number of individuals. The resulting changes I cannot attempt to explain. Besides being not referable to any known general laws, they are in direct opposition to these. Climate, geographical position, &c., should, as we saw so satisfactorily in the case of *canescens*, have enlarged and blanched these birds, and given them heavier plumules, whereas we have the contrary condition. We might suppose, indeed, that the wide dispersion and irregular movements of the Dusky Red-polls may have interfered with the equable operation of the laws just alluded to, but this does not account for the diametrically opposite result attained.

The relations of this style to typical *linarius* may be briefly exposed. So far as known, it is decidedly more different from the latter than either of the two forms last considered are. Out of several hundred specimens examined, there are a few that cannot be referred without a query to either species; these are all from the interior of British America, and most of them are immature individuals. Except in these rare instances, the line between the two kinds is distinctly drawn. There is just a possibility that these dusky birds represent a seasonal aspect of *linarius*; but almost everything is against the suggestion. On this supposition, the dusky birds ought to be found, at times, wherever *linarius* occurs,—which is not the case, as far as known. The difference in the average size, and particularly in the size and slope of the bill, is not satisfactorily disposed of in this way.

If I were to venture an hypothesis in this case, I should be inclined to frame one looking to such a class of causes, as, for example, that which has operated in the Colorado desert in bleaching birds. As is well known, several birds chiefly confined to that region are paler and grayer than their congeners (con species?) elsewhere. An incidence of this class, working in an opposite direction, may have modified a certain fraction of northern *Ejiolthus*, such as character of the forest or shrubbery mainly inhabited by these birds, the [Oct.
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nature of the food obtained there, &c. I noticed nothing, however, in Labrador, that seemed sufficient for such end. It would be interesting to have information upon this point from observers in the interior of Arctic America.

If *canescens* has been shown to have probably been at one time *linarius*, and subsequently modified, as we have seen, by the operation of known laws, I see no reason for supposing that *fuscuscens* is more distinct because we cannot so readily trace the laws under which it has been made what it is. We have only to take for granted, in this case, either a later departure from the common standard, or, what is more probable, a less regular, continuous, and consentaneous operation of modifying influences. In *fuscuscens* and *holboelli* the effect of these influences is as yet barely apparent; in *fuscuscens* it is already very evident.

In Greenland, side by side with the blanched mollipose *canescens*, we have a few singular *Egiothi*. It seems as if they had sprung like offshoots from *fuscuscens*, and there in Greenland, stationary or nearly so, and isolated, the law of latitude had come into play to enlarge them; but that further interference with fususcens features had not been experienced. These *Egiothi*, that I call *rostratus*, are: 1, as large as, or scarcely less than *canescens* (about six inches long); 2, with a bill that is even an exaggeration of that of *fuscuscens*, being still larger, thicker, more turgid, with short plumules, and black in color; 3, with the colors of *fuscuscens*, the heavy stripes on the side being sometimes carried quite across the belly. There appear to be fewer of these than of any other *Egiothi*; I have not seen a dozen in all, and none except from Greenland. One or two of these are appreciably lighter than the rest, and in fact, shape of bill and total size apart, rather recall dull plumaged *linarius*. I scarcely know what to make of this form, after accounting for its size as above, and prefer to leave it with this simple statement of fact. In a classificatory point of view, it appears to hold somewhat the relation to *fuscuscens* that *canescens* (or possibly rather only *holboelli*) does to *linarius*. Though I did not reach such opinion in my monograph of 1861, I should now, in spite of its several very obvious peculiarities, consider its characters, in relation to those of *fuscuscens* or *linarius*, as of less systematic value than those of any "species" except *fuscuscens* and *holboelli*. The small number of specimens at my command will not allow me to expose the precise degree in which it graduates towards *fuscuscens*; but it is probable that some such assimilation occurs, and that nothing but the birds' isolation in Greenland prevents them from shading insensibly into *fuscuscens*.

IV. Perhaps the most interesting modification of *Egiothi* remains to be noticed; I refer to what I call *exilipes*. Audubon figures it by mistake for *canescens*, which I presume he never saw; and Elliot has recently given another illustration. It is the "mealy red-poll" of American, but not of European, writers. The peculiarities of *exilipes* do not occur, so far as known, in Asia, Europe, or Greenland, but they are characteristic of a large number—perhaps the majority—of boreal and arctic American *Egiothi*. These modified *Egiothi* do not come so far south as *linarius* does; in general they may be said to be confined to British and Russian America, though some appear to occasionally pass the northern boundaries of the United States in winter. They are very generally dispersed, being contained in almost every collection sent from the interior and the north-west coast, but are perhaps more abundant westward. They are migratory, if irregularly so. They sometimes seem, judging from collections, to be the only form in some localities, but more generally they are associated, if not at the same season of the year, with *linarius* and *fuscuscens*—sometimes both. It seems as if there were a wave of *linarius* swaying north and south, between certain parallels of latitude; another of *exilipes* between certain higher parallels; yet the two regularly meeting on common ground, and each sending and preying still further in the direction of the other.

The characters of *exilipes* are these: 1, size of *linarius*; 2, colors (very 1869.)
nearly) of _canescens_; 3, a smaller, more regularly conic bill than _linarius_, generally rather dusky than yellow, and with extremely heavy plumules; 4, remarkably small feet, produced mainly by absolute shortening of the toes. We have here a unique assemblage of characters; the modification that this per centum of _Euphagus_ have undergone is not just like that of any other. Climate, apparently, has, as in the case of _canescens_, done what might have been expected in respect to color: it has bleached the tints into the semblance of those of _canescens_, taken away the stripes from the rump, leaving this largely and purely white, and reduced those on the sides to a minimum; whitened the edges of the wing and tail feathers; made the rosy paler, and thickened the nasal plumules. Latitude, on the other hand, has not effected any perceptible increase in size. This is curious, viewed beside the case of _rostratus_, in which size is increased, but color unaffected. Superadded to these changes is the singular modification of the feet.

As is well known, absolute size of these members, and relative proportions of the toes to each other, as well as to the length of tarsus, are among the more constant features that birds present. Only a narrow margin seems to be allowed, in the same species, for variation in these respects. In fact, looking over the annals of ornithology, one is struck with the number of proposed species called "longipes," "brevipes," "brachydyactylus," etc., that have subsequently been shown to be only accidental, or very partial modifications, not holding good as a general rule. There are a great number of synonyms of this particular class, needing no more than this allusion. At the same time, it is equally well known that certain closely allied birds do really differ in precisely this particular,—sometimes with other peculiarities superadded, sometimes with scarcely any, or none. A more or less decidedly terrestrial or arboreal mode of life may reasonably be presumed, if not logically inferred, to have something to do with this change. The case is better illustrated in comparing allied genera. Thus _Mimus_ is an eminently bush- and tree-living genus; the species of its nearest ally, _Harporhyuchus_, spend much of their time on the ground, walking and scratching among leaves, &c. The feet of the latter are correspondingly larger and stronger than those of the former. The same is the case regarding _Pipilo_, as compared with other allied genera less eminently, or scarcely, terrestrial in habit. If such modification can be traced in this grade of forms, I see no reason why it should not be exhibited, in however much less degree, between congeneric species that differ in a more or less decidedly arboreal mode of life. Admitting, then, possible modifications of the feet, in specific as well as generic grades,—modifications correspondent to the nature of the foot-hold that the birds habitually take,—there seems no reason why the argument by analogy should not be carried a step further, and made to include possible results from a difference in the kind of trees or bushes, or the kind of ground that arboreal or terrestrial species respectively frequent. Terrestrial sparrows of muddy situations will probably be found to have some modifications of the feet not shared by those of sandy deserts, or of rocky gorges. Rush-sparrows, as _Ammodromi_, that climb up perpendicular swaying stems, have not the same feet as their nearest allies among bush-sparrows that habitually rest upon horizontal and less yielding twigs. These are merely illustrations in point of what I wish to propose,—namely, that the small feet of _A. exilipes_ may be due to a difference in the size, texture, &c., of the trees or bushes that they habitually frequent, or are really confined to, as compared with the greatly varying range of footholds that _linarius_, in its extensive movements, necessarily takes. It does not seem irrational to suppose that the stunted resinous conifers that form so marked a feature of the northern flora may have produced, in the course of time, the modification that is now witnessed. However well or ill grounded the suggestion may be, it is at least a fair inference; and, at any rate, I know of no other assignable cause for the observed fact.

As intimated when _canescens_ was spoken of, it is interesting to note that the
same condition of feet is found in that species. The feet, indeed, are larger than those of *ezilipes*, and the tarsi, particularly, are long; but the toes are still notably short, in a relative sense, not having increased *puri passu* with enlargement in other respects. I would attempt to explain this fact in the same way.

So far as I know, the claws of *E. piatus* have not been modified coincidentally with those changes that have made the several races what they are. The claws of *ezilipes* and *canescens*, indeed, are longer, compared with the toes, than those of other forms; but this a relative, not absolute difference. The claws of all the species are liable to vary within rather wide limits.—this discrepancy belonging clearly, however, to the class of individual peculiarities.

The conclusions to be drawn from the foregoing facts are obvious. We have seen that *canescens*, the form most strongly differentiated at present, is also the one most easily accounted for by the operation of certain known laws that produce variation in species. If this were not a separate and independent creation, it must have been evolved at some time out of *linarius*. The question of its specific distinction, then, is merely a question of time; we can only say that it has divericated further than any other known forms from the original standard, and that, though it has reached a point where most ornithologists would draw a dividing line qua species, yet it is really only a variety of *linarius*. *A fortiori*, in the case of all the other above described modifications of *linarius*, we have varieties, not species. Simply, they have not progressed so far in the process of differentiation; they either began to be modified later, or the modifying influences have not been so effectual towards that end. But if *canescens* is a "species," so also is each of the others. There are only involved differences in degree, not in kind.

The Law of Development in the Flowers of *Ambrosia Artemisifolia*.

BY THOMAS MEEHAN.

In the fruit of *Ambrosia artemisifolia* the perigynium is crowned with a series of horns. I propose to show that these are all that remains of other flower buds, which have been absorbed by their elder sister during infancy.

It is not generally known that this species is occasionally dioecious, though Dr. Darlington in his *Flora Estrica* makes note of the fact; nor is it known to the mass of botanists that a peculiar form of neutral flower exists, though many years ago Torrey & Gray (*Flora of North America*) briefly alluded to it. These dioecious forms and neutral flowers afford the key to the whole structure.

In the regular form of this species the sequence of the flowers is according to the laws recently developed in my papers on sex. The female flowers receive the plants' first and greatest care, and always appear in the lines of strongest vitality, of which a vigorous axial development is one striking type. The male flowers only appear in the weaker lines, after the cohesive force so essential in building up the woody axis has been considerably spent. In the purely pistillate forms we almost always observe an unusual axial activity. The female flowers in the regular forms are sessile in the axis of the leaves; but in the mostly pistillate forms they are generally elevated on short peduncles, giving the plants a peculiar twiggy appearance. On the other hand, the nearly male plants, which by the way are rarely seen, present characteristics the reverse of these. The heads, usually female, when appearing as male flowers, exist as large burrs tightly set in the axis, without the slightest tendency to pedunculation. Though varying in intensity, and occasionally intermingling, no one can fail to see that these forces prevail in these forms—the feminine, in connection with cohesive and vital activity in the axillary parts—the masculine, with weakened axillary activity, and individualization.

The flowers themselves, however, afford a better illustration of this than the 1869.]
supporting parts. The male flowers are five to eight in each involucral cup. —in the female they are single; but in place of flowers the female has five to eight horns on the perigynium. The want of correspondence in number in parts which were no doubt embryologically the same, together with a correspondence in the number of the horns on the perigynium, would naturally suggest to one acquainted with the absorbing or coherent power of the female influence that the primordial in bnd had absorbed the rest, of which all that remained were these horns. This I subsequently proved to be more likely by the discovery of two forms of perigynia. Occasionally three female flowers appear in one involucral cup. In such cases the two lateral ones have, mostly, no horns, or rarely one or two; while the central one has but from four to six—evidently a less number than others which have no side flowers with them. In the male flower we find two forms; the perfect ones with five broad anthers, abundantly polleniferous, without horns, and without any attempt at producing a style. The other class has anthers which seem never to produce perfect pollen, but are projected into a "setiform inflexed appendage" or horn, and have a single sterile style which is capped by a numerously rayed stellate apex. Torrey & Gray (Flora N. M. Page 290) notice this form of flower, but err in evidently believing it universal; while other authors seem to refer to the former, ignoring or ignorant of the existence of the latter.

The absence of a style in connection with perfect anthers, and the attempted production combined with the deficiency of pollen in the neutral ones, show an evident progress towards a female stage; and also it is clear that with this progression is a tendency to corollin in the parts absorbed. I pointed out to some of our botanical friends in the Academy some weeks ago, that from these circumstances the horns on the perigynium could scarcely be anything else but the remains of absorbed flower buds.

I have now found a specimen which affords the practical demonstration of these truths—a female plant not a foot high, with enough of the cohesive power to give it an entire female character, but not to the same extent that more vigorous forms possess. The horns are in every state of gradation from their usual condition on the perfect perigynia to petaloid scales, down to perfect flowers with the regular twin styles; though adherent by their bases to the central or main flower. Only for this early cohesion with, and thus a reception of the female influence, the lower ones would undoubtedly have been male flowers.

I present this specimen, together with a suite of the others referred to, for the Society's herbarium.

I may be again permitted to repeat what I have frequently said already in papers before this and kindred associations, that there are probably in plants two distinct principles going along together—the one hereditary—a conservative, coherent, female force, which, as the very existence of all things depends on it, nature throws in and around it her strongest vital powers;—and variation a progressive, radical principle, the only object of which is to prevent stagnation,—to segregate and disperse rather than unite and preserve,—and by giving varied form to matter, is the source of the endless changes which give beauty and interest to the other;—less vital, less essential, less cared for by nature because she reproduces herself by buds, tubers, suckers, roots, and many other ways when she does not care for variety, without it, but not less essential to our pleasures and intellectual progress, and indeed the eternal progress of all things.

I submit this paper as another contribution to a theory which may not yet appear to others so clearly a law, as it continues by almost daily observations to grow on myself.

Nov. 2nd, 1869.

Mr. Isaac Lea in the Chair.

Twenty-nine members present.

The death of Dr. T. H. Turner, U.S.A., was announced.
MICROSCOPIC CRYSTALS IN GEMS.
Nov. 9th.
The President, Dr. Hays, in the Chair.
Twenty-nine members present.

Nov. 16th.
Dr. Ruschenberger, Vice-President, in the Chair.
Twelve members present.

Nov. 23d.
Dr. Ruschenberger, Vice-President, in the Chair.
Twenty-six members present.

Nov. 30th.
Dr. Ruschenberger, Vice-President, in the Chair.
Twenty-five members present.
The following gentlemen were elected Members: Rev. Z. M. Humphrey and Henry C. Miller.

Dec. 7th, 1869.
The President, Dr. Hays, in the Chair.
Twenty-one members present.

Dec. 14th.
The President, Dr. Hays, in the Chair.
Twenty-nine members present.
The death of Benj. D. Walsh was announced.

Dec. 21st.
Dr. Ruschenberger, Vice-President, in the Chair.
Twenty-three members present.
The following papers were presented for publication:
"On the Classification of Water Birds." By Elliott Coues, M. D., U. S. A.
"Characters of some new Hepaticse, mostly North American, together with notes on a few imperfectly described species." By C. F. Austin.

Prof. Cope made some remarks on a cranium of the Hyperodon bidens, from the coast of Rhode Island, presented by Samuel Powell, of Newport. He stated that it was a female, which entered the harbor of the latter place with a calf. A male was some time after cast ashore dead near Dennis, Mass., and 1869.
was preserved complete in the Mus. Comp. Zoology, Cambridge. (See Allen, Mammals Massachusetts.) He said that the muzzle of the female was longer than represented for European specimens, but that that of the male was as short, and that no difference could be detected in the skeleton of either. He therefore retained the name of H. bidens. He stated that Mesoplodon soverbien-sis also occurred on the coast of Nantucket.

He next exhibited the left ramus of the mandible of a finner whale, from the miocene of Edgecombe Co., North Carolina. He pointed out that its characters were nearest those of the Eschrichtius cephalus, but that there was a groove inside the upper edge of the jaw, that the nutritious foramina were much more numerons, etc., etc. He called it Eschrichtius polypropus.

He exhibited a number of remains of fossil reptiles, from Sampson Co., North Carolina, of cretaceous age, which were intrusive in miocene beds. Among these were humerus, tibia, fibula, metatarsus, caudal vertebra, and perhaps cervical vertebra and ungual phalange of a Dinosaur, discovered together by Prof. W. C. Kerr, Director of the Geological Survey of North Carolina. The remains indicated a species having the same general form and size as the Hadrosaurus foulkei. The caudal vertebra was of very different form, and resembled more that of Hylaeosaurus, minus the dinophysices. This vertebra was elongate, depressed and angulate. The animal presented various other points distinguishing it from Hadrosaurus, and was named Hypsibema crasicandia.

Two caudal vertebra of another animal from the same County, but different locality, indicated a true Hadrosaurus. One, near the thirtieth caudal, was twice the size of that of H. foulkei, the vertical diameter of the centrum being 4½ inches. It presented so many peculiarities of form that Prof. Cope thought it to have belonged to a species distinct from H. foulkei. A caudal, apparently terminal, was shorter than the same in that species. He named it Hadrosaurus trigos.

Another reptile from the same locality was indicated by an elongate, conic tooth, and perhaps by others, which had the cone in cone structure of those of the species of the Crocodilian genus, Theiochampsia. It differed from all these in the removal of the usually opposite dividing cutting ridges to a position near together on the inner face of the crown, and the slight median contraction of the crown, which produced an appearance of enlargements a short distance above the base and below the tip of the crown. Crown conic; length 2 in., 6 lines. He named it Polydectes biturgidus.

Dec. 28th.

Dr. Ruschenberger, Vice-President, in the Chair.

Thirty-eight members present.

The Report of the Biological and Microscopical Section was received.

The publication of Dr. Leidy's Extinct Mammalian Fauna of Dakota and Nebraska, constituting the seventh volume of the Journal, was announced.

The following gentlemen were elected members: Capt. George Wright, U. S. A., Wilbur F. Horn and Rev. Theodore W. J. Wylie.

On favorable report of the committees the following papers were ordered to be printed:

[Dec.
On the Classification of WATER BIRDS.*

BY ELLIOTT COUES, A.M., M.D., PH.D.

Captain and Assistant Surgeon, U. S. Army.

By "water birds" is meant the swimmers proper, as distinguished from aquatic, or even natatorial, Grallae. That the Natatores, so accepted, are one of three primary divisions of birds, at least of carinate birds, is held to be demonstrable. I shall attempt the proof, and endeavor to define the natural orders and families of the sub-class. I am authorized to state that the classification here proposed has been adopted without modification by the Smithsonian Institution, in the arrangement of the Natatores in its museum.

Not to allude to early classificatory schemes that the progress of ornithology has shown to be impossible, nor to those late systems, based upon the inestimable labors of Müller, Burmeister, Sundevall, Cabanis and others, that relate mainly to the arrangement of the higher groups, there still remain several that must be taken into the present consideration. Notably, those of Nitzsch, Vigors, Bonaparte, Lilljeborg and Huxley, which bear directly upon the subject in hand; notice of which is necessary before defining the modification of one of them that it is the design of the present paper to establish.

It may be here premised, and safely asserted, that heretofore no two ornithologists, bringing original research, and the conclusions deduced from it, into action, have been able to agree closely in classification. There are as many systems as there have been leaders in the science. But conflict in the field of taxonomy has been chiefly along the line of the higher groups,—more particularly Passeres. Respecting the Natatores, a singular unanimity has prevailed in the definition of the group; and in the main, similar subdivisions have been recognized, however differently these have been collocated, and estimated in the scale. Intermediate or "doubtful" forms are limited to two or three families. Only one author stands far apart from the rest in the distribution of natatorial families, assigning part of them among what are known as "Grallae," and the others with certain insessorial types. These facts have perhaps another significance than that of simple matters of ornithological record.

Referring to the authors just mentioned, we find four principal methods of primary division of birds: (1) a dichotomous arrangement in two "parallel series," based upon one physiological character,—Bonaparte; (2) a trichotomous, founded upon very general considerations,—Nitzsch, and after him Lilljeborg; (3) a quinary, a modification of the second, by dividing two of the three divisions into two each, and with minor changes,—Vigors, and many others; (4) another trichotomous, but from a totally different standpoint—recognition of birds as modified reptiles—and carried out with special reference to one anatomical character, afforded by certain cranial bones,—Huxley.

After Oken's generalizations upon the condition of newly-hatched birds, Bonaparte made the scheme of Altrices and Precoces his own by strenuous, unqualified advocacy, and elaboration of details with surprising care and skill. The system took strong root, and is held by many as the key-note of the natural classification, comparable, in equivalency, to such profound divisions as e.g., Exogena and Endogena among flowering plants, or Placentalia and Monotremata among mammals. That the system has been unduly stretched may perhaps be shown.

Comparison, for instance, of Bonaparte's two subclasses with those of placental and implantal mammals, may show how far the former may be

*Considerable time has passed between the preparation and the publication of this paper; in revising the proofs I have added foot-notes, where comment or explanation seemed desirable, in preference to altering the original text; this is left untouched.

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carried. There is, I believe, a perfect parallelism in the physiological point involved between mammals and birds; but it does not reach to the grade just supposed. In Marsupials, the condition of the young at birth is associated with a radical modification of the generative apparatus in both sexes. The sexual organs alone would enable us to predicate, regarding the condition of the foetus at term, a departure from the ordinary standard obtaining in higher orders, even were we unable to say in what the difference would consist. It is not so with birds; if there be any structural modifications correspondent to altricial and precocial nature, they remain to be discovered. From nothing now known could either be predicated, in any given instance; our inferences would be purely upon consideration of known allied forms.

Marsupials are so far "synthetic" that they comprehend the semblances of other mammalian orders. There are carnivorous, herbivorous, quadrumanous, etc., marsupials. The number of forms that a given group may represent or repeat under modifications peculiar to itself, is a well-known test of the character of such assemblage, and in a measure of its grade in a taxonomy, only inferior to that afforded by the modifications themselves. Marsupials and Monotremes conform in both ways to the requirements of a primary division of mammals. But among birds, altricial and precocial orders must be so drawn that, while they are mutually representative to a degree, as wholes, they do not include, each in itself, modified representations of each other. Thus, e.g., in Bonaparte's parallel of altricial Gavios and precocial Anaeroes, among swimmers, it is impossible to find families representing each other to anything like the degree, or in anything like the number of cases, that may be shown when Natatores are divided upon another basis, and the families differently worked out.

If helplessness at birth, compared with precocity, means, among birds, "high" as opposed to "low" in the scale, then either the reverse is the case with mammals, or else we must compare altricial Incessores with marsupials, and precocial Natatores with the higher orders: a dilemma, either horn of which is sufficiently difficult.

I believe that the strongest analogy, if not actual homology and exact parallelism, between the altricial and precocial series of birds, and certain conditions of mammals, really does exist. My meaning will be evident, if I simply refer to the difference between a kitten or puppy at birth, and a newly-born calf or colt. If all mammals are "altrices" by their very nature, as expressed in their name, there is a distinction with a difference in the two modes of exhibiting this nature. The young of one series of mammals are born weak and helpless, unable to stand, often blind and naked; the nipple must be brought to these. In the other series, the young walk or swim at birth, are clothed like the parents, and can see; these betake themselves to the nipple. Here is the mammalian representation of the two avian series. This is so evident and so certain that it must have been already recognized, though it is original so far as the writer is concerned.* As among birds, moreover, this distinction marks, in a general way, large groups; even orders might be based upon it. But it would not suffice for a primary dichotomous division of mammalia, even of placental mammals; nor, should occasion arise, as when its requirements did not accord with structural modifications, would it take precedence over the latter, to the dismemberment or inversion of natural groups.

In opposing undue estimate of the value of this physiological character, I am far from underrating, still less ignoring, its import. As collateral testimony in the formation of orders and location of families, it has much weight; and

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* I find exact expression of the case:—"The differences in degree of individual development attained at birth parallel, in Mammals, those in Birds expressed by the terms altrices and precoces. The hoofed quadruped enters the world with the use of all its senses; in a few hours can follow the dam, and keep pace with her if she sees cause for flight; the feline is born blind and helpless; some days elapse ere the commissure of the eyes is unsealed."—Owen, on membrana papillaris, Comp. Anat. and Phys. Vert. iii, p. 754, 1868.
certain doubtful cases will probably be decided by reference to it. It draws a sharp, if here and there a broken, line between Gallinæ and Columbæ. It separates, with precision, Herons and their allies from other Grallæ. It goes some way in distinguishing lamellirostral from other Natatores; and other instances of its application might be cited.

Some other points are to be considered in this connection. The various conditions of single, double, and middle monogamy, and polygamy, are to be regarded. Some generalizations, apparently important, may be drawn from the comparative size of the air-space in the eggs of the two series.* Altrices usually lay few eggs, Prococeæ many; an evident adaptation to facilities of caring for young under the two régimes. Yet an immense group of prococeæ—Grallæ—lay but four, which is below the average of altricial Insessores. There are also many families among Rauores and higher Grallæ,—too many to be considered as exceptions proving a rule,—in which altricial or precocial characters are but doubtfully expressed, or else do not agree with unquestionable affinities in other respects. Finally, it should be observed that, as all Insessores are altrices, no parallelism exists between the great majority of existing birds and the precocial series of walkers, waders and swimmers, the relationships between which and Insessores, if any, are only of remote analogy, not affinity. To speak figuratively: we come a long way,—the greater part of the whole way,—down the bird scale, before meeting with any indications of difference in this physiological point. Arrived at the lower walkers, and higher waders, we first dimly see a certain principle striving, with uncertain results, to assert itself. Wavering for a while, at length it gains force and effects fissuration of birds into two or more "parallel"—i. e., self-repeating or self-representing—series; the main stem continues unaltered, through wading Herons to swimming Toltalmi, Longipennes, &c.; the fork, first distinct among some waders, thence continuing through the smaller Grallæ, &c., to anatiform swimmers. This is a matter of observation, not an hypothesis; is it sufficient basis for a primary division of birds?

In the application of Bonaparte's principle to our subject of swimming birds, the results are seen to be no better than was to have been expected. It is difficult to say which one of this author's many schedules, variously modified, should be held most expressive of his views. That given in the Comptes Rendus of Oct. 31, 1853, probably does his classification the most justice. Here water birds form his sixth order, Gavice, comprehending Toltalmi and Longipennes, and his tenth, Anseres, including all other Natatores. The two groups are separated by all the Rauores, the Struthious birds, and all the Grallæ except Herons. Beyond question, swimming birds, however viewed as to their subdivisions, cannot be separated thus; the steganopodous and maceropterous Natatores cannot be separated from others by three, or by any, orders. Here they are made to differ more from other swimmers than the Gallinaceous and Grallatorial birds do. The structural differences between a penguin and a duck are certainly as great as those between an auk and a cormorant; yet in one instance the birds stand side by side in the system, in the other they are divided by intervention of three diverse orders. But a more serious objection to this schedule, and one, too, coming from the author's own side of the question, is found in the fact that Urinatores are not all Prococeæ, as they were in this place represented. They were consequently subsequently referred to Gavice, and the penguins made a distinct order. But it so happens, unfortunately or otherwise, that neither are the Urinatores, with or without the penguins, all Altrices. In short, birds will not lie conformably disposed in the two Procrustean beds of Altrices and Prococeæ. As far as known, all Insessores (Qu. Columbæ?), Herodiones, Steganopodes, and Longipennes are Altrices; Struthiones and Lamellirostres are Prococeæ; beyond these, neither can be safely predicated of groups of higher rank than families, without exceptions and reservations.

* Cf., e. g., G. A. Lewis' Lectures on Ornithology, pt. i. p. 17.

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As the sum of the criticism I would be disposed to offer on Bonaparte's arrangement, I would say: Not to refer to Ruoores, Grallae and Natatores as varying exponents of two primes, altrices and precoces, but to regard the former as themselves the integers, of which "altricial" or "praecocial" are predicable as exponents of modifications of which the three are alike susceptible. So, therefore, altricial or praecocial Natatores, not naturalor Altrices or Precoces.*

Nitzsch's earlier classification† was a dichotomous division of Aves into Carinata and Ratitae, after Merrem; an arrangement that anticipated the later one of Prof. Huxley in separating the struthious birds from those with a keeled sternum. He afterwards‡ became satisfied that Struthionidae et aff. should come among Curoroes, and divided all birds into Av. Aëree, Av. Terrestres, and Av. Aquatieve,—birds of the air, earth and water. These are difficult of precise definition in terms descriptive of structural modifications, in consequence of the occurrence of intermediate and aberrant forms, that furnish exceptions to almost any possible diagnosis. But it comprehends a broad, well-founded generalization, violates the requirements of no natural groups, and largely fulfils the main conditions of a natural system. If the point be well taken, it follows that birds—that Carinate birds at any rate—are modelled after three types, that, however modified or even changed into the semblance of each other in some cases, retain definite tangible characters. The system appears susceptible of a crucial test. If it be true, each one of the three main stems of the bird type must repeat or represent, with unquestioned fidelity, in some one or more of its branches, the other two. Among the orders and families into which, e.g., Natatores are differentiated and specialized, representations of Aëree and Terrestres must be found; the relationships, of course, not of actual affinity, but of analogical resemblance. I think that the system will stand such test, and shall in the sequel apply it in some detail. Establishment of one of the three groups is tantamount to fixing the other two.

Nitzsch's Natatores are a suborder Av. aquat. palmatet, as distinguished from Av. ag. grallae. He adopts five "families," two of which are rather associations of families (Steugaropodes and Pyggyopodes). He places the Flamingoes (called Odontoglossae) in Grallae. Podoc he adds to Steugaropodes.

The quinary system of Vigors,‡ in its primary divisions, is a modification of the trichotomous just noticed. Disregarding subclasses, he proceeds at once to five orders. The two first of these are a division of Av. Aëree into Raptorese and Insessores, according as the birds are habitues of the upper air or of the trees more particularly,—a distinction better borne out by actual structure of the birds than by reference to this assumed difference. Nitzsch's two divisions of Av. ag. Grallae and Palmatet give, with scarcely a variation, Vigors' two last orders Grallulators and Natatores. Vigors' middle order, Ruoores, comprehends gallinaceous birds and pigeons. That these divisions are in the main strictly natural, is probably not open to serious question. A chief defect is in the inequivalence of the five orders. Thus Ruoorese contains types more dissimilar from each other than Raptorese are from (other) Insessores; and this, too, without taking Ratitae into consideration. If he would make ordinal distinction of Raptorese and Insessores, pari passu he should have separated Columbae from Gallinae. His Insessores, again, contain types as mutually dissimilar as either of them are from Raptorese. Without opening here the question of Ratitae, nor of recognizing, aside from ostriches, groups higher than orders, it may be said that this system requires modification in the adoption of several more orders,—his Ruoorese and Insessores especially demanding dismemberment into two or three.

* In this discussion of Bonaparte's scheme, it might be objected that I galvanize a dead body in order to kill it over again. But doubtless my objectors can call to mind several signal instances where, within the last few years, Bonaparte's system has been accorded the importance which is here criticized.
‡ Pterylographie, etc., 1840.
‡ Observ. on the Nat. Affin. that connect Ord. and Fam. of Birds. Trans. Linn. Soc. xix. 1827.
By this means we should arrive at about a dozen orders of apparently the same taxonomic value.

With endless minor modifications at different hands, yet with main points intact, this system has come into general use, holding its own against many technical objections, with a vitality something remarkable in the history of the science. There is that about it that appeals strongly to general opinion, representing average "common sense," and commands assent, however qualified and guarded. The most extensively used, it is also the best abused system of all, particularly in that phase it gained at the hands of Swainson et al. Much argument, and not a little invective, has been wasted, or worse, upon the various "quinary," "septenary," "circular," &c., systems that have revolved like satellites around Vigors' standpoint. It must be vital, or it would before this have been buried. It must be weak at points, or it could not have been so successfully attacked. It appears to have suffered more from the indiscretion of its friends than the hostility of its enemies.

The child's "classification" is the placing of objects in a line one after the other. A step in advance is their arrangement in several contiguous lines, straight or waved, parallel, oblique or crossing. The insurmountable difficulty is that these lines lead anywhere,—nowhere in particular. Any linear arrangement is so clearly impossible, that I only excuse myself for alluding to it at all by taking it as the initial point of departure in this portion of the present essay. It was a stride onward when the idea was conceived of making these lines return upon themselves. Not only were otherwise inevitably bizarre juxtapositions done away with, but a greater end, the production of surfaces instead of lines, was secured. Anywhere in these planes, from centre or type-point to periphery or aberrant points, forms could be located. With the "circle," an indefinite number of points of contact or inoculation became possible. The circularian could bring his three, five, seven, or other "sub-typical" forms around his "type circle," weigh the importance of each by the size of his circles, and grade relationships from near affinity to remote analogy. The elastic system seemed perfect with its machinery of "wheels within wheels." Criticism of this scheme has too often ended in a smile or a sneer, yet without touching upon the really vulnerable point. A system that disposes objects in circumscribed planes is a great advance over a linear arrangement, but it stops half-way to the goal. The third dimension is needed; to length and breadth must be added thickness; the circle must become a sphere.

Thus I conceive that every group of birds, from the assemblage of individuals called a species, to the very highest, constitutes or represents a solid of the three dimensions. We cannot predicate affinity or analogy only to the right or left,—the top or bottom,—but must take it that all groups, near or remote, may approach, touch, or fuse with each other, along the axis of either of the three possible diameters. With whatever result in our attempt to project an ornithological system on flat paper, yet we cannot imagine the groups to be all distributed in one plane surface, or even in several "higher" or "lower" parallel planes. Just as the stars, that appear scattered on a concave surface, are harmoniously distributed throughout space in its three extensions, so, types of birds with reference to each other. The avenues of mutual approach, whatever their number, do not all lie in one plane, but may lie in any of the perpendicular planes whose intersection generates a solid.

I used the word "sphere" merely as the general expression of solids with indefinite number of sides; not presuming to say that this is the real shape either of birds as a unit, or of their subdivisions. Birds could only assume this shape if developed equally in all directions, which apparently, I may say certainly, is not the case. The figure may be conoidal, like half an hour-glass, whose other half is reptiles, or only the Pterosaurian type of that class; the two meeting at a point, perhaps Archaeopteryx. Speculations upon the contour of the figure are, however, out of place. Again, the superficies of this solid, whatever its form, is not necessarily, nor even probably, smooth. We may 1869.]
conceive of it as presenting irregular saliences drawn out even into arm-like processes, reaching toward, or touching, mammalian, reptilian and piscine groups; or reentrances, into which are extended corresponding outgrowths from other forms of life. Classification is not the laying side by side of plane figures, circular or otherwise; but the piling over against each other of variously shaped solids, that meet and fit at mutually conformed and adapted points or surfaces of contact. The bird is laid against the mammal at the point Struthio; against the reptile at the point Archaeopteryx, or rather by a surface of which this type was one point; against the fish (probably the Elasmobranchiate fish) at the point Spheniscus, and so on. Inside the figure Aves, everywhere from centre to superficies, lie piled in certain order, all lesser figures, from species to sub-class, mutually fitting on every side. The problem is to discover, as nearly as may be, the plan according to which the several stones are shaped, coaptated in the building of the solid structure. We do not deal with an empty shell.*

Professor Huxley’s classification† is materially different from any other. It is probably the most stirring ornithological event since the discovery of Archaeopteryx. It is an attempt to classify birds with reference to a single set of characters—the modifications of certain cranial bones. The test is critically applied and rigidly carried out, necessitating a new division of the class, by breaking up most of the higher groups usually recognized, substituting others, and calling for a hitherto unsuspected sequence of orders and families. The primary division is into three “orders,” apparently correspondent in taxonomic value with the “sub-classes” of most writers. Sauvage, represented by the Archaeopteryx alone: Ratitæ, including Struthionæ et al., seemingly about equivalent to Platyspermæ Nitz., Brevicepses Lillj., Cursores s. Currentis alii; and Carinate, embracing all other existing birds, that agree in the possession of a keeled sternum. This initial step, however, is taken upon other grounds than the characters of the palatal, &c., bones alone; and its adoption may be found imperative. I am not prepared to offer anything upon the question. Carinate only falling within the scope of the present paper. These are divided into four orders, correspondently with as many main modifications of the bony palate, that only exceptionally merge into each other. Diedolophus, Craz (globulosa) and Peicle are the only intermediate forms known to the author. The two first may be regarded “as transitional between the Schizognathous and Desmognathous sections, or, at any rate, as approaching the latter division” (l. c., p. 455). The woodpeckers “are in fact not Desmognathous, the palate in these birds exhibiting rather a degradation and simplification of the Aegithognathous structure,” (p. 468.) The fact then is unquestionable, that Carinate may be divided into four groups by certain characters, the value of which, as affording correct indications of natural affinities or not, is the point at issue.

It will scarcely be questioned by any, that groups, to be taxonomically equivalent, should be separated from each other by characters of equal or corresponding value; that is, the sum total or average of distinctive features should be as nearly as possible of the same amount or degree. An inequality in this respect of the groups formed under this system is evident. Not to refer to the primary divisions, in the next lower scale, that of “sub-orders,” one family stands apart from all other Carinate—the Tinamous alone representing Dromacognathæ. As the author truly says, “the small actual extent of the group in which” the dromacognathæ structure obtains, is no argument against its validity as a sub-order. While this would be conceded, issue would be

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*The three foregoing paragraphs are allowed to stand as they were written, with some misgivings; not lest the thoughts that prompted them be not well enough, but lest the expressions used may fail to convey to others exactly the idea desired to be advanced. I do not expect to be here accused of using the imaginative in place of the reasoning faculties, unless I am misunderstood.

† P. Z. S., 1867, p. 416.
taken upon the question whether any other characters separate the Tinamous as widely from the Rarores with which they were associated, as the latter are separated from the birds of other orders; or, in a wider sense, are the Tinamous as different from all other Carinatae as any Schizognathous bird, e.g. a plover, gull or dove, is from any desmognathous bird, as a hawk, parrot or cuckoo? If not, an inequivalency of value between the sub-orders is implied, without any reference of course to their comparative extent. Aside from the fact that the Tinamous have "a completely struthious palate," it would probably be denied by none—not even by the author himself—that no characters can be found whereby to separate Tinamous from other Gallinæa as a group of higher rank than a family; and further, that its peculiarities are of that kind or grade usually held throughout the ornithological system to be of family consequence.* But if Tinamous can sustain an order Dromecognathæ, the rest must follow. It is a fair test, apparently, of the real value of the basis of the system. Seeing that here the characters of the palate bones are at variance with all others, it is next to be inquired how far they agree with the indications of natural affinity, afforded in other instances by general characters.

The schizognathous structure obtains† in all Rarores (excl. Tinamous) in Columba, in most Grallæ, and about half of Natatores. The desmognathous prevails in other Natatores, in Herodiones of Grallæ, in all Raptures, and part of higher Isecessores, (not necessary to particularize here,) the rest of the latter being neogithognathous. If the palate characters are sure indices of affinity, the two large groups of Grallæ and Natatores must be dismissed as unnatural, and their components rearranged in two other series, in each of which occurs a serial relation of families usually held to be widely separated, or, in some cases to represent nearly extremes of form. A cormorant or gannet comes next to the birds of prey, which only separate them from parrots. A goose is nearer to an eagle than to a gull. A pigeon comes nearer to a penguin or crane than to an incassorial bird. An albatross is more nearly related to a peacock than to a pelican. These, it is true, are among extreme instances; but the extremes as well as the means are a part of the system. In Schizognathæ, a sequence of groups is Rallidæ, Laridæ et aff., Spheniscidæ, Rarores; in Desmoognathæ, a sequence is Herodiones, Steganopodes, Raptures. Discussion of these points is unnecessitated, as it would be merely a rehearsing of the principles that have hitherto guided all ornithologists in framing classifications. Here, characters of every sort are made subservient to one. The arrangement has the appearance—be it real or simulated—of a cryptogram, to which an arbitrary standard is the only key.

But ex parte statements do not do the subject justice; views for as well as against the system should be presented. Prof. Huxley considers Charadriformes as a central group of Schizognathus, leading outward by three "distinct series or gradations." In one of these, Otididæ lead from plovers to cranes, and such genera as Psophia and Rhinaechus, thence to rails. In another, Hemipodius is intermediate between plovers and Gallinae; whence Syrhaptes leads to pigeons. A third series begins with the gulls, leads through petrels to auks, and so to penguins; "the osteological resemblances between a plover, a gull," &c., "being so close that it is utterly out of the question to regard these birds as members of different orders," (p. 455.) Conceding these series and relationships to exist, without reservation, still another point is easily raised. Passing from plovers to cranes and rails, in the manner indicated, the general affinities of some of the latter lead quite as naturally to certain Desmognaths, as herons and Totipalmates. I may instance Heliorhynchæ, really ralloid, as Brandt has shown, if osteology goes for any criterion, but

* I hold Tinamous et aff. to be the expression of the gallinacean process towards, or tendency to inoscule with, Ratitæ; i.e., a struthious phase of development or modification of a strictly rariosal idea.
† I am indebted throughout to Prof. Huxley's paper for statements of facts respecting palatal characters.

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related to Stegano pods, at Plotos. From plo vers again, a pure grallatorial form, Recurvirostra, shows transition at least as sure as others claimed, to other palmate Grallae as Phenicopeters, and so to Lamellirostrae, of Desmognathae. In another series certain Procullariidae lead into desmognathous groups. Prion has a lamellated bill, like that of a duck. Halodroma has a gular pouch like the Stegano pods; these last are directly affined to the herons by Balantium and Caneron. In many general features an albatross is like a pelican. Another Cecomorph, Colymbus, is really totipalmate, like all Dyspomorphs; the hallux being lateral and connected with the base of the second digit; were its hind toe as long as a cormorant's and the webbing increased pari passu, it would be stegano podous. The relationships of the longest-winged Dysporomorph, Tachypetes, with the similarly constituted gulls and petrels, will scarcely be denied. In an opposite direction, the relations of some short-winged Cecomorphs, as auks and grebes, with similarly modified Dyspomorphs, as cormorants and darters, will hardly be overlooked. Not to multiply examples of these transitions, in another direction than that according with the requirements of the system, it does not appear that the links by which Schizognaths and Desmognaths are bound to each other are weaker than those by which either of the two is held together; or so weak as those connecting, for example, Raptore with Stegano pods. And however the present argument may be invalidated by insufficient or injudicious advocacy, the above given broad facts of comparative degrees of relationship remain.

Since palatal modifications do not indicate groups of the taxonomic grade we have been considering, it remains to enquire how far they avail in the construction of lower associations. No one will question how nearly Prof. Huxley's subdivisions agree with natural families, or orders, as the case may be. Charadriinomorpha correspond very nearly with that eminently natural assemblage of smaller Grallae, called Limicole or Scolopaces. Geranomorpha are as nearly Pata dicole or Fulicae: with the addition of Gruis, &c., which is here much more naturally assigned them among the herons. Cecomorphs comprehend both macropterous and brachypterous swimmers; but though the association may seem at first sight to be a little forced, really it is not so. Longipes and Urtinates come next each other in any system, and some forms actually inosculate: e.g. Halodroma with Mergula, Puffinus with Colymbida, (tibial apophysis, &c.) Spheniscormorpha are penguins alone—order Pilopeuth Bp., tribe Nullipes s. Impennes alior., Spheniscidae auct.: touching Cecomorphs at the point Alca inspen sis. Alectomorphs are Gallines, excl. Tinnus; and it is interesting, moreover, that the palate bones allow separation of Peristeromorphs. The unnatural nature of too intimate association of pigeons with the true scratchers is borne out by appeals to every character, it would seem. Chenomorpha are precisely lamellirostral or anatiform Natatores, a group respecting the boundaries of which there is no dispute. The Flamin goes, as might have been anticipated, are found to require Janus-like division—Amphimorpha, Pelagomorpha are precisely Heridiones: Dysporomorphs are exactly Stegano pods. And so on.

Prof. Huxley has laid ornithologists under twofold obligations: First, he has pointed out in elaborate detail a certain character, the value of which was not only unknown, but also unsuspected before; and has shown how perfectly it marks groups of a certain grade. Secondly, he has demonstrated once more—and, it is to be hoped, for the last time—the futility of attempting to found such fundamental divisions upon any one single character.

What has gone before is possibly an estimate of the value and office of palatal structure not very different from what the general verdict of ornithologists will be. That the palate bones afford nearly always correct indications up to a certain point may be regarded as demonstrated by Prof. Huxley's researches. That they may be taken as the basis of the primary division of Carinate will probably never be generally admitted. In ambiguous cases appeal to them may turn a nicely-balanced scale, and prove invaluable in limiting certain
groups. But final appeal must not be made from all other characters to these; but from these—as one of many sets—as collateral testimony—to the total of the rest. As the sole basis for a system of ornithological classification, the scheme will probably remain in critical abeyance only until the time when its brilliancy shall have been forgotten, and its unsoundness alone be remembered.*

Professor Lilljeborg's system† begins with the same three primary divisions that Nitzsch adopted after abandoning Rattiae, and reducing them to an order of Cursores. Further, however, it differs materially and is in some respects unique. It is particularly to be observed of this system, that no single set of characters—no special theory—guided its formation. The author takes a general average of characters, and seeks to harmonize, as far as possible, conflicting views of such ornithologists as have been led to propose schemes based upon special investigations. Bonaparte's ideas respecting Altrices and Praevores; Nitzsch's researches on the Carotides and Pterylosis; Sunderland's results regarding wing-coverts and flexor muscles of the feet; Cahan's studies on the scutellation of the tarsus and other points; Müller's generalizations respecting the lower larynx; no, to mention other data, have all been brought into use, judiciously estimated, and carefully coordinated. It is certainly the most 'catholic' system that has ever been proposed; there are intrinsic reasons why we might anticipate its high excellence.

Having already given some reasons for my belief that all carinate birds at least may be primarily divided into three groups, I need not repeat them, in ascertaining unreservedly to the way in which Professor Lilljeborg draws the lines dividing Natatores, Cursores and Insessores. There are a few ambiguous forms: Phaeocopterida and Helioranthidae are among them, coming between the first and second; some of the more terrestrial pigeons, or gallinaceous birds with barely elevated hind toe, may be others, coming between the second and the last. These may be noticed as well here as anywhere.

The Flamingoes are purely "gratorial" in general conformation, but they are palmate, with duck-bill; and their internal structure is said to resemble that of Anseres more than Herons. Too much stress must not be laid upon the webbed feet, for some undoubted Grallae are palmate, and all Natatores are not. The carotids show nothing, for they are exceptional in the class of birds. The balance is very even; there is perhaps no more purely transitional type. The palate bones would carry them near Chenomorpha; the birds are said, also, to be præcoelial, another indication to the same effect. But as the author takes the condition of the thigh and crus with reference to the body as a primary feature, he consequently assigns Phaeocopterus to Cursores. Helioranthidae are, has been said, pretty conclusively fulcariouls; the author does not specially refer to them. Pigeons, usually placed in Rages as a suborder, are here made an order of Inssesores. They are palpable intermediate connecting forms; some terrestrial ones insusculating with Rages, others, truly arboreal, as evidently coming under Inssesores; a few are analogized if not actually affixed with Accipitres. Now it is characteristic of Cursores to walk on the ground;

*I should remark that these paragraphs were written before I had seen any of the many criticisms that Prof. Huxley's article has called forth. I am more gratified than surprised to find how nearly the views of some authors for whom I entertain high respect agree with my own. I make no change whatever in consequence of what I have lately read; for though I might now be inclined to add considerably to the above, the appearance of the very articles in question has rendered unnecessary what more I should have to say.

†A correspondent, whose name, were I authorized to use it in this connection, would be recognized as that of an eminent ornithologist, writes just now:—"Inasmuch as [this system] is based upon a single set of characters, it cannot be otherwise than arbitrary, and hence unsatisfactory. So far as the anatomical facts presented are concerned, it has some value; but the arrangement I deem to be on the whole far from a natural one. In short, I cannot regard it as other than a retrograde step, notwithstanding the excellent character of the author as a naturalist. It is, it seems to me, far inferior to others of a much earlier date."
of Insessores to hop. Pigeons are cursorial in that they (invariably I believe) walk; and other rasorial features need not be dwelt upon. They are also schizognathous, like Rosores. On the other hand, it is a fundamental characteristic of Cursores to have the hallux elevated, though *Herodiones* are a single exception. This feature is not presented by the pigeons, which are moreover mostly as truly arboreicole as the majority of Insessores. They are mostly Alticore, like the last. The balance appears in favor of their being Insessores, as the author holds them.

The Ostriches and affines are in this arrangement reduced to an order Brevipennes of Cursores. Archæopteryx is not noticed, as may be said of other extinct forms.

Twelve orders succeed to the three sub-classes; agreeing in the main with divisions almost universally recognized, and defined in an unusually satisfactory manner. A notable point of difference between this and other systems lies in the tenth order, Strisores, which, as framed, does not largely accord with any previously established group. It is "a polymorphic group," as the author says, not easy to define by positive characters An order Zygodactyli, equivalent to Scansores anc. is retained; here, if anywhere, posterior revision and decided modifications may be required. The zygodactyle birds appear to have so long had their place as a distinct order more because it has not been clear what to do with them if dismembered, than anything else. Toes in pairs is a thoroughly artificial character, as used; it is universally allowed that it unites birds otherwise widely dissimilar. It seems to be really only a modification to which any one family or genus of several groups is liable; if so its value has been largely overrated. It is most probable that the "order" Scansores or Zygodactyli will be broken up, in time, or at least restricted to some one of the types—perhaps the parrots,—now included under it; more fitting places being found for the cuckoos, trogons, toucans, woodpeckers, &c.

Regarding Prof. Lilljeborg's Natatoses, I may express my conviction that the four orders he defines are the only natural ones, and that as such they must ultimately prevail. I only criticise the division of these four orders into two "groups," an intercalation between the subclass and the orders that is at least superfluous. Not that all the distinctions implied in the terms "Simplicirostres" and "Lamellirostres" do not obtain; but that the groups are inequivalent. Lamellirostres are not more different from the Simplicirostres than the several components of the latter are from each other. A goose, e.g., is not more different from a gannet than a penguin is. On this ground I hold the division to be unnatural as well as unnecessary. The two groups are further redundant, in that they have no analogues in other parts of Prof. Lilljeborg's admirable system. 

With the foregoing qualifications I follow this arrangement very closely. But I think that ornithologists will find it necessary to adopt many more families and sub-families than this author does, particularly among higher groups. I find it so even among Natatoses, as will appear in the sequel.

**NATATORES.**

*Relations and analogies of the sub-class.*

Swiming-birds are so definitely circumscribed, that there appear to be but two types holding disputable place. *Phoenicopteridae* have just been noticed. *Heterornithidae* have been located with the Grebes, by Schlegel and others, apparently on account of the lobed feet. But this is surely an error; the relationship is of analogy, not affinity. They have been referred to Stegapanodes, next to *Plotoidea*, by Bonaparte and others; upon what ground does not appear. As already said, osteology carries them to fulicarious Grallae. It

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* I doubt, too, that the definitions of these groups will stand test without qualification. In general, as claimed, one is altricial, the other precocial; but among *Pygopodes* are instances of both. Lamellation of the bill is a very general distinction; but *Prion* among "Simplicirostres" has laminae.

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would be interesting to know whether they are altrices or præcociæ, and how far the palate agrees with that of Geronomorpha.

The "naturalness" of the division as a sub-class is sustained in a satisfactory if not conclusive manner, by the large number of types that Na-tatores include under natatorial modification; the open passages that lead from it to the other groups; the number of points where other groups infringe upon it; and especially the highly instructive way in which its four primary subdivisions repeat each other. I shall endeavor to point out the principal of each of these.

The passage from anserine swimmers to heron-like waders is so obviously through and by Phoenicopterus, that the point need not be dwelt upon.

The passage from totipalmate swimmers to the same waders is unquestionably through the Pelecanidæ and Cærèridæ. The affinities of Balaeniceps and Canoroma among herons, with pelicans, have long been recognized and universally allowed.

The passage from urinatorial swimmers to certain of the Grallæ takes place from the point Podicipidæ, through Heliornithidæ, to fulcarious or paludicolæ waders, and from the same point through Phalaropodidæ to scolopacine or limicole waders. In each of these cases we have almost the only—if there be indeed any other—examples of the lobiped structure—a comparatively rare modification of the swimming foot. The phalaropes, besides being excellent swimmers, are further exceptional in their own sub-class in the texture of the plumage, which is completely duck-like.

The passage from longipenne swimmers to Grallæ, if not so evident, is nevertheless clear, in the osteological and pterylographic characters that are respectively more or less common to a gull, e. g., and the plover or snipe-like waders, as Nitzsch and Hauxley have pointed out. Certain small petrels again, as Oceanitis, Fregetta and Pelagodroma, are exceptionally "grallatorial" in length of leg.

The waders coming next to swimmers, it is not to be expected that higher, i.e. rasorial, Curœsæ, still less a further removed sub-class, Inassæores, should afford direct transitions; but as I shall endeavor to show, the swimmers give analogues to the main types of each of these sub-classes. Foreshadowing of the mammals in birds does not occur within the range of Natatores, unless the duck-like bill of Ornithorhynchus is a case in point. It really takes place at the point Rutulæ. It is among Natatores, as the lowest birds, that the counterpart of another vertebrate type is found. The mocking analogy with fish is complete in the penguins.

The raptorial modification of Natatores is seen in the sub-family Lestridinæ of Laridæ. The habitus of these is that of land birds of prey—a universally recognized resemblance. In their food the Jaegers are vulturine. Physiological analogy is borne out by physical characters. Jaegers are the only cered swimmers, as Accipitres are the principal cered perchers. The claws of Lestridinæ are more "raptorial" than those of any other swimmers. A singular rugosity of the tarsi is shared by the Jaegers and the most aquatic genus of Accipitres—Pandion.

The rasorial modification occurs in urinatorial swimmers. All these have short, more or less concave, wings that are rapidly vibrated, and fly with great impetus; very gallinaceous features. Some Alcideæ employ the characteristic habit of Grallæ in constructing their nests; rasorial has developed into fossorial. Other auks, notably Phalæridæ, instantly recall quails by their general aspect; a species has been named from the circumstance. The bill of Mergusius repeats a partridge's. Absence of the hallux that marks all Alcideæ, though sufficiently frequent in scolopaceous Curœsæ, is rare among the alectoromorph Curœsæ; yet it characterizes a family—Turnicidæ. One of the rarest modifications, viz., abortion of rectrices, that marks a family of Urinatores, is only again found in some representatives of a rasorial family—Crypturidæ.

Tubular nostrils are not a very common feature. It is the prime characteris-

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tic of the longest-winged and best flying family (Procellariidæ) of swimmers. Among higher birds it again occurs in certain Srisores, especially Caprimulgide, as well seen in Siphonoria. It is interesting to observe that these birds, like the petrels, are among the longest winged and best flying of their own sub-class. And further, that they mock the swimmers in the elevation and sometimes lateral position of the hind toe, together with the presence of a membrane between the toes not to be distinguished from a true "web," and equal in amount to that of many "semipalmate" waders. This is entirely different from the actual cohesion of the toes that obtains in many Insectores. The obliquity of the hind toe, too, is the necessary antecedent feature to its union by webbing with the second toe, as in all steganopods. Pecultion of the middle toe is another feature of these long winged Srisores, repeated in the longest winged swimmer—Tachypetes. Finally, the characteristic gular pouch of all totipalmates is represented virtually, if not actually, in the broad-mouthed, loose-throated Goatsuckers, &c.

The scansorial type is exemplified in certain swimmers. One of its essential features is such construction of the tail as will allow of this being used as an additional means of support, as best illustrated in the woodpeckers. It is repeated in the cormorants; birds with long, strong, stiff tail feathers, that use the tail as a third base of support when standing on level ground, and exactly as woodpeckers do, when clinging to rocky ledges. Phalacrocoracide are scansorial Natatore.

A certain family of higher "land"-birds is purely aquatic, deriving its whole subsistance from the water. I refer to the kingfishers. Their characteristic habit of sitting on projecting branches watching for their prey, and darting into the water to secure it, are repeated in the Plotoide. In both families progression on land is almost denied.

The term "sea-swallow," universally applied in our own and other languages (" Hirondelle-de-mer," "Meerschwalbe," &c.) to the Stermide, is expressive of a strong analogy, traceable both in general conditions and special characters. As to the former, I need only refer to mode of flight, and manner of hunting for prey, especially in such small delicate species as Hydrochelidon fassipes, e.g. The "skimming" of the swallow in the air, and its attitudes on the ground, are repeated in the tern. As to special physical points, I may instance shape of wing, and relative length of that member; length and furation of the tail; and the remarkable shortness of the legs that in both groups renders walking difficult and unusual.

In the active pursuit of prey under water, the very highest Oscines are brought into analogical resemblance with the lowest swimmers, by the singular genus Cinclus.

I do not observe any special analogies of anatiform swimmers with higher birds; though some might possibly be traced. This strictly monomorphic family seems specially reserved as the means of perfect transit from swimmers to waders through Phanicopterus.

Characters of the sub-class.

No one character can define Natatore. Covering of the knee by the skin of the body is the most general one, and one probably not found outside the sub-class; but it varies down to a minimum, ceasing to be diagnostic in certain Longipennes. Web-footedness is not an infallible indication; some Grallæ are palmiped, some Natatore are not. But these two, with qualified reference to two others, furnish the desired definition. Thus Natatore are palmiped with the knee internal; or, if external, the bill neither recurved nor abruptly decurved; or lobiped, with the tail rudimentary.*

* It might be advanced here, that I am liable to the charge of doing what I have above criticized others for doing, i.e., making a division upon a single feature. But there is a distinction between simple "definition" (i.e., limiting) of a group, and its "characterization" in full. The foregoing phrase is merely a convenient word-formula for the ready recognition of any Natatorial bird, which could only be "characterized" by reference to several other features.

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This expression is absolutely diagnostic; it marks every swimmer, and excludes all other birds. Reference to the bill is necessary to exclude the web-footed Grallae. Nothing can be predicated from the wing-coverts, which are similar in Carsores and Natatores; nor from the carotids, which are double in nearly all of both sub-classes, the Podicipide alone furnishing an exception in Natatores. So with most other single characters useful or indispensable in arranging higher groups. We must chiefly rely upon special combinations of common or general characters.

The statement that all Natatores possess the oil-gland, which has its circlet of feathers, has no known exceptions. The gland usually has two openings; frequently more among Steganopodes and Procellariae. Powder-down tracts have not been observed in any. The pterylosis of the sub-class adheres closely to a particular type, in the breadth of the tracts, that are "strong" and definite, and in narrowness of the spaces. The inferior tract, as a rule, has no free outer branch; the dorsal is not interrupted by a true gap. Laridae furnish exceptions to both these statements, in their scolopacine pterylosis; Diomedea, Columbus and Podiceps have the dorsal gap; Uria, Alca, and Fratercula have a half-free outer branch reaching to the knee-covert. There is also a trace of this in Anatidae, increased in Procellaridae. "In all these cases the ventral portion, which is often independent only from the extremity of the sternum, is usually not only very broad but dilated towards the sides in the middle of belly; a structure which occurs only in water birds, and has already been very distinctly recognized among the Scolopacines." (Nitzsch.) The contour feathers are placed in regularly parallel, oblique rows, not separated by a space along the median line of the body. Notwithstanding the denseness of the plumage the ptilosis is not so continuous, even in the penguins, as in some Insensorial groups. The spaces are all covered with down-feathers, perhaps double. The contour feathers are so situated that every contiguous four form a rhombus, made quincuncial by a down-feather in the centre. Other smaller down-feathers are frequently intercalated in the rows of contour feathers. The latter are furnished with an extensive series of comparatively large cutaneous muscles, of which each feather may have several. Each contour feather has its accompanying filoplumes, which may be as many as ten, as e. g. in the goose. The modified diversely colored feathers about the head of cormorants (and some auks?) are believed to be filoplumaceous. The feathers are frequently devoid of after shafts, which appear, in general, to be complementary to down-feathers.*

The wings of Natatores are remarkably diverse in size and shape; the modifications are scarcely or not diagnostic of either orders or families. Thus the wings of certain Procellaridae are exactly those of some Alcidae; those of some Pygopodes and Lamellirostres are alike. In this sub-class we find all gradations between the two possible extremes; albatrosses, c. g., are the best flyers of any, and have the most remiges (50); penguins have none, affording the only instance in the class of abortion of quills; though other birds share the degradation of flight. Tachyptetes again vies with Diomedea. The Natatorial average of remiges is about 30; the number may fall to 25, and frequently ranges up to 40. Notwithstanding this, the primaries are constant, 10; the first of these, as a rule, is longest, but there are many exceptions. Macronterous swimmers, as a rule, have flat, narrow, pointed wings; brachypteronous, concave, broad rounded ones. Tachyptetes and Podiceps best represent the two extremes. Alca impennis furnishes a singular wing; useless for flight, yet morphologically perfect. The greater wing covers are always longer than half the secondary remiges. The tail varies as much as the wings, both in shape and character of rectrices. As a general rule, the tail is small and rounded, with many short, rather soft rectrices; this may be called its typical condition. Abortion of rectrices definitely characterizes

* This paragraph is compiled from Nitzsch's Pterylography, Ray Soc. Ed. pp. 139-141.

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one whole family—Pedicipidae; in all others rectrices occur. A small, definite number of rectrices may be observed to be in inverse ratio to the size of the tail as a whole. The number is ordinarily 12, in those forms with well-developed tail; as in all Laridae, most Procellariidae, most Phalacrocoracidae, the genus Procellaria proper (Thalassidroma auct.) are said to have only 10; the statement requires confirmation; most of them, as Gymnocephalus, mihil, and Oceanites K. and B., have 12. Many larger Petrels, as Fulmarus, Daption, &c., have 14; Osystoga gigantea has 16. Among Cormorants the number of rectrices seems to be scarcely generic; some species having 12, others 14. As a rule Alcidae have definitely 12 rectrices. A. impennis is said to have 18. Phoebus has 16. Sulidae have 12 and 14. Tachypetes has 12. Other genera included in the Spheniscidae, Colymbidae, Pelecanidae and Anatidae have a number varying from 12 to 22, though rarely over 24, and in instances where the larger numbers are approached or reached the tail may have an odd number, as 21, 23.* Not taking into account the small, short, rounded tails above mentioned as "typical," the Natatores furnish great variations in shape of the tail as a whole. It may be long and deeply forked, with more or less filamentous rectrices, as in nearly all Sterneine, some Larinae, the Rhynchopinae, and more particularly the Tachypetidae. It is large and square in most Larinae; of corresponding size, and more rounded, or even approaching a wedge-shape, in many Procellariidae. It is moderate or rather large and coniculate, in one gull, Rhodostethia rosea, and one Petrel, Halocyptena microsoma. In certain terns (Anous) it is both forked and coniculate, i.e., lateral feathers graduated, central pair shorter than the next. It is short and coniculate in some ducks, and in Spheniscidae; certain of the latter, however, have much better developed tail, with fewer rectrices, than others. The tail is long, broad, and fan-shaped in Petrelae and Phalacrocoracidae, where, moreover, the rectrices are exceptionally stiff. Finally, a few swimmers have curiously modified central rectrices. Thus in Harelda glacialis these are long-exserted and filamentous; a condition exaggerated in most Lestrudinae and carried to an extreme in Phaethontidae.

There are few other modifications of the feathery covering that require notice. Some swimmers are ornamented with singularly modified feathers, chiefly about the head. Many Spheniscidae, and most Alcidae, especially phalericine forms, have curiously colored and shaped crests. Nearly if not all Podicipidae are instructed with conspicuous ruffs of long, loose feathers; when these are deficient, as in Podilymbus, stiff bristles occur. The bars of stripes on the neck of Colymbidae are of keel-shaped feathers. Cormorants have colored filoplumes about the head; others, perhaps similar, patches are found on the thighs. Some Anatidae, as Aix, and most Mergine, are conspicuously crested. Pelecanidae are crested, and have similarly elongated feathers on other parts, as the breast. The scapular feathers of many Fuligulineae are peculiarly curved; one or two genera of this sub-family have velvety-piled plumage. The well-known general condition of the plumage of penguins has suggested the name "Squamipennes." In many families or genera, plumage extends on the bill in varying degree; it usually, but not always, reaches the ankle joint, but the tarsus is never feathered, except in one genus, Tachypetes, and there only partially. No part of the body proper is naked, with the remarkable exception of the gular pouch of Stegopodes, carried to a maximum in Pelaeanus. Other dermal outgrowths than feathers are rare; but an example of horny development is seen in the spur-winged genus Plectopterus.

The highly interesting modifications that make the swimming foot what it is, affect the whole limb from hip-joint downward. The legs as a rule are placed further back than in Insectorial and purely Cursorial forms. But there is great difference in this respect among Natatores, and a regular gradation

*I am again indebted to Nitzsch's incomparable work for part of the data for these generalizations regarding number of wing and tail feathers.

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may be observed. In the highest forms, as Anatidae, the feet are brought under the centre of equilibrium, and the body is consequently supported with its long axis horizontal. Some Steganopods—the next order—have much the same condition; in others, as Cormorants, the legs are much further back, and the body must be held almost upright. Most Longipennes are like Anatidae in this respect, but here Halodrominae offer almost the other extreme. In Pygopodous families the maximum of backward position of the legs and upright position of body is attained. A few or several Alcidae stand and walk tolerably well, but all Colymbidae, Podicipedidae and Spheniscidea must rest nearly upright on the rump, and progress on land with extreme difficulty. Burial of the thighs and more or less of the crura in the skin of the body is ordinarily in direct ratio to backward position of the legs, and in inverse proportion to ease of walking. Nevertheless, some good walkers, as geese, have less free legs than certain small petrels that scarcely walk. As a rule, utility of the feet as pedestals and as paddles is directly complementary. The most adroit and nimble swimmers, and those that progress under as well as on the water with ease, are the poorest walkers. Compare a goose with a loon, e. g. In one order, Steganopods, we have the fact illustrated in contiguous families; pelicans do not follow their prey under water; cormorants do; there is a precisely corresponding angle of inclination of the body in each case. To avoid interference of the broad-webbed feet the legs are widely separated; a divarication begins in the axis of the femur, and is increased in other segments. Hence the characteristic "waddle" of ducks, &c.; their gait, compared with that of true walkers, corresponds somewhat to the difference that may be observed in the species of our own species, arising from difference in width of pelvis. There are many other interesting items in the construction of a perfect pair of paddles, too numerous to note here. A loon's legs may be taken as the type. Some time ago I worked out all the details, as seemed to me, in this case, and may be permitted to give the reference, in place of further observations.*

The tarsus most commonly presents no special noteworthy features. Occasionally it is extremely compressed, as among loons and grebes. Its horny covering has nothing of the importance that attaches to it among Oeisi, for example, though the two primary types of reticulation and scutellation sometimes mark natural groups, as geese as distinguished from ducks. The tarsal envelope is fused in one genus.

The toes may be three or four; if the former, it is always the hallux that aborts. All have the normal number of phalanges, the relative lengths of which usually, if not always, conform to a general rule. In comparative length as wholes the hallux is always shortest; the others usually run 2d, 4th, 3d in length, but not rarely 2d, 3d, 4th. There is often only a very slight inequality in the 3d and 4th, exactly compensated by complementary difference in length of claw, so that the claws-tips fall together, e. g. many Procellariidae.

The hallux, as a rule, is present; its absence or rudimentary condition marks one whole family, Alcidae, two sub-families, Diomedeinae and Halodrominae, of Procellariidae, and one species of one genus (Rissa tridactyla) of

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†In examining a great many Rissa from the North Pacific, I have found a hitherto unnoticed and probably unsuspected state of things. There are in that region two perfectly distinct species of Kittiwake. One is Rissa brooklynoidea, Gould, (=R. boremides, Brandt), with coral-red or yellow legs, yellow bill, &c., &c. This has a very small hallux; but still one bearing a small claw, that looks like a little black speck on the extremity of the knob. The other is the R. hyperborea, Bonaparte, or at any rate the bird I identified and described under that name some years since. Bonaparte's diagnosis is simply "halluce magis explicato." Now this form is identical with and not distinguished from R. tridactyla, except in and by the hallux. The hallux is almost always larger and better formed; and it ranges from a state scarcely or not different from that of R. tridactyla, up to a perfectly developed condition, claw and all. In some specimens the hallux and claw are as large, comparatively, as those of any Lerna I ever saw! The distinctive feature of the genus Rissa has disappeared. What makes the North Pacific Kittiwakes vary thus, while the Atlantic birds are constant, as far as known?

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Laridae. In the other sub-families of Procellariidae it is scarcely more than an
immovable sessile claw. When present, its condition varies. Without exception,
it is raised above the level of the anterior digits; but the elevation is slight in all
Tatipalum, among which are found the most arboreal swimmers, just as in
Ardeidae, of Curoroeae, which are pretty good perchers. Its direction is ordi-
narily straight backward; to which the best exception is seen in its oblique
inward position in all Steganoqodes, where, likewise, this toe is much longer
than elsewhere. In Spheniscide the hallux is very small, lateral and elevated.
As to its connection with the other toes or the tarsus, we find several modi-
fications. As in the first place, we have the condition in Procellariinae of sessile
immobility. Next a lengthening and freeing, as in Laridae and Anatinne.
Then with slight increase, or none, in length, there may be a broad membran-
ous lobe depending from it, e. g., Fuligulina, Podicipidae. This lobe, again,
may unite it at base with the tarsus or inner toe, as in Cylomibidae; a condition
intermediate between the foregoing modification and the only other one to
be noticed, viz., that characterizing the Steganoqodes, when the very long hind
toe completes, by webbing to the claws with the inner one, the totipalmate
foot. In most or all those cases where the hallux aborts, I think its access-
sory metatarsal is still to be found beneath the skin of the tarso-metatars
I have never sought for it in vain.*

Palmation is undoubtedly the prime characteristic of the swimming foot;
yet it does not always obtain. Lobation marks one whole family (the Grebes.)
but in Podicipedus, at least, there is a sort of compromise between the two
styles; the toes being perfectly lobed, yet webbed at base. More or less im-
perfection of the webs in truly palmate forms exceptionally occurs. Hydro-
chelidon fassipes, e. g., has the webs so deeply incised that it is scarcely more
palmp than such grallatorial genera as Symphenata, Ereunetes, &c. Some
Anserine genera are defective in this respect. But ordinarily the free margin
of the two or three webs departs but little (and that in concavity) from a
straight line between the ends of the toes; it is sometimes a little convex.

The claws as a rule offer nothing of importance. They are small, short,
stout, little curved, not very acute. One or two genera of Aleidae have a claw on
the second toe differing in all these respects from the others; it is ordinari-
also, laid flat, not upright. Rarely the middle claw is dilated and pectinated
(Tachypetes) as in Herons, Goat-suckers, &c. The Grebes offer exceptional
claws; these are broad, flat, and squarish in shape, much like human nails.
Rissa tridactyla offers perhaps the only instance of a toe without a well formed
claw.

The bill of Natatorae is so variable in all its features that it is best consid-
ered under heads of the several orders and families. I may remark here that
it appears under two principal forms: lamellate in all Anatiformes and one or
two genera of Petrels; simple in all other swimmers; but in these its toma
may be serrate. In a great number of cases, it bears a nail at the end, of
varying size, large or small, and in either case liable to be either very distinct
or lost by fusion. This nail, it should be observed, is an affair of the horny
covering altogether; not dependent upon the condition of the premaxillaries.
The horny case is ordinarily continuous; but sometimes, as in Jaegers
and Petrels, it consists of many pieces.† In Anatiformes it is softer, more like
ordinary skin than elsewhere, whence "Dermochynchi" as a name of the family.

Anatide, Laride, Procellariide and Podicipide are cosmopolitan; but Petrels
abound most and in greatest variety in Southern seas. Most Steganoqodes are
wide-spread, but Tachypetide, Phaethontide and Pluonide are chiefly tropical.
Cylomibide belong to the Northern Hemisphere. Aleidae are Pala-Ne-arctic,
foocussing in the North Pacific, replacing Spheniscide, which are exclusively

* So, also, I find it in Calidris arcuaria, a 3-toed sandpiper, in the Kagiilites, &c.
† Cf. the writer's "Review of Procellariidc," part v, Pr. A. N. S., Phila., May, 1866, p. 175.

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Southern, and essentially Antarctic. Nearly all Natatores are either largely migratory, or else are widely wandering pelagic birds.

Subdivisions of the Subclass.*

Assembled in such variety of character, swimmers may be easily and conveniently divided in several ways, according to the standard taken. But I presume only one of these can be the right (i.e. the natural) way; and further, that **ceteris paribus**, the scheme that takes into consideration the greatest number of characters will come nearer the truth than one that proceeds upon isolated grounds. A *sine qua non* of any scheme must be equivalency of value of the groups to which the same taxonomic rank is accorded.

There is no safe stepping-stone between the subclass and its orders. There are four orders, i.e., four modes of expression of the Natatorial plan or idea. In the following definitions of these, diagnostic or more important characters are italicized:—

Ord. I. PygoPodes.—**Legs posterior**, horizontal position of axis of body impos- sible: most of *crus* as well as femur buried. **Brachypteres**: wings short, never reaching end of very short, many-feathered tail, that is sometimes wanting. **Body depressed. Feet tetra- or tri-dactyl**, lobate or palmate, never totipal- mate; *hallux* elevated, functional or not. **Bill not lamellate nor serrate**; wholly corneous, entire. **Nostrils** lateral, mostly basal, well formed, never tubular. **No gular pouch. Tibia often with a long apophysis. Carotids single or double. Schizoquathous. Alltricial or Proneorial. Scarcely ambulatorial; sometimes not flying at all; urinatorial; swim under as well as on the water; lie deep on the water. **Heavy, clumsy on land. Natatorial Natatores.**

Ord. II. Longipennes.—**Legs near centre of equilibrium**, horizontal position of body usual. **Femur** buried; *crus* largely (or wholly?) free. **Macropterus**: wings long, pointed, surpassing the base, and often the tip, of the large well formed few-feathered tail. **Feet tetra- or tri-dactyl**; always palmate, never totipalmate; **hallux**, when present, free, elevated, very short, functionless. **Bill** wholly corneous, entire or pieced, ungulicate or not, never laminate (exc. **Pron,** &c.) nor serrate. **Nostrils** variously, but always well-formed, lateral or superior. **None, or only a rudimentary** gular pouch. **Tibia with or without apophysis. Carotids double. Schizoquathous. Alltrices. The majority ambulatorial; all highly volucral: none urinatorial; all rest shallow and swim easily on the water. **Light, elegant in all three elements.**† **Volucral Natatores.**

Ord. III. Steganopodes.—**Position of legs variable**; generally well posterior, but sometimes approaching the preceding. **Wings variable, but generally long and pointed**, approaching or equaling the preceding. **Tail** variable, sometimes short and indefinitely feathered, usually long and few-feathered; cuneate

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* Reduce to an order, and pari passu reduce the value of subordinate groups, if *Saurura*. Ratite and Carinata be accepted as sub-classes.

With such reduction in value, Testaceae, Cetacea and *Natatores* would become "orders" of *Carinata*, and the four "orders" indicated below would be suborders or "tribes"—i.e., simply collocations of families. Throughout this article I call *Natatores* a "sub-class" in a conventional sense only, as indicating one of the first divisions of a class *Aves*, as usually held.

Even with this depreciation in the scale, I do not suppose that the Avian groups have the value of those of the same name in other classes of vertebrates. Birds adhere so closely to a common type, that the extremes of difference in form found among them scarcely seem to indicate divisions of a higher grade than those marking orders in lower vertebrates; in fact, it is a question whether *Aves* as a whole are more different from some other vertebrates than certain (e.g., reptilian) "orders" are from each other. But, however variously vertebrates may be primarily divided (as into *Hematothermes* and *Homato- crys*, into *Ichthyoptera, Sturdoptera*, &c., &c.), the four "classes" of *Piscis, Reptilia, Aves* and *Mammalia* will probably always endure, and be virtually our taxonomically equivalent points of departure for further divisions. Therefore, as it seems to me, the rank of *Natatores* only hinges upon the question of *Carinata*, &c., as the primary divisions of *Aves*.

† To most of these characters *Halotrama* is a signal exception. But its tubular nostrils define its position.

1869.]
forked, rounded, or fan-shaped. Feet always tetra-dactyle, totipalmate, hallux depressed, lateral, long, functional. Bill wholly cornose, never lamellate; tomia serrate or not; its covering continuous or not, with or without a nail; external nares very small or abortive. A gular pouch. Tibia simple. Carotids double. Desmognathous. Altrices. Ambulatorial, or scarcely so; generally powerful flyers; often good perchers; urinatorial or not. Heavy, if not clumsy on land. Insensorial Natatores.

Ord IV. Lamellirostres.—Legs, as in Longipennes, near centre of equilibrium; position of axis of body in walking horizontal. Wings constant, moderate, reaching to, but not beyond, the short rounded (exceptionally long cuneate) many-feathered tail. Feet always tetradactyle, and palmate; never totipalmate; hallux elevated, moderate, free, simple or lobed, probably functional in all cases. Bill lamellate, but tomia not serrate, covered with soft skin in greater part, with more or less distinct nail at tip. Nostrils constant, well formed, latero-superior, subbasal or median. No gular pouch. Tibia simple. Two carotids. Desmognathous. Præcoce. Highly ambulatorial; good flyers; excellent swimmers; poor divers. Heavy, though not clumsy, in either element. Insensorial Natatores.

The sequence of these orders is fixed. Pygopodes are first or lowest; Lamellirostres last or highest, beyond question. It might seem, on several accounts, particularly position of legs, that Stegopodes should come next to Pygopodes. But we cannot put anything between Longipennes and Pygopodes, for they touch if not inosculate at the points Holodroma and Merugus. Moreover, other Procellariidae have the long tibial apophysis that characterizes divers, but disappears higher in the series.

Families and subfamilies of PYGOPODES.

The Penguins might be considered as presenting differences of more than family grade; they have been made a tribe or suborder (Impennes, Nullipennes, Squamipennes, Ptilopteri, auct.) Thus they are unique in possessing no remiges, scaly feathers, not entirely connate metatarsals, flat pterygoids and arm-bones, and peculiar elbow-joint, not to mention other lesser features. But their characters are mostly of degree, not of kind; and above all, the link between them and Alaidæ is so close and complete by Alca impennis, (extending even to elbow joint and metatarsals) that the differences are really not so great as appears at first sight.

Three other families are not open to question. The four are thus distinguished, by external characters alone:

Fam. Spheniscideæ.—Feathers scaly. No remiges; wings useless for flight. Hallux minute, elevated, lateral, functionless. Feet palmate. Tail many feathered (with thirty or more rectrices, but sometimes fewer.) Usually with modified feathers on head. Bill various. Altrices.

I doubt there being two or more subfamilies; that is, I think we must pass directly to the genera (technically though one subfamily), all of which differ from each other by characters of about the same value. The genera are few—perhaps only two or three—based chiefly upon the bill and tail. These birds are specially related only to the next.

Fam. Alcideæ.*—Plumage normal. Remiges present, well developed (except in one instance.) No hind toe. Feet palmate. Tail small, but definitely few-feathered. Usually with modified feathers about head. Bill singularly various. Altricial and Præcoce!?

Aucks vary in details of form, particularly of the bill, with almost every

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* But I do not believe that either of the two little bones at the elbow of these birds, as well as of Guillemots, represents a “detached olecranon;” I hold them for true sesamoids.

† Cf. writer’s monograph Alcida, Pr. A. N. S., Phila., 1868.

[Dec.
species. The genera are numerous; all apparently safely grounded. It is rather difficult to group them satisfactorily into subfamilies; but there do seem to be three series of genera, the components of each of which are de-
cidedly more intimately correlated with each other than with any of the
genera of either of the other two series. We have therefore three subfamilies, as follows:—

Subfam. Aleinæ.—Ptilosis reaching to or beyond linear nostrils; no crests; tail cuneate; bill sulcate, cultriform. Typical "Auks"; connecting with

Subfam. Phaleridinae.—Ptilosis not reaching various nostrils; mostly crested; bill various, but always compressed, somewhat cultriform, often appennaged; tail squarish or rounded. A middle group, leading nowhere; sometimes under a quail-like mask. Genera: Fratercula, Lunda, Ceratorynchus, Sagrautorrhina, Siumorrhynchus, Pychrorhamphus; the first named nearest Utamania, the last next to Mergus.

Subfam. Uriæ.—Ptilosis reaching to linear or rounded nostrils; bill conic or subcylindric, simple, usually much elongated; tail rounded or pointed; head not crested (exc. one species). "Guillemots." Genera: Mergus, Syn-
thilborhamphus, Uría, Lomvia. The last named repeating Alca in coloration; grading towards Colymbide in the char. of bill. The first (Mergus) in quail-
guise; and forming the inosculating point of the present order with Longipennes
by means of Halodroma.


A small family, of (technically) one subfamily and only one genus, Colym-
bus, with some half-dozen species. Related to auks through Lomvia. Repre-
denting, by its quasi-totipalmate feet, the Steganopods among Pygopodes! But affinities really closest with the next family.

Fam. Podicipide.—Plumage normal. Ptilosis not reaching nostrils; lores naked. Nostrils lanceolate, &c., not lobed. Wing rounded. Hallux well formed, lobed. Feet lobate, or lobate-semipalmate. Tarsi flat, their poste-
rior edge serrate. Conspicuous crests, or modified feathers about head. Tail rudimentary. Bill simple, variable, stout or slender, conico-compressed, long or short. Claws subquadrate, flat.

A family entirely among water birds in its single carotid, lobed feet, abort-
tive tail, and flat nails. Nearest Colymbide in affinity; replacing, in its sub-
class, fulicarious Grallæ.—in fact, linked therewith by Helionornithide. Counterfeiting some Crypturide, of gallinaceous birds. Its longest-billed and
-necked genus representing in its own family the place of Plautus among Ste-
ganopods.

But one subfamily is usually recognized. There may be two, for one genus differs more from the rest than any of the latter do from each other. The following would be the diagnoses, but I scarcely think it necessary to make this distinction with such little difference:—


Subfam. Podicipine.—Bill slender, straight at tip. Nostrils linear. Lores narrowly naked. Frontal feathers simple; usually conspicuous crests and
ruffs. Tarsus three-fourths or more of the middle toe. Feet with only a
small basal web in addition to the lobes; hallux broadly lobed. Genera: 1869.]
Echmophorus, Podiceps, Sylbeocycus; possibly one or two others, but most of the genera invented or used by Kaup, Bonaparte, and others, are untenable, representing only specific characters. Sylbeocycus (type S. minor) is the connecting link between the two subfamilies.

Families and subfamilies of LONGIPENNES.

There are but two families of macropterus swimmers, that moreover shade into each other so insensibly and completely that the condition of the nostrils is sometimes almost the only character. Thus Thalassoida glacialoides is a pure gull, even to colors, with tubular nostrils. In fact, I know of no positive unqualified character but this that will reach through the whole of the two families as a distinguishing mark. Still there are others of greater or less significance. Both the families are clearly differentiated into several subfamilies, which are much easier to define.

Fam. Procellaridae.—Nostrils tubular, lateral or superior, united or separate. Bill variable in shape, always hooked; its cornaceous envelope (always?) in several pieces; rarely laminate. Wings long and pointed (one exc.) Tail variable in shape; usually small, never very long, of 12–16 (rarely 10 ?) rectrices, of which the central are never suddenly long-exserted. Feet palmate; hallux present, minute, functionless, or absent. Tarsal envelope sometimes continuous (a unique feature among swimmers!). Truly pelagic birds, independent of land. Altrices.

Three strongly marked subfamilies, thus:

Subfam. Diomedinae.—Nostrils lateral, disjoined, horizontal. Feet tridactyle. Wings extreme, in length of humerus and ulna, and with highest number of remiges (fifty) known among birds, but only ten primaries, as usual. Genera: Diomedea, Thalasstria, founded on sulcation of mandible and shape of tail.

The albatrosses, in size, contour, and length of wing, repeat the Pelecanide in their own family; in length of wing they are only otherwise approached by another Steganopod family,—Tachypetidae. But still a constricted group, with no aberrant forms.

Subfam. Procellarinae.—Nostrils superior, horizontal, united in one double-barrelled tube. Too various in other respects to be concisely characterized. Still, the central or typical aspect of the family; throwing out feelers in several directions.

One group comprises the smallest species, with pointed wings, elastic flexible primaries, rather long tail, variable in shape; the most slender and longest legs of the family. These birds are pelagic Cypselidae! Genera: Oceanodroma, Gymnochore (Thalassidroma Bp. nec. Vig.), Halocrypta (caudâ cuneată), Procellaria (ex Linn. Thalassidroma Vig. auctt.), Oceanites (podotothecâ continuâ), Fregetta, Pelagodroma.

Another comprises heavier birds, of medium size, with long hooked bills, long, strong, pointed wings, and short rounded (rarely pointed) tail. It seems to occupy the very centre of the family. But it has a strong pygopodous feature in the tibial apophysis of at least some of its members, thus pointing to the Loons and Grebes. These are “Shearwater” Petrels. Genera: Majanus, Projinus (Adamastor Bp.), approaching Fulmar Petrels, and Puffinus (including Nectris), from which Thalassia only differs in a longer, more pointed tail.

A third group consists of the gull-like Petrels, called “Fulmars.” These are among the largest of the family; stout, thick-set; tail of 14–16 rectrices, well-formed; wings moderate, for this family; bill stout, moderately hooked. A group scarcely worth retaining as distinct from the last, for of its three genera, Fulmarus and Thalassioa are almost side by side with Puffinus; and the other, Osseiraga, with Majanus. Osseiraga points to the albatrosses, Thalassoa to the gulls; the last hardly differs from Fulmarus.
A fourth group is represented by three genera, 

*Estreleata*, *Pagodroma* and *Daption*, each distinctly characterized. The two last are unspecific. In the first I throw the very many species agreeing in medium size, strong largely-hooked bill, long wedge-shaped tail, and rather short wings. Its species have received a dozen, more or less, generic names. There are about a score of them. *Daption* is peculiar in its wide bill, with rudimentary lamellae and quasi-gular pouch, indicating *Anisures* and *Steganopods*. *Pagodroma* is among petrels much what *Gygis* is among terns, and *Pagophila* among gulls.

The last group, called *Prionae*, is remarkably distinguished by the lamination of the bill, equal, in one genus, to that of *Lamellirostris*, and only here found outside that order. There is also a shape of bill in *Prion* corresponding to *Cancrostra* among Herons! and the throat is somewhat pouched. One square-tailed, light-colored form *Halobema* recalls the Gulls. Genera: *Halobema*, *Pseudoprinon*, *Prion*.

Subfam. *Halodrominae*.—Nostrils superior, vertical, united, on the calces at base. Mandibular space wide, with a distensible skin. Feet tridactyle. Wings and tail, and general form, of *Alcidae*. Genus: *Pelecanoides* (Lacép., about 1800; = *Halodroma*, Ill. 1811, et alact.)

A singularly aberrant form, only Procellariid in the nostrils; standing at a point where *Longipinnes*, *Steganopods* and *Pygopodes* meet; Steganopodans in its dilatable throat, &c.; Pygopodans in feet, wings and tail. It is almost a *Mergula*.


A definitely circumscribed group, without any remarkably aberrant forms. Sharply divided by characters of bill, &c., into four subfamilies, thus:—


Comprehending the "Jaegers," or "Skua Gulls." Affording the only instances in the subclass of a ceroed bill. In this partition of the rostral envelope we have an interesting approach to an essential character of the preceding family,—an affinity borne out by the pterylosis. For, says Nitzsch, in the *Procellariidae* "the tract formation of *Lestris* is elevated into the type of a group." The peculiar construction of the tail is only elsewhere met with among water birds in the Aserine genus *Harelda* and the Steganopodans one *Phaethon*. The Jaegers are marine Accipitres.

There are only four possible conditions of the bill, with reference to the relation of the tips of the mandibles to each other. (1) The upper mandible overarches the under, and is deflected over it; (2) the under mandible extends beyond the upper; (3) the two meet at a point; (4) the points of the mandibles cross each other. I propose to call these conditions epignathous, hypognathous, parognathous and astognathous respectively. The first is exemplified by all the *Raptors*, *Pettae", *Procellariidae*, &c., &c. The second is exemplified by the *Rynchopinae*. The majority of birds, especially *Passeres*, exhibit the third. Of the fourth I only know one instance,—the *Cross-bills* (*Cinerinae Scop.* = *Levia Murat*). The family *Laridae* is the only one that comprehends examples of three of these forms; and here they are, as we have seen, almost diagnostic of the subfamilies.

In respect of the epignathous type, it should be noted that to constitute this form the modification should affect the premaxillary itself, and be perceptible in the skeleton; mere deflection of a point or margin of the corneous envelope of the bill is not sufficient; e.g., *Empidionacea* are parognathous.

That singular bird, the *Ansergryphes*, might be thought to represent a fifth kind; but I should judge it to be parognathous. The modification in this case is of a different kind altogether; a species of bilateral asymmetry, like the bent vomer of certain cetaceans.

The *Mohring’s* and *Briissos* genera cannot obtain, we must take *Curulatrix*, *Brunn.* type *Cekua*, *Brumm., and Lestes*, Ill., type *L. parasitica*, Linn.

1869.
Subfam. Larina.—Covering of bill continuous; bill epignathous. Tail usually squarish; rarely forked or wedged. Head never crested. Hallux in one species imperfect. Tarsi almost always smooth. Feet ambulatorial. Genera: Larus (possibly with a few divisions), Rissa, Pogophila, Chroicocephalus, Rhodostethia, Xena, Creagrus.

The central group of the family: all the genera closely related. Distinct, on the one hand, from Leucodroma, but on the other shading into Sternae, through the smaller, hooded, forked-tailed, &c., species, the bill of which insensibly passes into the tern-like form. Altogether too many genera have been invented, not discovered, in the genus Larus. I would unite under this name all the large square-tailed, unhooded forms, of whatever color, doing away with Branta, Adiarna, &c., not to mention a number of worthless "comps," as M. Temminck would justly call them. Rissa is different in its feet, at least in the type of the genus. Pogophila is well marked in several respects; it corresponds to Gygis among Terns, and Pugodroma among Petrels. Chroicocephalus may well embrace all the smaller square-tailed "hooded" Gulls; these go into the tern-like shape of bill. The other genera above named are based mainly upon shape of tail.


Adhering well to a recognizable type, but varying in details of form, whence the numerous genera. Gelochelidon is gull-like, especially in bill. Thalasseus comprises the largest robust species, with a soft, flowing occipital crest. Phaetusa has large southern species with great turgid bill. Sterna is central, with many deeply-forked tailed species like hirundo, &c. Hydrochelidon is singularly fissiped, from defect of webs. Halipdana is nearly Sterna, but with different bill, feet and coloration. Anous is a singular form, with a long forked-graduated tail; i.e., central feathers shorter than next, others again graduated. Icna comes near it, but has unique, curly plumes on the side of the head, as in the Cormorants, and especially some Auk's! Gygis is the Tern expression of the idea of the Gull Pogophila and the Petrel Pugodroma. The Terns are marine Hirundinidae!

Subfam. Rhynchopinae.—Bill cultrate, hypognathous; otherwise as in the preceding subfamily. Genera Rhynchopum.

The single genus is a Tern in everything but the anomalous bill. The light cancelled internal structure of the turgid part of the upper mandible suggests that of Rhamphastidae. The Skimmers feed as whales do.

Families of STEGANOPODES.

This order contains no less than six families, none of which have more than a single subfamily. Regard for equivalency of groups necessitates this view. For if we institute two families, upon whatever basis, as some have done, we shall find that their subfamilies are fully as different from each other as the families are. Recognition of six families here, and only one with numerous subfamilies among Lamellirostraa, might not seem at first sight to be based upon parity of reasoning. But I think the distinction is one with a difference; and one too for which a good reason can be shown. Steganopodes are compounded from other Natatores, that is, forms have been taken from other orders, furnished with a pouch, webbed hallux and abortive nostrils, and otherwise modified to make up this order. Hence the dissimilar types, each representing a family. This is not so with Anseres. I cannot find the centre of Steganopodes; the families seem all peripheral, looking towards other groups. They show no tendency to merge into each other; they represent
a scattering group. And in general among birds, the closer the inter relation of forms included in a group of any grade, the more definitely circumscribed is that group from its surroundings; and conversely.


Evidently anserine in form and general appearance, as well as many details. The serrated simulates the lamellated bill. The wings are like a goose's; the tail of few feathers repeats that of some Amötide; the feet are strongly ambulatorial.

Fam. Pelecanidæ.—Bill very long, slender, but strong; its covering not continuous; not serrate; distinctly hooked with a nail. Nostrils rudimentary. Gular sac at a maximum. Wings extremely long, with upwards of forty remiges. Tail short, rounded, indefinitely many-feathered. Head crested. Legs columnar, very stout. Body with unusual pneumaticity; moderately depressed. Taken from Albatrosses. Technically one sub-family. Genus: Pelecanus; perhaps another.

The immense, many-feathered wings, and the size and general appearance of these birds, recall the Albatrosses. So does the hamulate, broken-covered, non-serrate bill. Progression in either of the three elements is similar; neither of the birds can swim under water. The enormous pouch represents the extreme of development in the order. Yet some of the family to which Albatrosses belong have it; witness the genus Pelecanoidæ.

Fam. Phalacrocoracidæ.—Bill mediocrec in length, rather slender, strongly hamulate, non-serrate, but its covering scarcely broken. Nostrils obliterated, at least in the adult state. Gular sac moderate. Wings short or medium. Tail large, fan-shaped, very stiff, definitely few (12—14) feathered. Head with curiously modified feathers. Legs far back, not ambulatorial; upright position necessitated. Pneumaticity slight. Body greatly depressed. Heavy flyers; excellent divers. Taken from Auks. Technically one sub-family. Genus: Phalacrocorax; but probably capable of well-founded divisions.

These are palpably pygopodous; representing the extreme, in this respect, of the present order. They are forced to stand upright, and use the tail as additional support. They progress under water better than any other totipalmate birds, except the Plotidae. The curious colored feathers about the head are those of Auks and Penguins. By remote analogy, there is a resemblance to Scansores.


The analogy, if not actual affinity, is very striking in this case. Physically, the long neck, style of bill, shape of wings and position of feet, are like the same parts in Podicipidæ. Physiologically the Darters share with the Grebes a habit almost confined to these two families: that of sinking back quietly in the water, leaving only the bill exposed. Both are unrivalled divers. Moreover, we have in that singular family, the Helornithideæ, an actual link between Grebes and Darters; further carried to fullicious forms.

* Not actually, of course, but potentially, or ideally.

1869.]
Fam. Tachypetidae.—Bill rather long, stout, strongly hooked, its covering not continuous. Nostrils very small. Gular sac highly developed.* Wings and tail excessively long and strong; the latter deeply forked, 12-feathered. Legs extraordinarily short, well forward, but scarcely used. Tarsi plumose; middle claw pectinated. Unsurpassed flyers; scarcely swimmers; not divers. Taken from Petrels. Technically one subfamily. Genus: Tachypetes.

The tarsal ptosis, and pectination of the middle claw, are unique in the subclass; the webs are more deeply incised than usual. In wings, tail and bill these birds are modified Petrels.

Fam. Phaethontidae.—Bill medium, stout, straight, sub-serrate, paragnathous, its covering continuous. Nostrils small, but pervious. Gular sac smallest in the order; wholly feathered. Wings long and pointed. Tail moderate, but with long-exserted, filamentous median rectrices; 16-feathered. Feet well forward, short and stout; horizontal position of body necessitated. Excellent flyers; good swimmers; not divers. Taken from Terns. Technically one subfamily. Genus: Phaethon.

The gular sac is scarcely more than rudimentary, and it is fully feathered; the nostrils are comparatively well developed. The bill is almost exactly that of a Tern. The filamentous tail feathers are rarely found outside Sternine. The general resemblance to a Tern, in physical characters, as well as mode of life, is too obvious to require further comment.

So we see that each main group of water birds has been laid under contribution to form this scattering polymorphic family, a comprehensive mask for the rest.

Family and subfamilies of LAMELLIROSTRES.

A completely circumscribed group, of only one family, Anatidae, whose characters are those of its order. The only break in the family is at the point of departure from Natatorae to Grallatores, where the way is opened for the passage from Anatidae by Pharnicopterus. There are six subfamilies, just as there are six families of the preceding order. These are mainly distinguished by the varying combination of characters common to several; but some introduce peculiar features. Of the latter, Mergine are the furthest removed, perhaps, from all the rest. They have consequently been considered by some as a separate family. But a merganser is scarcely or not more different from a duck than a swan is. Regard for equivalency of groups therefore requires it to be placed as a subfamily of Anatidae.

Fam. ANATIDÆ (chars. as above).

Subfam. Cygninae.—Neck of extreme length for this family. Bill stout, high, and compressed at base, wide and depressed at tip, longer than head, sides parallel. Nail narrow. Lamellae of upper mandible vertical, in one row. Soft skin of bill reaching towards, or to, eyes.† Wings ample: the inner remiges highly developed. Tail short, rounded, indefinitely many (20⁺⁻) feathered. Tarsus short, reticulate. Feet large; webs always full. Hallux small, elevated, with a small lobe. Trachea convolute, entering sternum (always?). Sexes similar. Species of largest size in the family, proverbially elegant swimmers, strong flyers, poor walkers; do not dive. Genera: Cygnus, Olor, Coscoroba, Chenopus.

Subfam. Anserinae.—Neck lengthened; shorter than in the foregoing, longer

* The Frigate-birds have more of a pouch than they are usually given credit for. Mr. Cassin’s figure, in Gilb. U. S. Naval Astron. Exp., is not exaggerated.
† The abbreviation of the tarsus in this case probably represents the extreme of this feature in the class Aves.
‡ The genus Charadrius, Eyton, apparently Anserinae rather than Cygninae, is said to possess this character ("Rostrum longum, commissum laterum ad oculos tendentes."—Eyton, Mon. Anat.) If so, the character is not unexceptionable.
than in any of the following. Bill much as in foregoing, but generally not longer than head, sides converging, base very high, nail at end large, generally forming the whole tip. Lamellæ as before. Lores definitely feathered (always?). Wings mediocre, sometimes appendaged. Tail short, rounded, rather many (16+) feathered. Tarsus reticulate; longer than middle toe (always? ?). Feet moderate, webs sometimes defective. Traehea simple, at least not entering sternum. Sexes usually similar. Of large and medium size; strong flyers, good swimmers, and especially good walkers; do not dive. Genera: Anser, Berniclea, Chloephaga, Chenisea, Chenvalope, Plectopterus, Choristopus, Cyrcopsis, Sarkidiornis, Anseranas, Deuderoegyna; but some of these may be only subgenera, on synonyms.

A rather large group; none are entirely swan like, but on the other hand some forms grade toward the ducks, and their position is open to discussion. Such especially is Deuderoegyna, but its reticulate, not scutellate, tarsi, apparently define its position. Plectopterus is the only armed-winged swimmer. Chloephaga and Anseranas have more or less defective webs. The body is not so depressed in the geese as in other subfamilies; the feet are perhaps further forward; the species stand high, and walk better than any other Anatidae.

Some are more or less arborecolc, like many ducks.

Subfam. Anatinae.—Averaging smaller than either of the preceding; neck usually much shorter. Bill broad and depressed towards tip; rarely or never so high at base as in Anserineæ; of various details of shape, but rarely if ever gibbous. Lamellæ vertical, in single row. Wings mediocre; the scapulæ or tertials never curvy. Tail short, usually rounded, sometimes longer, and pointed; of varying number of, but generally few, feathers; its coverts always ample. Feet moderate, rather further forward than in the succeeding; hallux simple. Body depressed. Head sometimes crested. Sexes dissimilar. Strong flyers, good swimmers, poor walkers, scarcely diving at all; many are arborecolc. Genera: Tadorna, Cusarca, Leptotartis, Anas et aff., Spatula, Aix, Cairina, and others.

The river ducks have been so extensively subdivided, that many of the distinctions commonly claimed as generic are not of more than specific value. Some of these genera, so-called, could not stand a moment did they not take color from the birds' colors. I think the number must be reduced, and that Anas can conveniently hold some half-dozen of them.

Subfam. Fuligineæ.—With the characters in general of Anatinae, but the feet placed further back and wider apart, apparently, and much larger, with broader webs; the tarsi short. Hallux with a large hanging lobe. Tail sometimes narrowly long-pointed, its coverts always normal. Scapulæ or tertials often curvy. Bill frequently gibbous. Strong flyers, very poor walkers, excellent swimmers, and the majority dive well; decidedly marine. Genera: Fuligula et aff., Oidemia et aff., Somateria, and others.

The sea ducks form a group usually distinguishable on sight from the preceding, and well characterized; yet it is difficult to find any positive feature applicable to all, except the large-lobed hallux; this is simple in the river ducks. But the feet are comparatively much larger. The species are mostly marine, diving well, and scarcely walking. As in the preceding group, the genera are altogether too many; but, likewise as in that case, I am not prepared to speak authoritatively as to the amount of reduction that would be desirable. Above, I only indicate principal series or sets of genera. Thus Fuligula has grouped about it Fulix, Aythya, Nyroca, Clangula, &c., just as Anas has Nettion, Querquedula, Mareca, Dufila, Choutelasmus, &c. Oidemia might contain all the "Scoteræ," as Pelionetta, Melanetta, &c. Another central point has grouped about it forms like Histrionicus, Polyptilæa, Campylæmus, Horelda, &c. Somateria will embrace all the "Eiders" with gibbous, partly feathered bill. This is merely an indication of the grade of differences that I would be inclined to consider generic.

1869.]

NATURAL SCIENCES OF PHILADELPHIA.
Subfam. Erismatourinae.—As in Fuligulinae; but the rectrices rigid, lance-linear, acute, the coverts extremely short. Nail of bill chiefly inferior. Genera: Erismatura (et Biziura nilor.); and Thalassornis?

A group of one, perhaps two, genera, and upwards of a dozen species, like ordinary sea-ducks, but differing in the curious condition of the tail, which corresponds to that of the Cormorants in their order.

Subfam. Merginae.—Bill long, slenderer and narrower, more nearly cylindrical in its continuity, than in either of the foregoing. The nail narrow, forming a true hook. Upper mandible with a double series of laminae on each side, set obliquely backwards like saw-teeth, the single row in the under mandible fitting between them. Otherwise much as in Fuligulinae. Mostly crested. Sexes dissimilar. General habits as in the sea ducks. Genera: Mergus, Merganetta, Lophodytes, Mergellus.

A small group, well characterized by the bill. It offers the most conspicuously crested members of the family. The habits of the "fishing-ducks," as they are called, are much the same as those of the sea-ducks.

Characters of some new Hepaticæ (mostly North American), together with Notes on a few imperfectly described Species.

BY COE F. AUSTIN.

Scapania Peckii, Aust.

S. minuta, compacte caspitoso, valde surculosa; caulc subulisciplici serpen- tino-erecto vel adascende gente 3—4 lin. longo sursum accrescenti laxe vel sub-imbricante foliato; foliis integerrimis obtuse complicatis bilobis, lobis sub- conformibus late ovatis plerumque obtusis apiculatisque, dorsali parce minori; surculis sursum subdecrescentibus disite foliatis, foliis subdisformibus acute bilobios varie modo directis complicatisque subrectcis vel plerumque e basi erecto patuli-recursus nonnullis interdum explanatis; perianthio parvo sub-cuneato terminali et laterali sessili valde compresso, ore truncato integerrimo sepe subrecursiv; foliis involucralibus conformibus nonnullo subdenticulatis; rete foliorum e cellulis minutis subrotundis hyalinis pariformibus, intersticitis latisissimis fulgido-pellucidis confluentibus instructo.—Hep. Bor. Amer. Etsie. ined., No. 20.

On old logs in woods, near Belleville, Canada West, John Macoun (1865). Adirondack Mountains, New York, Prof. C. H. Peck (1867); also about Jor- dansville, N. Y. (Austin, 1868).

Remarkable for its minute size (being about the size of Jungermannia Hel- leriana), obtusely complicate leaves with the upper lobe sometimes small and tooth-like, at other times nearly equaling the lower one; and for the great number of surculi, which are extremely variable in size, and clothed with smallish leaves, which resemble very much those of Jungermannia Helleriana, or J. minuta, and are very different from those of the main stems. The gemme bearing leaves occupy the middle of the stem, which is interrupted on account of them; they are usually ovate, subentire and subtruncate at the apex, and closely wrapped about the stem.

Resembles small forms of S. exsecta (Schmid), but is readily distinguished by its compressed perianth, never tridentate leaves, &c.

S. brevicaulis, Tayl., with which it may be possible to confound our species, is larger, with much more condensed stems and vertical leaves, and is desti- tute of surculi. Moreover, the perianth is very different, being scarcely more compressed than in S. obtusifolia.

Scapania Bolanderi, Aust. Mst. 1865.

S. caule subdichotomo-ramoso caspitoso subascendecente; foliis acute complicatis grosse ciliati- vel subinciso-dentatis siccate non mutantibus, lobo
ventrali valde convexo oblique obovato-oblongo valde obtuso patenti-decurvo, dorsali dimidio minori haud angustiori minus convexo erecto-subverticali vel subappresso orbiculato vel late ovato, apice subacuto grossius dentato leniter incurvo, margine externa ad basin longe producta ciliis valde longioribus subdecompositis deflexis ornata; perianthio compresso oblongo terminali, ore subciliato.—cit. Bor. Amer. Exot. Med., No. 19.

On Redwood trees and stumps, California, Dr. H. N. Bolander.

Remarkable for the long, deflexed, often compound ciliae on the attenuated outer basal angle of the dorsal lobe of the leaf, and for the leaves retaining their position and shape in drying. Remembers S. nemorosa in general appearance, but is rather smaller than the ordinary forms of that species, with longer and narrower, more obovate, and much more coarsely-toothed leaves.

**Jungermannia rigida, Aust.**

*J.* examphigastriata, subrobusa; caule decumbente flexuoso rigido nudo ex apice prolifero; foliis sursum incrassatis erecto-conniventibus arcte imbricatis oblique cordato-orbiculatis rotundatis integerrimis, margine flexuoso-undulatis praeclue dorsali subsinuatis ventrali inflexis; perianthio terminali mox laterali obovato-oblongo plurimum plicato demum versus basin nudo, ore ciliato; involucri foliis ciliatis.

Sandwich Islands. Communicated by Dr. H. N. Bolander, 1865.

Differs from *J.* flexiculis, Nees., Syn. Hep. p. 87, in the undulate leaves—those of the involucre ciliate, and in the multi-plicate perianth.

*J.* colorata, Lehm., Syn. Hep., p. 96, differs in the leaves being more connivent and orbicular, smaller, and not undulate, &c.

*J.* grandiflora, L. & G., Syn. Hep., p. 673, differs in its small subtrifid involucral leaves, connate with the amphigastria.

**Jungermannia robusta, Aust.**

*J.* examphigastriata; caule stricto vel subarcuato erecto ex apice proliferof-continua e ventre toto longitudinal radiculoso; foliis pallidis exacte verticalibus late oblique cordato-orbitalis rotundatis, toto margine minutissime eroso-dentatis dorsali undulatis subsinuatis subdecurrentibus; perianthio terminali subcylindrico triangulare-subcompresso basi nudo ore plicato subcilato; involucri foliis subbulobis, lobo ventrali subciliato-denticulato, altero integro.

Sandwich Islands. Communicated by Dr. H. N. Bolander, 1865.

Differs from *J.* rigida in its pale color, much larger size, more vertical leaves eroded-dentate on the margin, in its bilobed involucral leaves, longer and less plicated perianth, and radiculose stems.

*J.* colorata, a closely related species, is smaller, with more orbicular and connivent, reddish leaves not undulate on the dorsal margin.

**Jungermannia coriacea, Aust.**

*J.* caule repente vel adscendente subramoso radiculoso; foliis subcoriaceis rigidis arcte imbricatis madefactis patulis siccatis subverticalibus ovato-oblongis obtusis planisculis, margine subrepandis integerrimis dorsali subdecurrentibus; perianthio magno cylindrico-oblongo sublati, ore subplicato minute ciliato; foliis involucralibus subbulobis inciso-dentatis, basi ventrali minute lobulatis, emm stipulis parcis lanceolatis vel oblongis acute bi-quadrifidis intermixtis.

Sandwich Islands. Communicated by Dr. H. N. Bolander, 1865.

Remarkable for its large size, and for the thick epidermis of the leaves, which are of a reddish color.

Differs from *J.* grandiflora, L. & G., Syn. Hep., p. 673, in its oblong leaves, those of the involucres slightly enlarged and not connate with the amphigastria; also in the radiculose stem. There are no amphigastria except at or near the base of the perianth, and these (about four in number) are situated on 1869.]
at least two sides of the stem, and some of them below the two outer involu-
eral leaves, which are simply retuse at the apex and nearly entire, while the
two inner ones are unequally bilobed and lacerate-toothed.

**Jungermannia biforis**, Aust.

J. caule dense cespitoso valde intricato e ventre innovante pluries ramoso,
valde radiculoso, radiculis tenuis-simis longissimis subfasciculatis supremit
nonnullo rubris; foliis succinis vix imbricatis subcomplanatis oblique semi-
circularibus vel late ovatis tenuibus, margine dorsali decurrentibus apice
integris retusivae, rete e cellulis magnis subrotundis hyalinis intersticiis,
angustissimis instructo, surculorum foliis dimidio minoribus ovatis obovatis
valde obtusis vix decurrentibus; amphigastriis nullis; fructu ignoto.—*Hep.
Bor. Amer. Exsic. ined., No. 26.*

On wet rocks, at the Delaware Water Gap, New Jersey, 1867.

Remarkable for the closely entangled and matted stems and surculi, and
for the leaves of two forms. The texture of the leaves is much as in *Calypo-
geia Trichomanes.*

**Jungermannia fossombrionoides**, Aust.

J. caule dense cespitoso adscendente (radicibus purpureis subinserassatis)
valde radiculoso; foliis distichico-subverticilabulis arcte imbricatis orbiculatis,
margine undulato-repandis, apice brevi unipliicatis laterer emarginatis patulo-
subrecurvis, basi subcordatis caulem amplectentibus subventricosis radicilo-
sis, involucralibus conformibus cum perianthio alte connatis; perianthio
maximo longissimae exserto subcampanulato sex—decempliicato, ore hiante
profunde laciniato, lacinis integerrimis; calyptra omnino violacea; capsula
ovari.—*Hep. Bor. Amer. Exsic. ined., No. 32.*

On rocks along a rivulet, near Closter, New Jersey.

Remarkable for its large, subcampanulate and multi-pliicata perianth. Al-
lied to *J. crenulata*, Smith, but much larger, &c.

**Jungermannia porphyroleuca**, Nees, var.

Caule dense lateque cespitoso prostrato innovante' ramoso crassissuculo
valde radiculoso, radiculis ad cauli insertionem rubris longissimis subfascici-
latis, foliis plerumque rubris pallido viride plus minus variegatis subverticalibus
obtusissime subcompliicatis e basi erecta suberecurvis oblongo-quadratis sub-
cuneatis emarginato-bilobis integerrimis, sinu obtuso, lobis plerumque
acutis subinsequais inscurvatis; perianthio adscendente subclavato valde
exerto a tergo ventrque subappresso apice obtuse 3—4-pliicato ore con-
nivente subciiliato; foliis involucralibus parce majoribus, apice subtruncato
obtuse 3—4 lobulato et cedemque numero late plicato; caule gennifero
spiciformi attenuato rigidio microphylllo, foliis bifarisis arcte imbricatis sub-
ovatis apice emarginatis erosio-dentatis subintegerrimisve, gemmis rubris.—

On old logs in the region of the White Mountains of New Hampshire, Oakes;
also in Canada West, near Belleville, Macoun.

Remarkable for the usually variegated, often deep red color of the whole
plant, and for the cuneate-oblong shape of the leaves. Differs from *J.
Michauxii*, Web., in its usually smaller size, reddish color, prostrate and
densely radiculose stems, longer, narrower, subcuneate and vertical leaves,
with an obtuse and broad sinus, and shorter, less acute and less incurved
lobes, and in the obtusely 3—4-lobed, somewhat enlarged involucral leaves;
also in the genniferous stems, which are almost precisely as in *J. Helleriana,
Nees.*

**Jungermannia polita**, Nees.

J. amphigastriis nullis; caule subsimplici undinsculo nigrescente flexuoso,
ascendente et fertili dissite repente imbricante foliato; foliis nitidis ad

[Dec.]
caulem oblique insertis undulatis flexuoso-patulis late amplexicaulibus (vix complicatis) late enneato-quadratis integerrimis truncato bi—trilobiis, margine obtuse 1—3 undulato-plicatis (basi media vix saccatis); fructu terminali (in auctunnno matur.), periantilio valde elongato (circa 3 lin. longo) subcilindrico nudo pericarpio uno minute ciliato; foliis involucralibus binis latissimis brevissimis valde crassulo-undulatis obtusissime plurimum lobulatis.

—Hep. Bor. Amer. Excell., No. 46.

In a peat bog near Closter, New Jersey; growing among Sphagna, and associated with J. Taylori, J. infula, J. connivens, etc.

The sterile plant agrees perfectly with authentic European specimens. The fruit appears to have been collected now for the first time, and is extremely rare in our locality. The leaves on the horizontal and fertile stems are crisped and wavy, much as in most Fossombroniae. The former often bear little balls of green gemmae on the apices of their lobes, and are subhorizontal and frequently imbricated, while the latter, towards the perianth, are usually 1—3 lines apart, subopposite and erect. The leaves, particularly on the erect stems, are about as often two as three lobed, and can hardly be said to be composite, or either saccate at the base. The stem is usually very conspicuous on account of its blackish color. The perianth is whitish or membranaceous above, and at first subtriquetrum.

**Jungermannia Wallrothiana, Nee.**

"Nigricans, minutissima. Caule repente, adscendente, subsimplici vel innovante ramoso, vix ½—1 linea longo, valde radiculoso; radicibus crassi papilliformibusque. Folii diametro caulis latioribus, amplectentibus, firmis, ovato-quadratis, arcte imbricatis, semiverticalibus, concavis, sursum conniventibus, emarginato-bidentatis; sinu vel obtuso in foliis inferioribus, vel acuto in foliis superioribus; dentibus obtusiusculis integerrimis; margine pellucidis; areolatione distincte, cellulis ovato polygonis, olivaceis, margine tantum pellucidis. Folii involucralibus majoribus, erectis, tridentatis, undato-plicatis, basi connatis; dentibus acutis vel obtusis. Perianthio ovali-cylindrico, superne contracto, plicato; ore subdentato, pellucido, inferne rubello." (Lesq. in Herb.)

On coarse sand, on the slopes of the White Mountains of New Hampshire, Oakes.

A very minute species, but more than twice the size of J. Sullivantii, from which it is also distinguished by its entire leaves, papille-form rootlets, and different perianth. Leaves round-ovate, thickish, 1½-bifid, the lobes triangular-ovate, acute; cellules irregularly angled, subquadrate or oval, rather uniform, largest for the size of the leaf (about ten across its widest part), opaque, with broad hyaline spaces between. Apex of the lobes hyaline, often slightly eroded on the margin. Color dark or olive-brown. Perianth terminal, subpyramidal, cleft about one-third way into about six sublinear truncate lobes, the apex white and pellucid, the middle and base dark brownish-red; the mouth crenulate by the protrusion of the ends of the very large, oblong cells, of which the upper portion of the perianth is composed. Leaves of the involucre enlarged, entire on the margin.

**Jungermannia Sullivantii, Aust.**

J. amphigastrìata, minutissima, olivaceo-vel saturate viridis; caule circa ½—1½ lin. longo carnoso valde radiculoso, fructiiero suberecto elavato, sterilì repente subfiliformi vel subjunaceo; foliis imbricatis caule sàpe angustioribus ovato-orbiculatis vel subquadratis erecto-subverticalibus plus minus dentato-serratis bifidis, sinu acutiusculo, dentibus acutis; amphigastris (solum versus apicem in caule sterilì observatis) lanceolato-ovatis strictis integris (folii lobo fere similibus) suberectis; perianthio circa ½ linea longo late ovali subobovatovi obtuse parceque angulato, apice paulum plicato truncato, 1869.]
ore connivente lobulato-deutato nonnullo auguste scarioso; involucri foliis tribus erectis haud coaliitis; pedicello longitudine semilinaris; capsula ovalis.


J. divaricata, Suliv, Musc. Alleghan. N. 239.

On very rotten wood near Columbus, Ohio, Sullivant. About Closter, New Jersey, and Jordauville, New York. Also near Belleville, Canada West, Macoun.

Remarkable for its extremely minute size. Differs from J. divaricata, Engl. Bot., in the much smaller size of the whole plant, particularly the perianth, in the larger, sublaucenate amphigastria, in the discrete involunral leaves, and in the roundish, less quadrat and less angular cells of the leaves.

JUNGERMANNIA MACOUNII, Aust.

J. caule compacte lateque caespitoso tenui valde innovante ramuloso, ramulo fructiferio brevissimo ventrali; foliis caule latioribus subimbricatis erecto-subverticalibus subcomplicato-concavis et basi angustiori subconnato-quadratis ultra medium bifidis, sinu plerumque lato obtuso, lacinii triangulare-amphigastria, vel subulati recticulati sub pressa divaricatis, areolis parvissimis angularibus; perianthio minuto albido subtrigono ovali; ovario gibbositate sub flavido, apiice contracto subapicali, ore denticulato ciliato; involucri folii subobtusissimis subinsequituli bi-trifidis serratis longe ciliatis.—Hep. Bor. Amer. Eexic. ined., No. 55.

On decayed logs in woods, Canada West, John Macoun.

Differs from J. diuericata in the more matted stems, in the rather wider, more complicate leaves with an obtuse sinus; and chiefly in the much shorter, white, and differently shaped perianth, which is situated on a short ventral branch. The habitat (old logs) is also different. Color very dark green, changing to dark fuscos- or brownish-green in the herbarium. Perianth shaped much as in J. Helleriana, Nees.

JUNGERMANNIA PLEXICPS, Aust.

J. caule dense caespitoso perbreve et ventre valde radiculoso innovanteque ramoso; foliis incrassatis orbiculatis valde concavis verticallis conniventibus subsemiamplexicaulibus ad ½ bifidis, sinu acutissimo obtuso, lobis omnino acutis incurvis valde conniventibus; fructu in ramulo ventrali terminali, perianthio confertissimis magnis oblongo-ellipticis obtuse trigonis, ore picato denticulato late laciniate; involucri foliis rectis oblongis bi palmato-quadriis nonnullis stipuloides; ret exfolium et cellulis amplusissimis subrotundis hyalini instructo.

Among Sphagna, White Mountains of New Hampshire, Oakes.

Remarkable for the very concave, upwardly connivent and thick leaves, which are composed of very large inflated cells; for the very short stems with numerous ventral innovations, and for the very abundant fruit,—the perianths completely covering the caespites. Color pale or albescent. (Some of the involunral leaves (the ventral ones) are amphigastria-like. Resembles J. connavis, Dicks., but is somewhat larger, with shorter stems, more vertical and concave and thicker leaves, which are not decurrent, and a larger more cylindric-perianth, which is not ciliate at the mouth. Perianth much as in J. bicuspidata, but the shape of the leaves is quite different from the specimens of that species collected by Oakes, in precisely similar situations; the stems are also shorter and the involunral leaves not spreading at the apex.

LOPHOCOLEA HALLI, Aust.

L. caule repente parcisssime radiculoso; foliis subverticalibus oblongis integris vel subrepandis crenulatis fere ad medium bilobis, sinu obtuso, laciniiis subrectae plerumque obtusis, ret e cellulis subparvis rotundis convexis hyalinis, intersticiis angustissimis instructo; amphigastrias inferioribus parvis profunde bipartitis, sinu valde obtuso, laciniiis subaequalibus teretiusculis patulis in—Dec.
curvis, superioribus majoribus extrorsum utrinque unidentatibus vel palmato tri-quadrupariitis, apicibus sublanccolatis anguste bifidis extrorsum repando-dentatis; fructu —

On the ground, Illinois, E. Hall.

Remarkable for the obtusish lobes and crenulate margin of the leaves. A very small species.

**Lophocolea Macounii, Aust.**

L. minuta, condensata, lute viridis; caule perbrevi prostrato dense fasciculatim radiculoso innovante ramoso ad apicem adscendentem incurviu scculo; foliis erectissculis ovato-subquadratis retnuis vel emerginato-bilobis aut sepe integris, margine leniter repanda crenulatis, sinu lobisque obtusius vel acutiusculis his rectis vel curviu sculis, ret e cellulis magnis intersticiis angustissimis hyalinis instructo; amphigastris profunde bifidis (trifidi ete?) sinu late obtuso, laciniiis serie cellularum 1—2 instructis filiformibus patulo-incurvis, colore lute carpophylloideis; perianthio subobovato leniter trigono, apice cristato-dentato sepe in uno latere profunde obtuseque inciso, angulis hand vel vix alatis; involucri foliis majoribus suboblongis subrepandis apice valde in-qualiter 2—4 repando-dentatis; amphigastris valde majoribus lanceolatis minus profunde bifidis repando-dentatis.—*Hep. Br. Amer. Essic. ind., No. 66.

On old logs in woods, hidden among other Jungermannia, Canada, Macoun; also near Little Falls, New York.

About the size and with much the general appearance (when sterile) of small forms of *Jungermannia sectata*, resembling it in the color, general form, position, and in the areolation of the leaves. Remarkable, among other things, for the light pink color of the amphigastria, with thread- or necklace-form divisions (usually composed of a single row of cells.) Differs from the preceding species in its much smaller size, densely radiculose stems, shorter and less deeply lobed leaves, &c.; and from *L. minor*, Nees., in the more obtusely lobed, often entire leaves. The lower leaves are usually rather deeply and acutely lobed, while the upper ones are only emarginate or reteuse, or often quite entire at the apex.

**? Gymnanthe Bolanderi, Aust.**

? G. caule eradiculoso prostrato subimbricato e ventre innovante ramoso complanate foliato $\frac{1}{2}$—$\frac{3}{4}$ unciali; foliis succubis stricte patentibus lineari-oblongis subfalcatis integerrimis planis, apice rotundatis vel oblique subtruncatis aut nonnullo inaequaliter emerginato-bilobis, margine dorsali subdecurrentibus; ret e cellulis laxis maximis heteromorphis discretes, intersticiis latis hyalinis instructo; amphigastris (inferne obsolertis) minuti oblongo-ovatis longe bicornibus, sinu obtuso, laciniiis subulatis paralellis; fructu —

Sandwich Islands. Communicated by Dr. H. N. Bolander, (1865.)

A neat and pretty little plant, about the size of *Lejeunia serpyllifolia*; the form of the leaves suggesting a *Plagiochila*, but the general appearance of the plant is still more suggestive of a *Saccogynia*, and, indeed, I am not sure but that it ought rather to have been referred to this latter genus than to *Gymnanthe*. The cells of the leaves are very large and loosely arranged, and are usually furnished with broad and short projecting points. They also vary greatly in size and position, being roundish or oblong, and frequently some of them are obliquely or even transversely disposed through the leaf. Those on the margin are usually narrower than the others, and vary from subquadrature to elongated-oblong or parallelogrammoid. The cells of the stem are also very loosely disposed; however, they are still larger than the leaf-cells, and uniformly oblong.

**Calypogea bifurca, Aust.**

C. albida, caespitosa, parvula; caule prostrato et ventre apiceque valve flagelifero-ramoso circa 3—5 lin. longo, dorso in statu siccati convexo (nec canaliculato) ob cellulis oblongis eleganter striolato perspicue secus foliorum 1869.] 16
basin cum cellulis maximis oblongis hyalinis marginato; foliis imbricatis late et suboblique ovatis margine inferiori abrupte decurrentibus supra valde convexis siccate non mutuatis abips apice pro genere lato subcontractis marginato-bidentatis, dentibus triangulari-subulatis rectis vel plerumque divaricatis, sinu plerumque lumnulato; rete et cellulis hexagonis magnis hyalinis, versus basin oblongis, versus apicem rotundatis ac sensim minoribus, secus marginem angustioribus plus minus quadrangularibus transversimque elongatis instructo; amphigastriis valde dissitatis minuti caule angustioribus vel cum vix excedentibus ovatis vel reniformi-rotundatis obtuse profundeque bifidis, lacinias rectis subulatis integrisque vel subtornudis divaricatis ac iterum bifidis.

Sandwich Islands. Communicated by Dr. H. N. Bolander, (1865.)

A neat and pretty little species. Possibly too near the Mexican *C. laxa* L. & G., Syn. Hep. p. 713, but nothing is there said about the flagiferous ramification, a striking feature of our plant; and the leaves are said to be lax and minutely bidentate, characters which do not agree with our plant, whose leaves do not change their shape in drying, and, for the genus, are pretty strongly toothed. The peculiar bifurcation of most of the amphigastria, and the transverse elongation of the marginal cells of the leaf, appear to be generic characters (specific only in degree), as they occur (in a less degree) in *C. Tri-chomania*, and at least in two other species.

Physiotium subinflatum, Aust.

Ph. foliorum lobulis subinæqualibus lanceolatiss acuminatiss circa ½—⅓ libe-bris; dorsali convexo, margine exteriori versus basin inflexo subbidenticulato-que, apice subconvoluto dentibus parvis rectis acutis minute bifido; ven-trali parce minori convulto-concavo, basi ob marginis coalescentes breviter tubuloso non appendiculato, marginie interiori subalato, ad apicem angustum subuligulato obtusiusculo integro et integerrimo vel erosio-denticulato.

Sandwich Islands. Communicated by Dr. H. N. Bolander, (1865.)

Remarkable for the subequal acuminate lobes of the leaf; the lower one not appendiculate, and inflated only at the base, convoluto-concave above.

Polyotus Peckianus, Aust.

P. caule repente pinnatim vel bi—tripinnatim ramoso, ramulis dissitiusculis patulis-recursis ⅓—⅓-uncialibus subattenuatis; foliis arctissime imbricatis sub-ovatis obliquis convoluto-recursis inaequiliter bi—trilobis integerrimis basi utrique auriculatis, sinu angusto, lobis ovatis acutis vel subapiculatis aut rare obtusis inferioribus incurvatis; auriculis subparvis oblongo-lanceolatis canaliculato-concavis, ventralibus stricte patentibus caulem arcte amplexentibus, dorsalius plus minus deflexis cauli arcte appressibus; amphigastriis maximis oblongis profundiis et æqualiter bifidis, basi ut in foliis auricularis, auriculis caulem utroéque arcte amplexentibus; fructu in ramulo brevi poly-phyllo; involucri foliis valde majoribus oblongis basi parce longissimeque ciliato-lobulatis profunde bifidis, lacinias ligulatis undulatis subdentatis canali-culatis.

Island of Mauritius. Communicated by Prof. C. H. Peck, (1868.)

Remarkable for the bi—trilobed leaves, and for the very large bifid amphigastria, which are ariciled at the base in much the same manner as are the leaves. The stems are about 2½ inches long and rather widely branched. The leaves do not change their shape in drying. In size the plant rather exceeds Frullania Tamarisci.

Sendtnera tristicha, Aust.

S. parvula, rufo-brunnea vel subnigra; caule rigido parce ramoso tenui subbunciali; foliis amphigastriisque exacte tristichis ovato-lanceolatis falcato-subsecundis apertos vel siccatis appressis apice ad ½ partem fissis, lobis acutis-simis inæqualibus recto-conniventibus; fructu ———.

[Dec.]
Sandwich Islands. Communicated by Dr. H. N. Bolander, (1865).

Diffs from S. fissa, Nees, in the leaves being much less deeply fissured at the apex.

**Phragmicoma elongata, Aust.**

Ph. caule stricto parce innovante diviso subnunciial; foliiis late subfalcato-ovatis convexis patuli recurvus et decurvis ere linea longis apice serratis subacutis vel obtusis, lobulo minuto subinflato mutico in folii margine trans-cuente; amphiagariis squarrosis caule duo latioiribus orbiculatis subreniformibusve subitus convexus, margine omnino minutissime serratis; perianthio parvo a lateribus compresso fere sessili subdecem-alato caeteroquin lavi.

Sandwich Islands. Communicated by Dr. H. N. Bolander, (1865).

A large species, being about the size of *P. semireplanda*, Herb. Lehm., but the leaves are less strongly toothed, and the perianth more numerously angled, the angles winged, &c.

**Phragmicoma subquarrosa, Aust.**

Ph. caule brevi flexuoso compacte caespitoso rigidpio apice suberecto; foliiis arctissime imbricatis in siccis subsquarrosis undulatisque obovato-rotundis maxime areolatis, lobulo majuscule semirotundo-ovato vix inflato; amphiagariis caule duo vel triplo latioiribus reiformibus apice subrecurvis; perianthio obovato hand compresso circa 10-alato caeteroquin lavi.

Sandwich Islands. Communicated by Dr. H. N. Bolander, (1865).

Perianth terminal, at length lateral, deeply and closely grooved or angled, crowned with a very minute cylindrical tube. Calyptra crowned with a very long style. Elaters very large, containing a single thick, imperfect fibre. Leaves margined by a row of diminished, subequal cellules.

? Lejeunia Biseriata, Aust.

? L. foliiis rufo vel fusco-brunneis siccati convoluto-adpressis madefactus patentibus obovato ovatis integris convexis, supra minute elegantanque papilo-sis, toto margine inferiori late inflexis; amphiagariis biseriatis alternatis foliorum medio oppositis basi ad caulem exacte diagonae insertis erecto-divaricatis lineari-oblungis obtusis in longitudine circa 2 folii metientibus; fructu ———.

Near Augusta, Georgia, Sulliv., (1845).

About the size and color of *Frullania Virginica*. Remarkable for the genuine papilae on the surface of the leaves and amphiagria, for the broadly inflexed ventral margin of the leaf, and chiefly for the double row of amphiagria. These are alternate with, and equal the leaves in number. They are 2 as long as the leaves and less than 4 as wide, and are placed diagonally or obliquely opposite them, and about midway between their upper and lower margin. Areolation and texture of the leaves much as in *Frullania Virginica*. The rootlets are remarkably stout, and of a brown color, and few in number; and proceed from the whole under surface of the stem as well as from the base of the amphiagria. A few stems only of the plant, without fruit, were found in Mr. Sullivant's collection, mixed with *L. serpyllifolia* and *L. Sullivantiae*. Dilent but unsuccessful search was made for more of it, among numerous specimens from the same locality.

**Frullania Saxicola, Aust. MSS., (1865.)**

F. digyna: caule brevissimo arcte repente vage innovanteque pluries ramoso; folii orbiculatis (vix obliquis) planis vel subconvexis aut nonnullo leniter concavis subassurgentibus, auriculis cauli approximatis rarissime majusculis subtusundis galeiformibusque autem fere semper parvis explanatisque; amphiagariis minutis caule non vel parce latioiribus subobovatis bifidis integer-rimis, sinu lobisque plerumque obtusis; perianthio compressiusculo obovato majuscule, ore brevissimo pateriformi papuloso, dorso convexo, ventre abrupte-

1869.]
lateque carinato, utrineque uni—plurimerosso, carina biangulata, nervis angulisque plus minus utatis undulatisque.—

Closely adhering to the surface of steep shaded rocks, near Closter, New Jersey; very rare. Also, Texas, Wright in Herb. Sulliv.

Remarkable for the short, innovately much branched stems, and orbicular, plane, subascending, scarcely if at all oblique leaves, with the auricle almost always expanded into a small, oblong, concave, obtuse lamina. Areolation of the leaves distinct, scarcely enlarged in the centre at the base. Perianth longer than in F. Virginica and more exserted, but angled much in the same manner; however, the angles are never crested, and the "style" or mouth is very different; (tubular and considerably elongated in F. Virginica). The stems are much shorter, the leaves larger, and the perianth very different from F. Eboracensis.

Frullania Sullivans, Aust.

F. digyna; caule arcte adpresso vage breviter ramoso; foliis subrotundis convexis integerrimis obtusis, auricula magna galata rotunda latitudinem folii square cauli approximata; amphigastriis obovatis obtuse bifidis subintegerrimis caule parce latioribus illis versus perianthium oblongis cuneatis; lobis obtusissimis vel supræmum acutis; perianthio obovato subcompresso brevi rostrato, dorso minute 1.—2—nervosæ, ventre unicarinato, carina biangulata bialatave; involuci foliis rotundis cum perianthio et uno alterove cum amphigastriis connatis, lobulis paralellis subaequalibus, (ventrali ½—¾ angustiori).

On the bark of trees, Georgia, Sullivant; also South Carolina, Curtis (in Herb. Sulliv).

Differs from F. infotata, Nees, in the fewer and less distinct nerves on the back of the much more compressed perianth, in the shorter amphigastria. in the auricle placed close to the stem, &c.; and from F. Oakesiana in the different perianth, smaller auricle, more unequal lobes of the involucral leaves, &c.

Frullania Oakesiana, Aust.

F. monogyna; caule vage ramoso intricato, ramulis fertilibus brevibus suberectis; foliis suboblique orbiculatis laxe imbricatis subconvexis margine leniter repandis, auriculis maximiis (folia fere aquantibus) rotundatis cucullato-galeatis cauli fere continguis, lobo dilatato interjecto nulo vel fere obsoleti; amphigastriis ovato-rotundis vel subobovatis caule parce latioribus bifidis integerrimis subserratis; perianthio parvo subobovato subinfato ventre late carinato, utrineque varie numero (1—7) nervosæ vel alato, caeteroquin lavi; involucrificoli bilobis integerrimis cum amphigastriis uno alterove subsaeat connatis, lobis equilabilibus obtusis paralellis.

On the bark of Betula excelsa, in the region of the White Mountains of New Hampshire, Oaks.

A small species, scarcely as large as F. Eboracensis, and of a reddish color. Remarkable for the very large auricle (more than ⅔ the diameter of the leaf,) for the more or less connate involucral leaves, and for the extremely variable number of rib-like nerves of the small, subinflated perianth.

Frullania Bolanderi, Austin MSS., (1865.)

F. trigyna? caule repente inordinata fasciculatin ramo flagelifer, ramis fructiferis adscendent-erectis clavatis; foliis parvis imbricatis oblique orbiculatis convexis marginatis, basi in auriculam magnam orbiculatam galeatum compressam (subus concavam) margine crassiusculam basi integram complicatis; amphigastriis subpatentibus miniimis orbiculatis subobovatis bifidis, lobis obtusis vel acute oblongis integerrimis vel plumereque repando-dentatis serratis; foliis involucralibus duplo vel triplo majoribus appressincusulis cum amphigastriis alte connatis; perianthio potius magno compreso inaequiliter triangulari obovato-elliptico, dorso concavo vel demum convexincusulo leniter bicostato versus apicem breviter et inaequiliter 2—4 nervoso, ventre obtuse unicarinato versus apicem leniter bicostato, caeteroquin lavi.

[Dec.]
On the bark of *Negundo aceroides*, "Tomaes Bay," California, Bolander, (1864).

The flagellæ are nearly erect, about as high as the fertile branches, and clothed on the underside with crowded, squarrose amphigastria, but are without leaves except at the apex, where these are crowded into little tufts or heads, and are not mixed with amphigastria.

A small species; scarcely as large as *F. Elboracensis* (which has somewhat similar flagellæ), and differing from it chiefly in the 2—4 nerves on the back of the perianth, in the involucral leaves connate with the amphigastria, and in the compressed (much as in *F. squarrosa*) auricle of the leaf.

**Frullania Leana, Aust.**

*F. pusilla, rufo-brunnea; caule brevi—; foliis rotundato-ovatis obtusis omnino crassiusculis apiculatis, auriculis fere maximis subcylindricis obliquis a caule valde distantibus oblongo-areolatis basi dependente distincte crenulato-dentatis; amphigastriis majusculis oblongis bisädibus integerrimis planis rectis caulis latitudinem parce excedentibus; perianthio et basi subattenuata obovato-oblongo multum exserto levii dorso plano ventre uniarinato apice subtruncato, rete ad basin maximo oblongo supra medium minuto heteromorpho maxime stelliformi; involucri foliis cum amphigastriis (semper?) connatis margine sinuato-dentatis, lobulis plus minus incisis erectis parallellis, amphigastriis valde majoribus parce inciso-dentatis.

On trees near Cincinnati, Ohio, T. G. Lea (in Herb. Tayl. mixed with *Lejeunia longiflora*).

Remarkable for the very large, oblong, distant auricle, obtusely dentate at the base, and for the thickish, apiculate leaves.

A very small species. about the size of *F. Drummondii*, Tayl.; from which, however, it is readily distinguished by its more imbricated, apiculate leaves, by the much larger auricle very distant from the stem, and with a very distinct tooth-like lobe on the margin of the leaf close to its base. The perianth is also differently areolated, and the perichactal leaves are toothed on the lower lobe, or even incised.

**Frullania Mauritiana, Aust.**

*F. tetragyna (semper?); caule bi—tripinnato flexuoso; foliis siccatis caulem subcircumvolutis madefactis patentibus e basi valde angustata oblique (subfalcato—) ovatis, apice deflexo-incursiva longiusculis acuminatis apiculatis, rete e cellulis (marginatibus subrotundis exceptis) angustis linearibus oblongisae plus minus sininosis in centro subhyalinis, intersticiis latissimis (quam cellulis parce latioribus) obscuris confluentibus instructo; auricula oblongo-cylindrica mediocri oblique et apice distantibus; amphigastriis et basi angusta late obovato-planiusculis vel margine versus basin subrecurvis ad 3—4 bisädibus, sibum angusto obtuso, lobis acutis, perianthio obovato, dorso levii, ventre uniarinato, apice longe rostrato; foliis amphigastroisque involucralibus erectis adpressis, lobis ovato lanceolatis inciso-serratis.

Island of Mauritius. Communicated by Prof. Chas. H. Peck.

Readily recognized by the very narrow base, acuminate apex, and narrow subsinuous cells of the subfalcate leaf; by the large, subcylindric, oblique auricle distant from the stem; by the nearly plane and strongly incised lobes of the involucral leaves and amphigastria. The lower margin of the leaf, between the auricle and the stem, is narrowly but distinctly inflexed; it is also furnished with a minute, cilia-like tooth, which is close to the auricle, and composed of about six roundish cells arranged in a single row.

**Frullania orrificialis, Aust.**

*F. monogyna; caule lato extenso bi—tripinnatim decomposito circa 3 unciali, ramulis plus minus divaricato-recursivis; foliis laxe imbricatis majusculis oblique ovatis vel ovali-auriculiformibus convexis subpellucidis, apice 1869.]
obtuso plus minus decurvis, rete e cellulis minutis subrotundis margine sinuatis, illis ad basia valde majoribus obscureis, intersticiis latis subobscuris instructo; auricula tecta cucullata valde compressa parva subovali cauli ad- proximata; amphigastriae magnis orbicularibus planis apice integris vel rare subemarginatis margine leniter repandis; perianthio oblongo subexsero, dorso plano convexo, ventre (carina valde compressa) unica sinato; involuci folla semicordato-ovatis acutis integerrimis vel subundulato-repandis, lobulo longiori lineari-setaceo canaliculato, amphigastria elongato-lanceolatis profunde bifidis subintegerrimis.


Readily distinguished from *F. interistipula*, Nees, by the fertile flower containing but a single pistil, by the orbicular amphigastria plane on the margins, by the cucullate, suboval, compressed auricle, &c.

**Fossombronia Crystula, Aust.**

*F. minuta*, albescens; caule perbrevis (1—2 lineas longo) arcte repentis recurvatis vel fastigiatim diviso, radicibus plurumque purpureis terrae affixo; foliis angulariter lobulatis subintegrisse quadratis vel obovato-rotundis sub- differribus plurumque basi subangulatis atque apice valde undulato-crassissatis; perianthio fere ut in *F. psylla*; involucro nullo? capsula in pedicello brevissimo immersa; sporis pallido-fuscis parce subgrosseque tuberculata circa 1-600—1-700 unc., metentibus; elateribus delicatissimis hyalinis uncellularibus brevibus crassissulis plus minus differribus, fibro tennissimo pallido-fusco annulari et spirali (plerumque partim annulari ac partim spirali) depictis.—*Hep. Bor. Amer. Erzic. ined.*, No. 121.

On damp sand, associated with *Diciarum cervicatum* and *Jungermannia crumulata*, in an unfrequent path, near Butsto, New Jersey, (Oct., 1868).

Remarkable for its small size, and very delicate, often somewhat branched elaters of more or less variable shapes (much as in the *Anthocerotae*), and with the single fibre usually partly annular and partly spiral in the same example! Antheridia few and large, oval or roundish obovate, nearly sessile on the back of the stem. Pistillidia (about 20) somewhat crowded towards the apex of the stem, above the antheridia, and just below the perianth, and partially immersed in the stem; not involucrate, or very imperfectly so.

**Androcryphia longiseta.**

*Fossombronia longiseta*, Austin, MSS, 1864.

A. dioica; caule suberecto vel depresso 3—4 lin. longo e dorso proliferoso, radicibus purpureis terrae affingenti; folla pallidis subimbriicatis subhorizontalibus subquadratis lobis plurumque obtusis undulato-lobulatis subintegrisse inferioribus nonnullis parvis, involucralibus plurumque valde majoribus subtillabelliformibus basi nonnullo attenuatis ac in tubulum cum caulis apice confluentibus; perianthio plurumque magno campanulato varie modo inciso vel subincentro; pedicello longiusculo (4—6 lin. alt.) tenui basi in caulis apice longe incluso; capsula irregulariter lacerata magna calyctram (et nonnullo perianthium) implementi; sporis subangularebus subangularebus valde muricatis; elateribus longiusculis bispiris.

On the ground among mosses. California, Bolander; Texas, Wright.

A variable species. The perianthia often smallish, but frequently very large; sometimes divided to the base into 2—3 flabelliform divisions and again nearly entire, the smaller ones undulate and crisped at the mouth; the larger ones often nearly entire and nearly plane at the mouth. The upper leaves are more or less involucrate, with their bases often costa-form, and more or less united into a tube and confluent into the stem. Pistillidia quite numerous, at first naked and scattered on the back of the stem (as in *Fossombronia*). Stem frequently bearing a descending tuber underneath the perianth, and usually considerably extending beyond it. On the prostrate stems the leaves are often
broader than long, and subhorizontal; on the ascending ones they are more or less attenuated and 1—2 costate at the base, and erect or nearly so. In length the style is 1½ times, and the elaters 3—5 times, the diameter of a spore. Spores with more numerous and larger muriculae than in *Fossombronia pusilla.*

Separated from *Fossombronia* chiefly by its dioecious inflorescence, and by the perianth being (apparently at least) an expansion of the apex of the stem.

**Plagiochaeta erythrosperma,** Sulliv. in Herb.

P. fronde expanso-ovata (3—5 lin. lat.) pallido-viridi rugulosa late fuscescente marginata, subitus dense radiculosa squamosaque; squamis albidis setaceo-incisis versus apicem ultra marginem exstantibus; pedunculo 5—8 lineas alto basi nudo apice paleaceo; sporis aurantiaceo-rubris tuberculatis; elateribus 4-spiris.

Rocky Mountains, E. Hall.

Remarkable for the red spores, and for the white, fringe-like scales extending beyond the margin of the frond towards the apex.

**Sauteria limbata.**

? *Grimaltlia limbata,* Austin, MSS., 1895.

S. fronde obovato-oblonga subdichotoma concava reticulato-papulosa hæte viridi latissime marginata, subitus nigro-purpurea valde incrassata, margin nigro-purpurea membranacea subplicata undulato-crenata involuto-incurva; squamis arcte imbricatis sanguineo-purpureis, inferioribus amplis obliquis bicornibus nodoso-dentatis juxta marginem positis, superioribus majoribus lanceolatis attenuatis frondis margine superantibus incurvis; pedunculo subtus pallido nudo, receptaculo femino 1—3-carpo, subitus multum sed breviter paleaceo.

Under wet rocks. California, Bolander. (No. 4619.)

Remarkable for the broad, wavy, dark purple, membranaceous margin of the frond. The scales towards the apex of the frond increase in size and become abruptly two-horned; these horns (laciniae) are very long and narrow, and extend beyond the margin of the frond as a strongly inflexed fringe; the very apical ones are triangular-subulate or setaceus, bifid or entire, and extend still farther beyond the margin of the frond, and in the fertile plant they become (by age) whitish. Pedicel sulcate, naked at the base. Receptacle very obtuse (1-fruited in our meagre specimen).

? *Sauteria crassipes,* Aust.

? S. fronde obcordata subcuneatasse bifida fuscescente-purpurea vel viridi supra subpapuloso-reticulata minutissime porosa, squamis venalibus purpuris apicem superantibus; pedunculo brevisculo (6—8 lin. alto) parcissime paleaceo, circa basin nudo vel parce barbato-involucrato, versus apicem incrassato; receptaculo femino 4—7 inciso-lobato, subitusque eodem numero carpo brevissime submultumque paleaceo; capsula firmuscula distincte pedicellata; elateribus tris (quadrir?) spiris; magis immatura.


I have doubtfully referred this species to *Sauteria.* It resembles *Priessia* very much,—also, in some respects, *Duvalia.* It is remarkable for the pedicel being much thickened towards the apex. There are occasionally a few scale-like palea on the peduncle, and a few filamentose scales or hairs on the frond about its base. Involucre rather large, somewhat flattish, fuscous-green tinged with purple, and it bears as many capsules, underneath around the margin, as there are lobes. On account of the immature state of the specimens, it is not possible to tell in what manner the capsule ruptures.

? *Duvalia intermedia,* Aust.

? D. fronde partiuscula obcordata subcuneatasse subbifida concava (2—4 lin. longa 1—2 lin. lata) laxe texta crassiuscula anguste albidio submarginata 1869.]
vesiculoso-striolata in ætate valde foelata, subitus plus minus purpurea et squamigerula, squamis purpureis margine non attingentibus; pedunculo frondi continuo longiusculo nigro-purpureo, basi apiceque multum ac totò longitudine parissime albo-paleaceo; involucro hemisphaerico, apice papuloso-caverno-\noso; capsula sessili vel brevissime pedicellata supra medium deopercula; sporis flavis tuberculatis subpellucidó cinctis; elateribus bispiris.


The general appearance of the peduncle and of the involucre is that of a Grimaldia, but the loose texture of the involucre and of the frond are as in Duvalit, and it is difficult to decide to which of these, probably too closely allied genera, our plant belongs.

Fimbriaria Bolanderi, Austin, MSS. 1865.

F. fronde anguste linearí (1½—2 lin. lata, 6—10 lin. longa) solida indi-

F. fronde anguste linearí (1½—2 lin. lata, 6—10 lin. longa) solida indis-

F. fronde anguste linearí (1½—2 lin. lata, 6—10 lin. longa) solida indis-

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F. fronde carnosá vesiculosa incressata subpalmatim vel furcastim lobata, supra subelevato-papulosa eporsa, laciniis subobovatis madefactis margine erecto-appressis vel subinvolutis; squamis fusco-purpureis versus apicem margines excedentibus; pedunculis singulis vel binis circa 3 proculibus robustis plures canaliculato-cretis fere nudis, basi non involucratis; receptaculo femino depresse-hemisphaerico vesiculoso 3—6 (et ultra) -carpo; perianthii brevisculis subobovatis tenuissimis albidis subsex.—octofidis, laciniis subconcretis; capsula subglobosa operculo subsinusus deopercula; sporis luteis grosse tuberculatis; elateribus trispiris.


Remarkable for the thick vesiculose frond, with the margins more strongly erect or involute when moist than when dry! (in fact, when moistened it is too hard to be flattened out); also for the about six-fruit, flattish, fertile receptacle, and very delicate perianth, which sometimes burst through its upper surface.

Anthoceros scariosus, Aust.

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-

Fronde pallido-viridi lacunoso-striata sublamellatave, laciniis flabelli-
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Remarkable for the somewhat lamellated surface of the frond and involucre; the latter with a very broad, abrupt, subcontracted, scarious margin, which usually forms nearly half its length.

CRYPTOCARPUS, (gen. nov.) Aust. MSS., 1864.


A genus intermediate between Riccia and Sphacrocarpus, having the characters of vegetation and spores of the latter, while the fruit is immersed in the frond as in the former genus. Represented by a single species, which occurs both in the Southern States and in France.

CRYPTOCARPUS CURTISH, Aust. MSS., 1864. Riccia Curtisi, James, in Herb. (fide Curtis).

Frond exserta valde imbricata fibroso-papulata, lacinii inciso-lobulatissimae marginis crenatis; sporangios maximis in statu siccati latentibus sed frondes humefactae sunt in substantia earum ut maculis nigris apparentibus; sporis fusco-nigris valde maculatis.

On moist ground, South Carolina, Ravenel (in Herb. Sulliv., 1849). North Carolina, Curtis (l.c., 1853). "Moutaud après Marseille" (Herb. Lamning, "ex Herb. Torrey").

To the naked eye the dried specimens look like little heaps of some filamentose conferva. In this state the frond is very brittle, and, on account of its loose texture, appears to be deeply pitted and fibrose and papulose above. Upon moistening the specimens the fronds become tough (much as in the Anthoceroteae), the upper surface loses its pitted appearance, and the stipes (apparent fibres) between the large cells close up; and the fruit, which was completely hidden before, now appears as a black spot in the substance of the frond. Upon re-drying the specimens the fronds become much thinner than they were at first, and the fruit remains visible, protruding from the upper surface. The frond is larger than in Sphacrocarpus Micheliit, from the Southern States, but lobed and reticulated in the same manner. The extreme apices of the lobes are often suddenly contracted and subsolid (much as is often seen in the Anthoceroteae). The base of the divisions are contracted and subsolid, and the rootlets are smooth on the interior surface as in Sphacrocarpus. The divisions are flabelliform, and palmately or incised-lobed, and lie so closely over one another as to be separated with difficulty, the upper ones, by their numerous long rootlets, knitting firmly to the pitted surface of those immediately beneath them. The lobes are crenate and obtuse, not emarginate, extremely thin and hyaline. Spores firmly united in fours into a sort of coccus which is deeply 4-lobed, and very beautiful under the lens,—more deeply lobed than in Sphacrocarpus terrestris and more finely reticulated and papillose. [From narrowed places in the divisions (as it were sinuses) there appears to arise young plants, folded over on the back of the parent frond in such a manner that they seem to arise out of its back near the margin. Whether this really is the case, or only apparent, can only be determined by fresh specimens.]

RICCA ALBIDA, Sulliv., in Herb., 1853.

R. frondes solida albida alternatim bifurcatis ter divisa; lobis (4—4 lin. lat.) oblongis creberrimis anguste profundeque sulcatis, apice rotundatis sub-emarginatis, subitus subsquamosis valde radiculosis; epidermide superiore (nisi in canalis fundo) spongioso-papulosa profunde foveolata quam frondis substantia crassiori; fructi ignote.

Texas, Dr. Charles Wright.

1869.]
This species is remarkable for its thick, spongy epidermis of a whitish color, much as in *R. bullosa*, Link.; but that is a much larger species, with the lobes of the frond not so much crowded, and with the upper surface rugulose.


*R. fronde* solida subcelliata incassata orbiculari subradiatim pluries divisa subgeregario-imbricata in diametro 4—8 lineari, supra papulooso-recticulata obscure viridi vel denum secus margines purpurea, subitus nuda vel obsolete squamosa valde obtuseque carinato-incassata ob sporangia tumentia valde nodosa; lobis obitususculis obsolete emarginatis lineari-ellipticis vel fere linearibus dichotomis versus apicem incassatem leniter dilatatis, apice in statu juniori subadscendentibus vix canaliculatis, in atate horizontalibus subcompresso-accuminatis evidentiis lateque sulcatis, margine planis acutis (in aspectu incassatis obtusisque); ciliis albidis brevissimis omnino inconspicuis subobsoletiis; fructibus primum versus apicem loborum infra canalem aggregatis, sporis angularibus fusco-atriis reticulato-muricatis—*Hep. Bor. Amer. Exsic. ined.*, No. 141.


On damp ground in cultivated fields and (the var.) in rocky places about Closter, New Jersey, common.

The canal occupies about 1/4 of the upper surface of the frond, and has a plane or slightly convex bottom with abrupt sides. That portion of the frond between the canal and the central face is slightly convex above as if thickened. The typical form appears to be near *R. paradoza*, De Not., but that is described as being a smaller species, and the spores are said to be light-red. The var. differs from *R. cilifera*, Link., in the fronds being purple and more or less scale-bearing underneath, and not membranaceous on the margin. The sporangia are placed rather towards the apex of the lobes as in *R. palmata*, Lindbg.; which appears to be a larger species, with the lobes of the frond concave-canaliculate above, &c., and seems to be intermediate between this and the following species:


*R. fronde* solida subcelliata orbicularata stellatim vel subcruciatim divisa incassata, supra punctato-recticulata glauco vel cineraceo-viridi epidermide macula purpurea supra fructum notata, subitus nuda concolor vel denum purpurascente; lacinis bilobis vel di-trichotomia obcordatis lineari-cuneatissimae (2—5 lin. longis 1—2 lin. latissimae) leniter concavo-canaliculatis, apice emarginatis brevi sulcatis, margin bisruto-ciliatis incassatis obtusis subadscendentibus ad apicem subinvolutis; ciliis crassimbrevis libidibus obtusis in statu juniori subobsoletis; fructibus sporis non seriatis subbasilaribus, sporis fusco-atriis angularibus reticulatis: gemmis? numerosissimis ellipticis sternimbris in frondis facie superiori versus loborum apicem positis quam sporis triplo minoribus.—*Hep. Bor. Amer. Exsic. ined.*, N. 143.

Var **α**, cruciata. Fronde cruciatim parce divisa, lacinii ciliisque brevissimis.

Var **β**, trichotoma. Fronde magis divisa, lacinii ciliisque longioribus.

The var **α** occurs almost exclusively on damp ground in cultivated fields; the var. **α** on rocky soil, associated with the var. of the preceding species, and with *R. sorocarpa* and *R. lamellosa*.

*R. palmata*, Lindbg., a closely related species, is described as having the frond palmately lobed and the divisions broadly sulcate, with the cilia arranged in a single series. *R. Bischofii*, Huben, has the margin of the frond membranaceous, the lobes much expanded, and spores twice as large! The var. **α** has much the appearance of *R. bifurca*, Hoffm., as figured in Lindbg. Monogr. d. Ricc. T. XX, f. 1, but that has the margin of the frond naked.
R. terrerstris, velutina, valde cavernosa, fulgida, luteo-viridis; fronde orbiculari cellulo-so-ucculenta radiatim pluries divisa diametro subsemipoli- cari; lacinii di-trichotomis linearibus (vel in statu juniori subbeneatis) subimbricatis canaliculatis, apice tenuiori angustiori emarginatis, subitus carinato-incresiassati concoloribus nudis (vel ut in R. fluenta ob epidermide evanida ad apicem minute squamigerulis), margine undique tenuibus sub- hyalinis crispato-undulatis cum serie cellularum singularum hyalinum circumdatis crenulatisque in statu siccati omnino adascendentibus ad apicem que subrectcis, carina cavernoso-straata copiose radiculosa ob sporangia subius tumenti; fructibus copiosis simis e frondis pagina superiori prorumpentibus; sporangii supra non prominentibus in carina immersis singulatim natis stylo longo nigro coronatis, sporis obscure angularibus reticulatis sub- muricatis luteo-fuscis vel nigris.—Ilep. Bor. Amer. Etsic. ined., No. 147.—R. crystallina, Sulliv. Mosses of the U. S. p. 84. pro parte.

On damp or wet ground, in fields and meadows, about Closter, New Jersey; also Pennsylvania, Lesquereux.

R. Sullivantii resembles both small forms of R. crysallina and terrestrial forms of R. fluenta, Linn., but the former is distinguished by its less divided frond with the divisions plane above and expanded towards the apex; and the latter by its diverse lobes somewhat thickened at the apex, by its fewer and smaller air-cavities, and by its sporangia rupturing underneath the frond, as well as by its shorter style and smoother spores.

[There are occasionally found, imbedded in large cavities on the underside of the frond, a bundle of rootlets, matted or coiled together. These rootlets are apparently longer than those which fix the plants to the earth, and have the interior surface papillose (a character common to the rootlets of all Riccia). Their free end is much expanded and open at the extremity, and towards this extremity they are filled with cubical green bodies, arranged (mostly) in fours, and resembling the spores of a Conferta. What these bodies are is doubtful; it is barely possible that they are a sort of reproductive organ belonging to the plant in whose tube-like rootlets they occur.]

Riccia tenuis, Aust.

R. frondo tenuissima valde cavernosa fibroso-nervosa saturate vel olivaceo- viridi fulgida parce divisa, subitus parciissime squamosa concolorre, squamis albidis tenuissimis ligulatis; lacinii rotundo-ovatis (2—4 lin. long. 1—3 lin. lat.) planus, marginine sinuato-undulatis, subitus ob costam tenuem anguste carinatis, ad solum radiucibus parciissimis tenuissimis affingentibus; fructibus in nervo sitis, sporangii parvis depresso-globosis plerumque 2—4 aggregatis in frondis pagina inferiori protuberantibus sed e neutra prorumpentibus, calyptra tenuissima laxissime texta frondis substantiam arcte adherenti stylo brevissimo apice praemorsum (non dilatatum) coronata, sporis parvis globosis vel subovalibus fuscis valde echinacea-muricatis.—Ilep. Bor. Amer. Exsic. ined., No. 150.

On wet, broken ground in open woods, near Closter, New Jersey; also near Lawrence, N. J., James.

The closely allied R. membranacea, L. & G., differs in the sub-cavernous frond with the lobes suddenly widened and subsuculate towards the apex, in the oblong-rotund sporangia, and longer style dilated at the apex. R. nigrescens, Mont., is doubtless also very near our plant, but the margins of the frond are said to be ascending,—furthermore, the description is altogether too meagre.

Riccia natans, Linn.

The spores of this species vegetate upon mud in summer, and by autumn the young plants become considerably developed: (vide Aust. Hep. Exsic. ined. N. 144, B.; also Lindbg. Monogr. d. Ricc. t. 26, f. 1, under the name of R. 1869.)
lutescens.) They are suborbicular in outline, lobed and rooting underneath, as in the true terrestrial species. They also have rudimentary scales at the apices of the lobes underneath. These fronds become immersed by the autumn rains, and during the winter the apices of the lobes thicken and expand greatly. These apices being destitute of rootlets and extremely buoyant, gradually assume a vertical position in the bottom of the pool, and at length (in the spring) become detached and rise to the surface of the water, (where they float in a horizontal position,) often carrying with them portions of the effete base of the frond. In the meantime the scales develop into long purple fringes. These floating apices alone constitute the L. nutans of Linnaeus and authors; (vide Aust. Hep. Exsic. N. 144, A.; also Lindbg. Monogr., p. 115, t. 31 and 32; etc.) They fruit copiously in the vicinity of Albany, N. Y., in the months of May and June (Prof. C. H. Peck). Sometimes the autumn fronds do not become immersed, in this case they remain whole; again the fertile fronds are often left upon the mud by the dessication of the pool in summer; in this case they are plainly continuous from the apex: (vide Hep. Exsic. N. 145; also Herb. Tayl. (in part), under the name of "Riccia velutina.—N. Amer. Drummond.")

Riccia lutescens, Schweinitz.

A single frond only of this species was found by me in Sept. 1858, at Closter, N. J. This frond contained a single sporangium! which is about as in R. crystallina. The spores are also as in that species. During the past eight years I have not only watched this plant in all the stages of its growth, from the time of its first appearance in the month of June, until its final disappearance in winter, but have collected many specimens of it in the mature state. I have also received numerous specimens of it from many localities, from New England to Canada and Missouri; but not a single one of these specimens shows any trace either of fruit or other kind of reproductive organ whatever! and it is still a mystery how the plant reproduces itself. The young plants make their appearance in great profusion, in the bottoms of exsiccated ditches, &c., in the beginning of summer. These rapidly develop into the sterile plant, which has been most accurately described and figured by Mr. Sullivan: (Mem. Amer. Acad. Arts & Sci. (Boston) 4, p. 176, t. 4.) No rootlets are produced underneath the frond above the middle; and as the ditches become filled with water late in autumn, the fragile laciniae break asunder near the middle, in consequence of the extreme buoyancy of their apices. The detached pieces (or apices) rise to the surface of the water, where they remain suspended in an oblique position (the extreme apex only reaching the surface), until they become frozen up in the ice. Upon the ice disappearing in the spring, no trace of any portion of the plant is to be found!

The following reports were read, and referred to the Publication Committee:

REPORT OF THE CURATORS.

In presenting the annual report, the Curators embrace the opportunity of congratulating the Academy on the near prospect of procuring a new and suitable building to accommodate its now crowded and ever increasing collections, both of the museum and library. A plan of the building prepared by Mr. Windrum, the architect, at the suggestion of and in conjunction with a committee of the trustees of the building fund, has been approved by the latter. It is proposed to commence with the foundation of the building, the coming spring, on the fine property obtained by the contributors of the building fund, on the southwest corner of 19th and Race streets, and opposite the beautiful Logan Square. The style of the building is college gothic,
180 feet in length on Race street, and 65 feet in breadth fronting on 19th street. It is to be fire proof, and it is proposed to construct the walls of green serpentine ornamented with Ohio stone. The estimated cost is about $125,000, to which we hope an enlightened public, fully appreciating the importance of such an institution as the Academy, will liberally contribute.

The collections of the museum are in their usual condition of preservation, but for want of proper space generally excessively crowded, often partially or totally unarranged, and in some cases in the utmost confusion. The Museum is now too extensive to depend wholly on voluntary labor for its being properly arranged, labeled and catalogued. To accomplish this it is necessary to employ competent persons, and it is to be hoped that before long an effort will be made on the part of the Academy to procure the means essential to the purpose.

The increased attractiveness of the Museum of the Academy, and the almost unrestricted admission of the public, have led to such an increase in the number of visitors as greatly to endanger the condition of the more perishable portions of the collection. During the year the Museum, though open to the public only two afternoons weekly, and though closed during August for cleansing and repairs, was visited by nearly 100,000 persons. In a single afternoon recently there were upwards of 4,500 persons admitted to the Museum. In consequence of the very small amount of unoccupied room the visitors move in nearly continued streams through the narrow intervals of the cabinets, affording little opportunity for the examination of specimens. Beside this disadvantage to those who would really wish to examine the collections, the crowds lead to many accidents, the sum total of which amounts to a considerable destruction of property, in the way of broken glass, light wood work, &c. Further, the excessive clouds of dust produced by the moving crowds, rest upon the horizontal cases, obscuring from view their contents, while it penetrates others much to the detriment of parts of the collection. An annoyance arising from the great number of visitors is due to the necessity of having tickets of admission, provided gratuitously from members of the Academy or from agents authorized to issue them by the Curators.

In view of all these annoyances, inconveniences and detriment to the Museum, attendant on an excessive number of visitors, the Curators would suggest to the Academy the propriety of making a small charge for admission, as the best means of qualifying or removing the various difficulties indicated. The Curators recommend the charge of a small fee, say ten cents, which will probably be sufficient to moderate the crowds of visitors, and at the same time will be no obstruction to those who are desirous of seeing the Museum. Of course it is not intended to restrict the right of members to visit the Academy in company with their friends at any and at all times according to their convenience.

The donations during the year, to the different departments of the Museum, are as follows:

Mammals.—Two skins and the skeleton of a Lemur, together with the skins of several other mammals from Port Natal, Africa, were presented by the Rev. S. A. Grout. Five other mammals were presented by Dr. James M. Green, U. S. N., Prof. S. D. Gross, George Davidson and John Krider.

Birds.—A special report, on the condition of the ornithological cabinet, has been prepared by the standing committee and is appended to the present one. Two collections of bird skins from San Domingo, were presented by Wm. M. Gabb; another from Port Natal by the Rev. S. A. Grout; and a collection from St. Martins, W. I., by Dr. H. E. van Rijgersma. A mounted specimen of the Golden Eagle was presented by Frank L. Altemus; a Lophophorus impeyanus from Asia, by the Rev. J. L. Scott; and a small collection of birds, in alcohol, from South America, by Prof. E. D. Cope. Specimens of birds were also presented by John Krider, Harvey E. Molé, W. P. Turnbull, [1869.]
Mr. Haines and D. G. Elliot. A small collection of bird eggs, from Sable Island, was presented by J. R. Willis.

Reptiles.—A collection of fifteen species from Africa, thirteen from Asia, and nine from Australia, together with five jars of specimens from Uruguay, one jar from New Grenada and other specimens from South America were presented by Prof. E. D. Cope. Two small collections, comprising eighteen species from San Domingo, were presented by Wm. M. Gabb. A small collection from St. Martins, W. I., was presented by Dr. Rijgersma; another from Port Natal, by Rev. S. A. Grout; and three jars from Venezuela, by L. Morgan Davis. Specimens were likewise presented by George Davidson, Dr. Hassler, L. P. Whiting, Capt. J. Barclay, John Krider, Joseph Jeanes and Joseph A. Damon.

Fishes.—Two collections, one of forty-one specimens of twenty-five species, and another of many specimens of sixteen species, from St. Martins, W. I., were presented by Dr. R. E. van Rijgersma of Philipsburg, St. Martins, W. I. Other specimens were presented by Mr. Gabb, A. H. Smith, Dr. I. Hays, Dr. Howel and Jos. Jeanes.

Mollusks.—For the principal donations we refer to the report of the Conservator of the Conchological Section of the Academy.

In addition there were presented two species of cephalopods by Dr. Rijgersma, and small collections of shells by Wm. M. Gabb, Rev. S. A. Grout, Dr. Leconte and S. Powel.

Articulates.—Two collections, comprising seventy specimens of crustaceans, two jars of spiders and one of insects from St. Martins, W. I., were presented by Dr. R. E. van Rijgersma. A collection of myriapods and insects from Port Natal, W. A., was presented by Rev. S. A. Grout; and a jar of myriapods, arachnides and insects from Lower California, by Alfred DuBois. Specimens of crustacea were also presented by George Davidson and Dr. F. A. Genth.

Radiates, &c.—A collection of twelve asteroids, six corals, a large Gorgonia and five species of sponges, from St. Martins, were presented by Dr. Rijgersma. Six species of Echini and Ophiura and a Madrepore, from San Domingo, were presented by Wm. M. Gabb. Several corals were presented by Dr. Hassler, several radiates by S. Powel, and two specimens of Euplectella by the latter and Mr. Crawford Coates.

Fossils.—An additional portion of the Poirier collection, of vertebrate remains from the miocene and post pliocene formations of the basin of the Loire, France, was presented at the expense of Messrs. E. S. Whelan, Richard Wood, Benjamin Marsh, S. Morris Waln and Wistar Morris. A collection from France and Greece, consisting of remains of Mastodon angustidens, the Cave Bear, Horse, Hipparion, Reindeer, and specimens of prehistoric works of human art, together with casts in plaster of others, was presented by Prof. Ed. Lartet of Paris. A collection of Devonian plants, twenty-four species, from near St. John, N. B., was presented by the Natural History Society of that place. A collection of corals from the corniferous limestone of Canada West, many specimens of twenty-three species, presented by Prof. J. W. Dawson of Montreal. A collection of fragments of several species of extinct turtles, the specimen from which the insectiverous mammal Oromys Caryteri was described, and a slab of bituminous shale with cipoid fishes from near Fort Bridger, Wyoming, were presented by Mr. J. Van A. Carter. A collection of fossil plants was presented by Dr. F. V. Hayden; of infusorial earths by the Smithsonian Institution; of fossil corals by Mr. Sidney S. Lyons; and of fossil cetacean bones from Ashley R., S. C., by Dr. James C. Booth. Teeth of horses and sharks were presented by Thomas H. Streets, H. W. Faucett, Charles Conrad and Dr. H. S. Chapman. Specimens of ceta-
Ocean bones were presented by the latter and C. W. Matthews. Other fossil specimens were presented by Col. James Greer, Wm. M. Gabb, Mr. Horabush, W. Morrison, A. H. Smith, Dr. J. Leconte, T. H. Streets, T. Guilford Smith, Enoch L. Johnson, Louis Godoy, P. T. Tyson and George Davidson.

Minerals.—A small collection was presented by T. Guilford Smith. Specimens were also received from Alexander E. Dougherty, J. Blodget Britton, C. W. Matthews, Joseph Wilcox, J. Lawrence Smith, Isaac Lea, John L. LeConte, George Davidson, T. D. Rand, P. W. Sheaffer, Capt. J. Barclay, Mr. Tyson, W. McKee Mason, W. L. Mactier and Joseph Leidy. A few others were also obtained in exchange.

Botany.—A series of Juneci representing the monograph of Dr. Engleman, and a series of Potamogeton, collected by Dr. J. W. Robbins, were presented by Mr. E. Durand. A rare fern was presented by Mr. Redfield.

Comparative Anatomy.—A skull of Hyperaodon bidens and other portions of the skeleton, from Newport R. I., were presented by Samuel Powell. An artificially elongated human skull from the vicinity of Lake Titicaca, Bolivia, was presented by Dr. J. M. Greene, U. S. N. A collection of bones of the Bison, Wolf, Deer, &c., was presented by Prof. Hayden. Remains of Indian skeletons were presented by Prof. Cope; the jaw of a Dolphin and several teeth of the Sperm Whale, by Dr. Rijgersma, and portions of human muscles with Trichinæ, by Dr. J. S. Hough.

Miscellaneous.—Nine jars of vertebrates from St. Martins, W. I., were presented by Dr. Rijgersma. Seven specimens were presented by Prof. S. D. Gross, and several by unknown donors.

Respectfully submitted by

JOSEPH LEIDY,
Chairman of the Curators.

REPORT OF THE ORNITHOLOGICAL COMMITTEE.

The Committee begs leave to report that the following named donations to the collection of birds have been made during the year 1869:

March.—2 specimens of Lagopus mutus, 1 specimen of Lagopus islandorum, presented by D. G. Elliott. 1 specimen of Accipiter Cooperii, presented by Mr. Haines.

April.—A specimen of Aythya Americana, (variety), 1 specimen of Corvus Americanus, (albino), 1 specimen of Cairina moschata, 1 specimen of Gracula musica, presented by Jno. Krider. 2 specimens of Pica abolarvatus, ♂♀ presented by Wm. P. Turnbull. 1 specimen of Lophophorus impexus, ♂ presented by J. L. Scott.

May.—Sundry specimens in alcohol, presented by E. D. Cope. 1 mounted specimen of Larus argentatus, presented by H. E. Molé. 6 mounted specimens (5 species) of birds from St. Martins, W. D., presented by H. E. Van Rijgersma.

July.—A mounted specimen of Aquila chrysetos, presented by F. L. Altens. And a collection of skins from Port Natal, Africa, presented by S. A. Gront.

August.—Collection of 30 specimens of skins from St. Domingo, presented by Wm. M. Gabb.

October.—Collection of eggs from Sable Island, presented by J. R. Millis.

December.—21 specimens of skins from St. Domingo, presented by Wm. M. Gabb.

The Committee would further state, that since last spring the work of over-1869.]
looking and poisoning the entire collection of birds has been going on, and is
now nearly completed. Almost every mounted bird has been examined, dis-
infected and the cases cleaned. It was found that there was no time to lose in
this work, as many specimens had been attacked by insects, and further delay
might have occasioned the loss of a portion of our collection which could
probably never be replaced. The remaining cases will soon be gone through.

The Committee cannot too strongly urge the necessity of such an examina-
tion being made, if not annually, at least once in two years, even should it
involve some expense to the Academy to secure the preservation of the best
collection of birds on this continent, and, with one exception, the largest in
the world.

By permission and special vote of the Academy, a duplicate specimen of the
rare egg of the Great Auk (Alca imperennis) was presented to the Smithsonian
Institution at Washington. In addition to some rare and valuable bird skins
this Institution intends giving us from late expeditions to Alaska and the
North-West, there is being made up for this Academy a collection of eggs,
many of value and interest, procured mostly from Arctic America. But we
are badly off for a place to put them, the present cabinets of eggs being nearly
full and in too dark a room to be of any use for study. We would, therefore,
ask that some appropriation be made for additional cabinets, and also that
the whole be placed in a more suitable part of the building.

The Committee recommends that permission be given to sell (or exchange)
the duplicate bird skins packed away in chests and drawers, some now in-
jured by insects, and which, in a few years, may become seriously damaged;
the proceeds of such sales to be appropriated to the purchase of specimens
wanted, and that might be procured in this way, and especially of newly
discovered species, our additions to which, for the last five or six years, have
been far behind other Ornithological Museums in this country and elsewhere,
and consequently has brought our collection to a comparative stand still.

The Committee would also call attention to that portion of the Library de-
oted to Ornithology. Since the death of the late Dr. Wilson, only such books
on the subject then going on in parts, and for which he made appropriation,
have been continued, thereby causing some leading periodicals and other
works to be dropped, thus impairing the value of the whole as a Library of
reference. Very many important books published during the last few years are
wanted, and to keep up with the present state of Ornithological Science
throughout the world, it is necessary that students should be able to refer to
the latest and best authors.

Respectfully submitted.

BERNARD A. HOOPES, Chairman.
WM. P. TURNBULL.
EDWIN SHEPPARD.

LIBRARIAN'S REPORT.

The Librarian respectfully reports that the number of additions to the
Library from January to December, 1869, inclusive, amounts to 1131.
Of these 183 were volumes, and 946 pamphlets and parts of periodicals.
They were derived from the following sources:
Societies, 440; Editors, 200; Authors, 102; Wilson Fund, 177; Library
Fund, 76; purchased, 51; Norwegian Government, 13; Geo. W. Tryon, Jr., 10;
Jos. Jeannes, 8; Treasury Department, 8; Publishers, 6; Minister of Public
Works in France, 6; John Warner, 4; Isaac Lea, 4; Messrs. Townsend and
Adams, 7; Smithsonian Inst., 3; M. de Caligny, 4; Surgeon General, 1; J. D.
Whitney, 1; General Humphreys, 1; Thos. Meehan, 1; Department of Educa-
[Dec.
tion, 1; Navy Department, 1; L. H. Morgan, 1; Dr. Hassler, 1; Sanitary Commission, 1; Dr. H. C. Wood, Jr., 1; in exchange, 1; Don Rafael Arango, 1. Total, 1131.

And were divided as follows:
Journals, 798; Conchology, 149; Geology, 46; General Natural History, 46; Botany, 21; Ornithology, 20; Bibliography, 9; Entomology, 8; Anatomy and Physiology, 7; Herpetology, 6; Physical Science, 5; Helminthology, 5; Mineralogy, 3; Voyages and Travels, 3; History, 3; Chemistry, 2.

Of these 10 volumes and 91 pamphlets were received through the Conchological Section.

The duplicate works which have accumulated from time to time have been catalogued, priced and packed, preparatory to sending them to Wm. Wood & Co., of New York, for sale. Selections from these duplicates to the value of $150.00 have been exchanged by the Library Committee for a copy of Elliot's Birds of North America.

During the year the books in the Conchological Department have been newly catalogued and numbered. The latter arrangement has been productive of all the good results anticipated, and demonstrates the necessity of extending the same system of numbering throughout the entire library, at as early a date as possible.

All of which is respectfully submitted.

EDW. J. NOLAN, Librarian.

REPORT OF THE RECORDING SECRETARY.

During the year ending November 30th, 1869, there have been elected thirty-three members and eleven correspondents.

The death of the following members and correspondents have been announced.
Mr. John Cassin, Mr. Chas. N. Bancker, Mr. Jason L. Fenemore, Dr. Chas. D. Meigs, Mr. Fred. Klett.

Four correspondents, namely: Frederick Cailliaud, Herman Von Meyer, Mr. George J. Durham, Dr. T. H. Turner, U. S. A.

The number of papers contributed and ordered to be printed in the Proceedings and Journal during the year has been thirty-six, as follows:

In the Proceedings thirty-three, namely:
Prof. Joseph Leidy.......................... 2  |  Prof. E. D. Cope.......................... 7
F. B. Meek & A. H. Worthen.................. 5  |  Thomas Meechan........................... 4
George N. Lawrence.......................... 1  |  Elliott Cones............................ 1
Dr. John L. LeConte.......................... 3  |  Isaac Lea.................................. 3
John Cassin.................................. 1  |  Capt. C. M. Scammon (edited by
Jacob Ennis.................................. 1  |  E. D. Cope............................... 1
Dr. W. W. Keen................................ 1  |  Dr. C. Johnson............................ 1
Robert Ridgway................................ 1  |  Dr. J. G. Richardson..................... 1

In the Journal, namely:
J. Barnard Davis, 1; Alphouzo Wood, 1; Jos. Leidy, including all the Nos. of Vol. 7.

There were four papers recommended to be printed in the American Journal of Medical Sciences, namely:
Dr. William Pepper......................... 1  |  Dr. Christopher Johnson.................. 1
Dr. James Tyson............................. 1  |  Dr. S. W. Mitchell........................ 1

One paper to be published in a Medical Journal to be selected by the author,
Dr. J. G. Richardson.

There were four papers withdrawn by their authors, namely:
E. D. Cope, papers 165, 179 and 180.

Mr. Cassin's paper No. 168, withdrawn by Mr. B. A. Hoopes.

All of which is respectfully submitted.

SAMUEL B. HOWELL, Recording Secretary.

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REPORTS OF THE CONCHOLOGICAL SECTION.

RECORDE R'S REPORT.

During the year ending Dec. 2d, 1869, there have been elected one member and three correspondents.
One member has resigned.
Papers have been accepted for publication in the Journal, by the following authors:

T. A. Conrad, 5  John H. Redfield.........  1
G. W. Tryon, Jr.................  9  S. R. Roberts.........  1
W. M. Gabb, Jr..................  5  Theo. Gill, M.D........  1
W. Harper Pease .................  3  W. H. Dall...............  1
Jas. Lewis, M.D................  2  Ralph Tate..............  1
Temple Prime....................  1  Wesley Newcomb, M.D....  2
Binney and Bland...............  1  J. G. Cooper, M.D.......  2

Respectfully submitted,
S. R. Roberts, Recorder.

CORRESPONDING SECRETARY'S REPORT.

To the Conchological Section of the Academy of Natural Sciences, Philadelphia:
The Corresponding Secretary would respectfully report that letters have been forwarded and received as follows, viz.:

1868. Dec. 31.—To Dr. Leopold von Schrenck, St. Petersbrg., with publications.
May 13.—To Luigi Benoit, Messina, letter of acknowledgement.
May 21.—To Dr. H. E. v. Rijgersma, St. Martins, W. I., soliciting collections.
To W. B. Pryor, Esq., Shanghai, China, soliciting collections.
June 11.—To Prof. Joseph Henry, Smithsonian Institution, soliciting publications.
June 22.—To the Société Malacologique de Belgique, Bruxelles, exchange of publications.
To E. A. Bielz, Hermanstadt, Transylvania, exchanges.
To Bulletino Malacologico Italiano, Pisa, for exchange of publications.
June 23.—To R. J. Leechmere Guppy, Trinidad, exchange of specimens.
Nov. 5.—To Sylvanus Hanley, Middlesex, England, letter of acknowledge ment.
The following letters have been received:
1868. Dec. 29.—M. de Malzine, Bruxelles, with publications.
Mons. Terver, Lyons, France, acknowledgment of election.
Dr. Leopold von Schrenck, St. Petersbrg, with publications.
Arthur Morelet, Dijon, France, letter of acknowledgment.
Frederick Calliaud, Nantes, France.
Feb. 4.—T. B. Bourningnat, acknowledgment.
Feb. 16.—F. M. Souverbie, Bordeaux, acknowledgment of election.
Capt. J. Mitchell, Madras, with publications.
March 4.—L. H. Abbott, Boston, letter of acknowledgment.
March 30.—F. de Malzine, Brussels, proposals for exchange.
S. L. Abbott, Boston, with publications.
E. C. Bolles, Portland, Me., acknowledgment of publications.
Leon Vaillant, Paris, acknowledgement of election.
L. Chenu, Paris, acknowledgment of election.
Prof. O. A. L. Mörch, Copenhagen, with paper for publication.

May 12.—Luigi Benoit, Messina, acknowledgment of case of shells.
August 5.—D. C. Gentiluomo, Pisa, exchange of publications.
Oct. 16.—Sylvanus Hanley, Middlesex, Eng., with case of shells.
E. A. Bielz, Hermanstadt, with publications.
Oct. 29.—W. A. Pryer, Shanghai, China, information as to collecting shells.

All of which is respectfully submitted.

Philad., Dec. 1, 1869.

E. R. Beadle, Corres. Sec'y.

LIBRARIAN'S REPORT.

The Librarian respectfully reports that there have been presented during the past year to the library of the Conchological Section 10 volumes, 91 pamphlets and one map. Of these 34 were received from authors, 20 from editors, 30 from Societies, 5 from the Publication Committee, 1 from Wm. M. Gabb, 1 from Don Rafael Arango, 10 from George W. Tryon, Jr., and one from the Smithsonian Institution.

In addition, thirty-two pamphlets, volumes and continuations of Conchological works have been received through the Academy.

During the year the Catalogue has been carefully revised, and the books numbered, with the effect of greatly lessening the labor of those referring to them.


CONSERVATOR'S REPORT.

The Conservator of the Conchological Section respectfully reports that the donations to the Cabinet during the year have been as follows:

From Isaac Lea. Nineteen species of Unionide from Ouachita, Arkansas, Chamostrea albida, Roissy, with oscule, from New South Wales, and twelve species of shells from the island of Andaman, Bay of Bengal.

E. R. Beadle. Three species of Unio, Auricula aurismidea, Liu, and two unknown species from Asia; also a Trochus from the West Indies, and Trivia sulcata, Dillw.

John Ford. Seven specimens of Busicon aruanum from Atlantic City, five specimens of Natica heros from Brigantine Beach, N. J., and types of Astarte nubigena, Ford.

F. V. Hayden, M.D. Numerous specimens of Helix Cooperi, Bland, and H. Haydeni, Gabb, from Weber Canon, near Salt Lake City.


J. L. LeConte. Type specimens of five species of Melania described by Isaac Lea.

Wm. M. Gabb. Eleven species of Unio from Central America and twenty-four species of land shells from San Domingo, personally collected; including several undescribed species.

Ralph Tate. Seventy-seven species, numerous specimens of land and fresh-water shells from Central America, Venezuela, Guayana and Nicaragua, including types of several new species described in our Journal; also nineteen species of land shells from Venezuela and the island of San Lucia, W. I., mostly undescribed.

1869.]
W. H. Pease. Seventy-nine species of marine shells from the Polynesian Seas, including types of new species.

R. E. C. Spears. Sixty-four species of marine, fresh-water and land shells, principally from California, Oregon, South Carolina and Florida, and seven species from Tampa Bay.

F. A. Hassler, M.D. Fine specimen of Marginella carne,a, Storer, fine series of Livinaea columella, and embryos of Vivipar a Nolani and Buyleon carica.


W. S. W. Ruschenberger. Two hundred and twenty-seven species, principally marine mollusca, personally collected by the donor.

Dr. J. C. Cox. Two hundred and twenty-three species land, fresh-water and marine shells of Australia, New Caledonia and adjacent islands, including types of many new species.


Smithsonian Institution. Five hundred land, fresh-water and marine shells, carefully named by Mr. P. P. Carpenter.

Luigi Benoît. One hundred and eighty-six species of land shells from Sicily, including types of most of his descriptions.


Sylvanus Hanley. Four hundred and four species of land, fresh-water and marine shells, principally European, but including a number of rare East Indian shells, some of them undescribed.

Paul Tevere. One hundred and seventy-six species of European land and fresh-water shells.

Smaller collections have been received from Gabriel Duqué, E. H. Jenks, Prof. J. Powell, Edw. D. Cope, G. A. Lathrop, Mrs. Lewis, Dr. Jos. Leidy, C. W. Peale, Dr. James Lewis, Dr. Samuel Lewis, A. H. Smith, John Wolf, J. R. Willis, Dr. Harrison Allen and W. L. Macler.

The number of species presented during the year amounts to about 2150, many of them new to the collection, and a yet greater number from localities not heretofore represented.

The systematic arrangement of the collection has proceeded from the Pholadidae to the end of the Tellinidae. The thanks of the Section are due to Messrs. Parker, Roberts, and Hassler, who have devoted a considerable amount of time to this work, and have succeeded in perfecting an arrangement of the specimens which has been much admired for its neatness, as well as for the opportunity it gives the student of studying, without disturbing the shells.

During the year we have continued to receive collections from many of our foreign correspondents, as will be seen by reference to the list of donations given above. The following collections have been sent in exchange by the Section: One hundred species of American shells to Luigi Benoît, accompanied by a list of Sicilian species desired by us; eighty species to Aug. Brot, and types of Mr. Gabb's new species to H. Crosse. A collection of our duplicate Veneridae has been forwarded to Dr. Edw. Römer, to assist him in preparing for the Section a catalogue and synonymy of the Veneridae, which work he has kindly undertaken to perform.

All of which is respectfully submitted.

Edward J. Nolan, Conservator.
The election of Officers for the ensuing year was held, in accordance with the By-Laws, with the following result:

**President**..................... W. S. W. Ruschenberger, M.D.,

**Vice-Presidents**................ Wm. S. Vaux,
Jos. Carson, M. D.

**Corresponding Secretary**........ Edw. D. Cope.

**Librarian**....................... Edw. J. Nolan, M. D.

**Treasurer**....................... Wm. C. Henszey.

**Curators**...................... Jos. Leidy, M. D.,
Wm. S. Vaux,
Geo. W. Tryon,
Edw. D. Cope.

**Council**........................ Isaac Lea,
Isaac Hayes, M. D.,
Robert Bridges, M. D.,
Edw. S. Whelen.

**Publication Committee**.......... Jos. Leidy, M. D.,
Robt. Bridges, M. D.,
Wm. S. Vaux,
Jas. Tyson, M. D.,
Edw. J. Nolan, M. D.

**Committee on Finance**.......... Robt. Bridges, M. D.,
Wm. S. Vaux,
A. H. Smith.
ELECTIONS FOR 1869.

Members and Correspondents of the Academy of Natural Sciences have been elected as follows for the year 1869:

MEMBERS.

Dec. 29, 1868.—Albert Peale, Edw. A. Spooner, M. D., Franklin Platt, Jr.
Jan. 26, 1869.—William M. Wilson, Caleb S. Hallowell, R. J. Levis, M. D.
Feb. 23.—Hector Tyndale, Theodore Cuyler, William Dulty, Charles Morris.
March 30.—John Birkinhine, James Greer, Dayton O., Douglass R. Bannan, M. D., U. S. N., George C. Henszey.
April 27.—Isaac S. Fogg, J. S. Withron, John C. Sinclair.
June 29.—N. Roe Bradner, M. D.
April 27.—Henry Bower.
May 25.—William B. Corbit, William Rudder, Persifor Frazer.
June 29.—Harry Emlen, Charles B. Nancrede, M. D.
July 29.—Chas. L. Cassin, M. D., U. S. N.
Sept. 28.—W. H. Finn, M. D.
Nov. 30.—Henry C. Miller, Z. M. Humphrey.
Number of members elected in 1869.......................... .......................... 33

CORRESPONDENTS.

Dec. 29, 1868.—George Neville, Calcutta, E. I., Joseph F. Berg, New Brunswick, N. J.
June 29, 1869.—Alexander Carte, Dublin.
April 27.—F. Curtis, M. D.
April 27.—Albany Hancock, New-Castle-upon-Tyne, Eng.
Aug. 31.—A. Kölliker, Nathaniel H. Bishop.
Sept. 28.—Geo. H. Cook, New Brunswick, N. J.
Number of correspondents elected in 1869.......................... 11
Members, 33; correspondents, 11. Total, 44.
CORRESPONDENCE OF THE ACADEMY,
For 1869.

January.—Dr. C. A. Martius, announcing the death of Herr Dr. Carl Fried- rich Philipp von Martius.

William M. Darlington, acknowledging receipt of notice of election as member.

J. S. Wilson, acknowledging receipt of notice of election as correspondent.

John R. Willis, with collection of fishes forwarded.

R. Osten Sacken, asking that a wood cut be sent to A. S. Packard.

Joseph F. Berg, acknowledging receipt of notice of election as correspondent.

James Orton, acknowledging receipt of birds sent.

Wistar Morris, with check for $100, and making suggestions in regard to the location of the proposed new building.

A. J. Morrison, returning thanks for permission to visit museum.

Elías Lewis, Jr., asking permission to visit museum and library.

H. V. Poiziez, in regard to sale of a collection of specimens.

Thos. Earkins, in regard to collection shipped from France.

John Tomes;

A. Milne Edwards;

Samuel Haughton;

T. Spencer Cobbold; severally acknowledging receipt of notice of election as correspondent.

Royal Society of Edinburgh;

Société Royale des Sciences à Upsal;

Académie Royale des Sciences à Amsterdam; severally acknowledging receipt of Journal and Proceedings.

Institut Impérial de France;

Bibliotheca Universitatis Lugduno-Batavæ; each acknowledging receipt of Journal and Proceedings, and asking that deficiencies be supplied.

Société de Physique et d'Histoire Naturelle de Genève;

L'Université Royale de Norvège à Christiania; each with publications, and also acknowledging receipt of Journal and Proceedings.

Smithsonian Institution;

Die Gesellschaft für Beförderung der Naturwissenschaften zu Freiburg;

Die Naturforschende Gesellschaft des Osterlandes zu Altenburg;

Die Naturforschende Gesellschaft zu Basel, Switzerland;

Naturforschende Gesellschaft zu Halle;

Bataafsch Genootschap der Proefondervindelijke Wijsbegeerte te Rotterdam;

Die Königliche Gesellschaft der Wissenschaften zu Göttingen;

Museum at Bergen, Norway;

Royal Society of Northern Antiquities at Copenhagen;

City Library at Hannover;

Königlich Preußischen Akademie der Wissenschaften;

Die Naturforschende Gesellschaft zu Freiburg Leopoldino-Carolinische Deutsche;

Academie der Naturforscher;

Académie Royale des Sciences à Amsterdam;

Société Royale des Sciences à Upsal;

Der Naturforscher Verein zu Riga;
Société Hollandaise des Sciences à Harlem; 
Musée public de Buenos Aires; 
Kaiserliche Akademie der Wissenschaften; 
Fürstlich Jablonowskiischen Gesellschaft zu Leipzig; 
Société Hollandaise des Sciences à Harlem; 
Königliche öffentliche Bibliothek zu Dresden; severally acknowledging receipt of Proceedings.

Prof. J. Henry, with specimens for microscopic examination.

Institut Royal Météorologique des Pays-Bas, acknowledging receipt of donation to library.

F. A. Randall, in regard to shells left at the Academy.

Henry Woodard, in regard to paying for fossils.

D. Lindley, with box of specimens sent.

B. Waterhouse Hawkins, acknowledging receipt of resolutions.

Kgl. Norske Universitet Christiania, asking for a duplicate set of the Academy's publications.

February.—Der Naturwissenschaftliche Verein für das Furstenthum Lüneburg; 
Edinburgh Geological Society; 
Gesellschaft Naturforschender Freunde zu Berlin; severally with publications.

J. S. Latimer; 
A. A. Breneman; 
W. Kitchen Parker; 
Dr. H. E. van Rijgersma; severally acknowledging receipt of notice of election as correspondents.

Lyceum of Natural History; 
Surgeon-General's Office; 
Library of Essex Institute; 
K. K. Zoologisch-botanische Gesellschaft in Wien; 
Verein für vaterlandische Naturkunde in Württemburg; 
Smithsonian Institution; severally acknowledging receipt of Proceedings.

E. B. Worthington, wishing to purchase glass eyes for bird skins.

F. W. Putnam, declining to print paper, etc.

A. S. Bickmore, asking for a lecturer.

C. T. Seiss, asking information in regard to membership.

C. Hering, asking for a specimen.

A. Boucard, offering to send specimens of insects, etc.

March.—Congrès International d'Archéologie Préhistorique à Copenhague, with organization, programme, etc.

Smithsonian Institution; 
Essex Institute; 
Lyceum of Natural History; 
American Antiquarian Society; severally acknowledging receipt of Journal.

Die Naturforschende Gesellschaft in Dantzig; 
Académie Royale des Sciences de Lisbonne; 
Utrecht Society of Arts and Sciences; 
Academia Real das Ciencias de Lisboa; 
Naturhistorischer Verein der preussischen Rheinlande und Westphalens; severally acknowledging receipt of Journal and Proceedings.

Marquis de Caligney; 
Samuel Haughton; each acknowledging receipt of diploma.

Theo. Cuyler, acknowledging receipt of notice of election.

Société Linnéenne de Bordeaux, asking for missing numbers of publications of the Acad. Nat. Sci., and presenting publications.

Société Linnéenne de Lyon; 
Institut Royal Météorologique des Pays-Bas; each with publications.

Edw. Rhoads, M.D., giving notice of change of residence.
CORRESPONDENCE.

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Samuel Powell, calling attention to a magic lantern.
Andrew Sherwood, offering to collect for the Acad. Nat. Sci.
Herman Poole, in regard to the formation of a Natural History Society in
Cornell University.
Geo. T. Knight, giving information of a collection for sale.
W. B. Pryr, in regard to collections at Shanghai.
J. E. LeCompt, in regard to Fin-back whale.
A. Horner, Jr., resignation of membership.
J. W. Dawson, with specimens for museum.
A. S. Bickmore, inquiring for Prof. Ebell.
Université Catholique de Louvain, acknowledging receipt of Journal and
Proceedings.
Gesellschaft der Wissenschaften, with publications, and acknowledging re-
ceipt of Journal and Proceedings.
April.—Académie Royal des Sciences, des Lettres et des Beaux-Arts;
Société Entomologique de France;
Boston Society of Natural History; severally with publications.
Société Impériale des Naturalistes de Moscou;
Société Liégeoise de Bordeaux; each acknowledging receipt of Journal and
Proceedings.
Prof. Henry, in regard to skeletons of Batrachia, etc.
Geo. Neville, acknowledging receipt of notice of election as correspondent.
Wm. M. Wilson, acknowledging receipt of notice of election as member.
Carrington & Co., in regard to sending freight to the Amazon.
Fred. Franck, in regard to sending freight to St. Domingo.
Wm. C. Henszey, Treas., with list of members who have paid initiation fee.
Auguste F. Müller, in regard to Expedition to the Amazon.
E. P. Borden, in regard to bark "Trinity."
Jos. Jeanes, resignation of position as auditor.
Société des Sciences, Physiques et Naturelles de Bordeaux, asking for miss-
ing numbers of publications of Acad. Nat. Sci.
May.—Lyceum of Natural History;
Portland Society of Natural History;
Hof und Staatsbibliothek München; each acknowledging receipt of Pro-
ceedings.
K. B. Akademie de Wissenschaften, acknowledging receipt of Journal and
Proceedings.
Smithsonian Institution, with collection of birds from Alaska.
Mrs. Willard Parker, in regard to box sent to the Acad. Nat. Sci.
John J. Lawson, Sr., in regard to the skeleton of a whale.
Prof. Baird, in regard to monograph on Cetacea.
Jas. Orton, in regard to Hauxwell’s collections.
Zool. Botan. Gesellschaft zu Wien, asking for missing numbers of the publi-
cations of the Acad. Nat. Sci.
Albany Hancock, acknowledging receipt of notice of election as corres-
pondent.
B. Waterhouse Hawkins, acknowledging receipt of notice of election as
member.
C. S. West, announcing the death of Geo. J. Durham, a correspondent of
the Acad. Nat. Sci.
Manchester Scientific Students Association, with publications.
Antonio Stoppani, announcing the death of Abbe Joseph Stabile, a corres-
pondent of the Academy.
June.—Schweizerische Gesellschaft, Bern;
Naturforschende Gesellschaft zu Bamberg;
Der Naturforscher-Verein zu Riga;
Naturforschende Gesellschaft in Bern; severally acknowledging receipt of
Proceedings.
Société Impériale d’Agriculture de Lyon, with publications, and asking for missing numbers of the publications of the Acad. Nat. Sci.
Naturforschenden Gesellschaft in Bern, with publications.
L’Académie Royale Suedoise des Sciences, Stockholm, with publications, and asking for missing numbers of Journal.
John Speedechey Golch, in regard to making collections in Australia.
Chris. Rünnebaum.

**July.**—Smithsonian Institution. Magyar tudományos Akadémia, with donation to Library.
New York State Library;
Académie Royale des Sciences de Belgique, severally acknowledging the receipt of Proceedings.
Boston Society of Natural History, acknowledging receipts of Journal and Proceedings.

L. J. Deal, with resignation of J. J. Stephenson's membership.
Smithsonian Institution, thanks for egg of Great Auk.
Public Library of Boston, acknowledging receipts of two pamphlets.
Dr. J. S. Billings, asking to borrow books.
Harry Eueln, acknowledging receipt of notice of election as a member.

**August.**—Essex Institute, acknowledging receipt of Proceedings.
Akademie der Wissenschaften, Berlin;
Naturhistorischer Verein in Ausburg;
Naturforschende Gesellschaft zu Halle, severally with publications.
Literary and Philosophical Society of Manchester with publication, and asking for missing numbers of publications of Acad. Nat. Sci.
Société de Physique et d'Histoire Naturelle de Genève with publication, and acknowledging receipt of Journal and Proceedings.

Geo. H. Cook, in regard to bones of Mosasaurus.
Vanderhorst & Boegler, package received from Holland for Acad. Nat. Sci.
Jas. Backhouse, in regard to naturalist in Australia.
D. H. Storer, in regard to report on fish of Massachusetts.
Chas. L. Cassin, M.D.;
Wm. B. Corbit, each acknowledging receipt of notice of election as member.


**September.**—Naturforschende Gesellschaft in Zürich, acknowledging receipt of Proceedings.

H. W. Hollowbush, in regard to minerals.
J. Aitken Meigs, with address of F. E. Rendon, M.D.
J. C. Spear, acknowledging receipt of notice of election as member.
Geo. Davidson, with specimens sent Acad. Nat. Sci.
J. E. Hilger, with report of the coast survey.
Stettin Eutomol. Verein, asking for missing numbers of Proceedings.
J. Wyman;
Peabody Institute, each acknowledging receipt of Synopsis of Batrachia, etc.
J. Stauffer, S. Lockwood, O. N. Bryan, E. Cones.

**October.**—Geo. H. Cook, acknowledging receipt of notice of election as correspondent.
Samuel A. Harrison, in regard to a fossil bone.
Lyceum of Natural History, acknowledging receipt of Journal and Proceedings.

Essex Institute;
Naturforschende Gesellschaft in Danzig, each acknowledging receipt of Proceedings.
Naturforschende Verein in Brün, acknowledging receipt of Proceedings and sending publication.

J. H. Blake;
J. A. Allen, each acknowledging receipt of paper on Cetacea.
E. N. Horstford, in regard to six-toed cat.
Vanderhorst & Boegler, in regard to package from Holland.
John T. Morris, invitation to see freezing apparatus.
A. M. Boyd, in regard to sending specimens.
Dr. J. T. Boynton.
J. R. Willis, asking that diploma be sent.
Thos. Meehan, with address of Dr. Mueller.
E. D. Bassett, in regard to collections in Hayti.
T. W. Hoyt, asking for copy of Constitution.
A. E. Verrell, in regard to Chinese reptiles.
B. F. Mudge, in regard to fossils in Kansas.
Dr. H. E. van Rijgersma, in regard to collections in St. Martins.
H. W. Hollowbush, in regard to fossil wood.
N. G. Macomber, acknowledging receipt of notice of election as member.

November.—New York State Library;
Library of Congress, each acknowledging receipt of Journal.
Wm. Smith, asking in what way he can serve the Acad. Nat. Sci.
Jas. Orton, asking in regard to specimens.
Edward Hitchcock, offering to lend fossil bones.
J. N. Jocelyn, in regard to "Nature."
J. F. Peck, in regard to white fish.
J. A. Hauxwell, in regard to making collections.
W. H. Finn, M.D., acknowledging receipt of notice of election as member.
G. A. Williams, in regard to an exchange of specimens.

December.—Prof. Edward Hitchcock, with box of specimens.
F. W. Packard, in regard to the McNeil reptiles.
J. A. Allen, offering to send paper on Massachusetts Mammalia.
Prof. Henry, asking the return of skulls belonging to Smithsonian Institution.
Schweizerisch Naturforschender Gesellschaft Berné, with publication.
Christine Hood, in regard to six-toed cat.
J. A. Allen, with copy of paper.
G. H. Lawson, asking information in regard to the Acad. Nat. Sci.

Whole number of letters received during 1869, 218.
* " " " written " " 137.

Edward D. Cope,
Corresponding Secretary.

* Number of letters written in 1868 and not printed with the report last year, 153.
DONATIONS TO THE LIBRARY.

1869.

JOURNALS AND PERIODICALS.

SWEDEN.


NORWAY.

Christiania. Forhandlinger i Videnskabs-Selsdabet i Christiania, Aar 1867, 1868. From the Society.

Registre til Christiania Videnskabs selskabs Forhandlinger. 1858—1867. From the Society.


Norsk Meteorologisk Aarbog for 1867, 1868. From the Meteorological Society.


Tre Akademiske Taler paa Universitets Aarsfest den 2den September af M. J. Mourad. 1863. From the Society.

Det K. Norske Frederiks Universitets aarsberetning for Aaret 1867 med Bilage. 1868. From the University.

DENMARK.

Kiobenhaven. oversigt over det K. d. Videnskabernes Selskabs Forhandlinger. 1867, Nos. 6 and 7. 1868, Nos. 1—4. 1869, No. 1. 1867—1869. From the Society.


RUSSIA.


Bidrag till kännedom af Finlands natur och Folk utgifna af Finska Vetenskaps-Societetens. 11e—14e Häftet, 1868, 1869. From the Society.

Acta Societatis Scientiarum Fennicae. Tomus VIII. 1867. From the Society.
DONATIONS TO LIBRARY.


HOLLAND.


Jaarboek van de Akademie van Wetenschappen gevestigd te Amsterdam. 1867. From the Society.


Rotterdam. Nieuwe Verhandelingen van het Bataafsch Genootschap der Prof. fondeer-vindelijke Wijsbegeerte te Rotterdam. Tweede Reeks, Eerste Deel, 1, 2 and 3 Stuk. 1867. From the Society.


GERMANY.

Altenburg. Mittheilungen aus dem Osterlande. 18er Band, 3es und 4es Heft. 1868. From the Society.


Zeitschrift der Deutschen geologischen Gesellschaft. XX Band, 3 Heft, to XXI Band, 3 Heft. From the Society.


Wochenschrift des Vereines zur Beförderung des Gartenbaues in den K.
Preussischen Staaten für Gärtnerei und Pflanzenkunde. Nos. 29 et seq. 1868. From the Society.


Mathematische und Physikalische Abhandlungen der K. Akademie der Wissenschaften zu Berlin, 1867, 1868. From the Society.


Bremen. Abhandlungen herausgegeben vom Naturwissenschaftlichen Vereine zu Bremen. 2 Band, 1 Heft. Bremen, 1869. From the Society.


Novorum Actorum Academiae Cesareae Leopolldino-Carolinae Germaniae Natura Curiosorum. 34 Vol., 1868. From the Society.

Darmstadt. Notizblatt des Vereins für Erdkunde und verwandte Wissenschaften zu Darmstadt und des Mittelrheinischen geologischen Verein. III Folge, 6 and 7 Heft. From the Society.


Freiburg. Berichte über die Verhandlungen der Naturforschenden Gesellschaft zu Freiburg, J. B. Band V, Heft 1, 1868. From the Society.


Halle. Abhandlungen der Naturforschenden Gesellschaft zu Halle. 10er Band, 3es und 4es Heft, and 11er Band, 1es Heft. From the Society.


Zeitschrift für Wissenschaftliche Zoologie. 18er Band, 4es Heft, to 19er Band, 3es Heft. Purchased.


Abhandlungen der Historischen Classe der K. B. Akademie der Wissenschaften. 10ten Bandes, 3e Abth. Philosophisch-Philologischen Classe. 11ten Bandes, 2e Abth. 1867. From the Society.
Mathematikai és Természettudományi Kazlemények vonatkozolag a hazai Viszonyokra Kiágy a Magyar Tudom. Akad. IV. Kötet. 1865, 1866. From the Society.
Légüni Eeziulete. 1 Kö tet, 1866. From the Hungarian Academy.
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January 4th.

Mr. J. D. Sergeant in the Chair.

Twenty-one members present.

Dr. McQuillen remarked that, in conjunction with Mr. Walmsley, he had made some attempts to mount blood corpuscles in such way as should maintain their natural shape. In solutions of glycerine and water, the form of the corpuscle of the frog had rapidly altered, but Mr. Walmsley had mounted some in glycerine jelly which remained unaltered up to date.

Dr. Tyson stated that to expect success with the aqueous preservative fluids was scarcely reasonable, unless a menstruum were used identical in its specific gravity with the liquor sanguinis of the blood. Such a solution can be obtained with glycerine and distilled water, in the proportion about 1/2 of Bourn's glycerine to 1/2 of distilled water, and if one part of carbolic acid be added to 100 parts of the mixture, a suitable preservative fluid is obtained for many animal tissues.

January 18th.

Director S. W. Mitchell, M. D., in the Chair.

Twenty-four members present.

Dr. Wood exhibited to the department four species of the genus Sirosiphon, all of which he stated to be new to North America, and three entirely undescribed. One of them had been found growing on the face of a wet rock on the banks of the Wissahicon, by Dr. J. Gibbons Hunt, from whom he had received specimens. These are referable to Sirosiphon pulvinatus of Europe.

Two of the new species were collected in South Carolina, by Prof. H. W. Ravenel, who sent them to Dr. Billings, U. S. A., to whom Dr. W. stated he was indebted for the specimens. The following are the descriptions:

S. lignicola.—S. strato expanso, tomentoso, atro; trichomatibus ramosissimis, arcte intertextis; ramulis abbreviatis vel elongatis, subrectis aut varie curvatis, apice obtuso rotundatis vel subacuminatis; trichomatum et ramulorum cellulis internis uni-biseriatis, plerumque pachydermaticis, dilute vel saturate äruginéis, enormibus, plerumque homogeneis terminalibus elon-
gatis, cylindricis, sæpium nonnihil oscillarium modo articulatis, granulosus; vaginis sat amplis, haud acrolois, vel luteo brunneo, vel fuscentibus vel ferrugineis.

Diam. Trich. C. V. max \( \frac{1}{2} \) "

For the second species the specific name of \( gUltula \) was proposed, from its habit of forming little drop like dots on the bark on which it grows. The following is the specific description.

*S. philoiophilum*, in maculis subnigris, parvis, tenuibus, plerumque rotundatis, interdum enormibus, dispositum; trichomatibus arce intertextis, ramossimis, rigidis, inaequalibus, subcylindricis, nonnihil contortis; ramulis abbreviatis vel nonnihil elongatis, apice obtuse rotundatis; ramulorum et trichomatum cellulis tri-multiseriatis, plerumque pachydermaticis, ferrugineo-fuscis, enormiter globosis, homogeneis; cellulis apiculibus interdum breve cylindricis, haud articulatis; vaginis sat amplis, luteo-brunneis vel dilute ferrugineo-brunneis.

Diam. Max. trich. cum vag. \( \frac{1}{2} \) "

The other new species had been found growing in some stagnant water, with a number of other algae in New Jersey. The filaments were widely separated and were so large as to be visible to the naked eye. The following is the specific description:

**Strosspon Disjunctum.**—*S. trichomatis subsolitariis, longis usque ad lineas quatuor, cylindricis, ramossis; ramulis singulis; cytoplasmate interdum erigineo, plerumque aureo-brunneo, in ramulorum apice interdum nullis sed plerumque in cylindricis longis oscillarium nonnihil modo articulatis; cellulis internis uniseriatis, rare biseriatis, subglobosis, interdum sejunctis, plerumque arce connectis et moniliformibus, modo confluentibus, haud pachydermaticis; cellulis interstitialibus nullis; vaginis acrolois, interdum brunneis.

Diam. Trich. cum vag. \( \frac{1}{2} \) "; sine vag. \( \frac{1}{2} \) "

Mr. W. H. Walmsley exhibited a slide showing an unrecognised larva which he found infesting the potato, and which he believes to be a cause of the potato rot, so common in the potatoes at present in the market.

Dr. McQuillen exhibited specimens of *Trichina spiralis*, from a patient recently dead of phthisis pulmonalis, at the Philadelphia Hospital. They were detected by Dr. Hough, a resident physician at the Hospital. No symptoms indicating their presence were noted previous to death.

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**February 1st.**

Director S. W. Mitchell, M. D., in the Chair.

Nineteen members present.

Dr. H. C. Wood exhibited to the section what he believed to be a new genus of fresh water algae. He found the plant floating upon the Schuykill River. It consists of a subglobular, bright green, firm, gelatinous thallus, the outer portions of which are so condensed as to give the appearance of a periderm, although there is no real periderm present. The trichomata or filaments radiate from the inner part of the frond towards the outer surface, but many of them have their origin in the outer parts of the thallus. They are branched, and are remarkable for the fact, that they are furnished with
large globular heterocysts raised on short branches. No distinct sheaths were visible; everywhere between the filaments was a uniform jelly.

The following are the generic and specific characters:

Genus Nostochopsis. Thallus definitus, trichomata ramosa; cellulis perdurantibus in latere sessilibus aut in ramulis brevissimis superpositis.

C. lobata.—C. thallo viride aut luteo-viride, cavo, enormiter lobato, natante, modice magno, (ad 0.5 unc in diametro); trichomatibus plerumque longis, flexuosis, viride, modo inarticulatis, partim articulatis, cylindricis aut submoniliformibus, sparse granulatis.

February 15th.
Director S. W. Mitchell, M. D., in the Chair.
Twenty-two members present.

March 1st.
Director S. W. Mitchell, M. D., in the Chair.
Twenty-six members present.

Dr. R. J. Lewis exhibited two pathological specimens illustrating embolism,—one, an embolus, three inches long, from the external iliac artery; the second, a gangrenous hand, in which the condition was induced by embolism of the brachial artery.

March 15th.
Director S. W. Mitchell, M. D., in the Chair.
Twenty-two members present.

April 5th.
Dr. Ruschenberger in the Chair.
Twenty-two members present.

Dr. J. G. Hunt remarked, that in a specimen of Cissus in his possession, he had recently noticed in the leaves such an exuberant growth that the parenchyma actually burst through the cuticle. That he had also noted, growing in its vicinity, a specimen of the Cuscuta, which soon embraced the Cissus, and by its parasitic rootlets planted itself upon the latter plant, in which the exuberant growth was taking place, after which this excess of growth was gradually checked. The Cuscuta is a parasite which never attaches to cryptogams; a fact probably indicating some undetected difference in the sap of the flowering and the flowerless plant.

April 19th.
Director S. W. Mitchell, M. D., in the Chair.
Twenty-three members present.

Dr. J. G. Hunt presented the following:

Improved Microscopical Cement.—Dissolve old and hard Canada balsam in chloroform until it is quite fluid; then add enough oxide of zinc ground in
linseed oil to bring the mixture to the consistence of cream. If it dries too quickly on the brush to work smoothly, add a small quantity of oil of turpentine. Occasionally stir the mixture before using. This cement dries very quickly and retains a fine polish, does not become brittle, and will not run in under the thin glass cover. If proper care be used, all ordinary danger from leaking when objects are mounted in cells, can be obviated. It may be colored if desirable.

An impression prevailed with some members that this was the form of cement recommended by Dr. H. C. Bastian, in No. II of the new "Monthly Microscopical Journal," of London, a cement much used in Germany. With this cement, however, composed of solution of gum-mastic in chloroform, thickened with nitrate of bismuth, Dr. Hunt was familiar, and having used it, finds it far inferior to that made according to the formula furnished by him this evening.

Mr. Walmsley had used these cements, and accorded the superiority to that of Dr. Hunt.

May 3d.

Director S. W. Mitchell, M. D., in the Chair.

Twenty-six members present.

Dr. J. G. Richardson read a paper "On the detection of red and white blood corpuscles in Blood Stains," with experiments to prove that the colorless material left after the action of pure water on dried blood clot is not simply fibrous, as appears to have been hitherto supposed by Robin, Virchow, Fleming and other authorities, but chiefly an aggregation of those external portions of innumerable corpuscles, which probably correspond to and certainly constitute their cell walls.

For paper, see Am. Jour. Med. Sciences, July, 1869.

Dr. William Pepper presented a specimen of a small pedicellated cystic body, attached near the free end of the right fallopian tube. This little cyst is described by Virchow under the name of the "terminal hydatid;" it is a normal, but by no means constant structure, and is the homologue of the vesicle of Morgagni, which appears as an appendix to the head of the epididymis.

The specimen was obtained from a young woman who died from uræmia, following granular degeneration of the kidneys. She is not known ever to have presented any disturbance of menstruation.

Dr. H. C. Wood exhibited specimens of an undescribed species of Bedagonium, which he named O. mirabile, Spirogyra Weberi and S. quinina, not previously found in North America, and found by him in the vicinity of Philadelphia.

May 17th.

Vice-Director W. Pepper, M. D., in the Chair.

Thirty members present.

June 7th.

Director S. W. Mitchell, M. D., in the Chair.

Twenty members present.

The following paper was read and ordered to be published:
Sections of Hard Tissues and other Substances for the Microscope.

BY CHRISTOPHER JOHNSON, M. D.

As hard substances cannot be examined microscopically in their natural state, they must undergo preparation by the investigator before the secrets of their physical and vital condition can be mastered. The end or object of this "preparation" is the production of a lamina so thin as to be translucent, and yet sufficiently thick to retain every physical characteristic. To accomplish this desired end much patience is called for in each of the several processes especially adapted to the particular and different states of hardness, with or without brittleness, or toughness, and finally to the condition of preservation of objects, whether recent or fossil.

It must be evident to every student in microscopy, that certain qualities of objects oppose a barrier to the tacile disentanglement of their web and woof, and such, for example, is the absorption of light, as totally by black or partially by colored bodies. Wherefore a knowledge of these qualities is requisite; and success will reward the operator in proportion as he adapts modes of preparation to tissues offered for examination, if he possess the amount of skill and patience indispensable in delicate manipulations.

It may be observed, before proceeding to develop any method of section making, that perfect sections, even, of some objects, such as biliary and vesical calculi, as well as certain pathological concretions, require the aid of a suitable mounting before their intimate constitution can be exhibited; so that the work of the microscopist does not always end with the production of a successful section, but must not be regarded as complete until the preparation be secured and displayed in some proper way upon a slide.

When I needed the aid of guides in directing my unskilled manipulations I was very often embarrassed by the meagreness of the assistance afforded by authors of works on practical microscopy; inexperienced readers, however, will find in my attention to detail that help which will secure me exomoration from the charge of tedious minuteness, and I beg to add that I theorize in nothing, but give the results of my own personal experience.

Hard substances may be divided into two groups, the first comprising all such as require the emery wheel for their reduction, and the second, all other and less resisting structures. Among the former are to be found the flints and siliceous petrifications, as also very hard calcareous bodies, whether petrifications or of recent and normal constitution, as the porcelain-like shell of many molluscs. In the succeeding group may be ranged recent or non-silicified teeth and bone, calculi of various kinds, brain sand and calcareous deposits, hard seed capsules, and the like. Whatever be the process employed to subdue these refractory substances, the resulting section must possess certain qualities or fulfill certain conditions. It must be perfectly flat, of suitable and equal thinness, and ought, if possible, to be polished on both sides. I say if possible, because there are many hard and tough substances which are not susceptible of a polish; and it is almost needless to add that, in the study of structure, sections cut in several directions are indispensable for its correct appreciation.

The apparatus I have employed is of very simple description. For the preparation of sections of objects of the first class, I necessarily have recourse to the lathe fitted with a "true" disc of thin soft steel, for emery on the side or edge, as I might wish to grind a surface or cut a slice; with an Ayrshire stone for grinding, and a wooden disc cut across the grain to bear the polishing powder, the tin powder in use by stone cutters. But to save time I have frequently availed myself of the steadily revolving fine stones in a glass-cutting establishment, which readily "cut" the chalk-flint by which they are sharpened and corrected. The lathe is a part of a former watchmaker's, and similar to those commonly in vogue with dentists. The emery
I use was sorted by eleutriation, a process indispensable before applying it to the production of an acceptable and polish-bearing surface. This method consists in shaking up good flour of emery with water in a tall cylindrical jar, suffering the whole to stand in repose for, say, two seconds, and pouring off into another jar the fluid overlying the sediment. The original deposit may again be treated in the same way, and when the water shall have been added to that first removed, the residual powder is collected, dried and labelled 2″ emery.

The finer particles withdrawn in suspension into the second jar are shaken up afresh, allowed to deposit for three seconds, are collected, dried and labelled 3″ emery; while the finest dust, which subsides very slowly in the decanted water, may be gathered as 5″ or 10″ emery, the last being fine enough for polishing.

For most purposes large portions of hard objects destined for microscopic examination are unnecessary; and besides, the grinding and other preparation of extensive slices involve a useless expenditure of time and patience. Small sections made from fragments or pieces cut off by wheel from a cabinet specimen are altogether satisfactory—indeed, chips flaked off with adroitness are oftentimes extremely useful in directing investigation, and may even bear mounting as permanent objects.

As small particles or pieces cannot be readily manipulated in their independent state, it is necessary to secure them in such manner as to insure the success of their skillful reduction. This may be done by attaching them singly by shellac or hardened balsam to pieces of heavy mirror glass of about an inch in diameter and ground smooth on the edges. Thus fastened a good surface may be obtained for one side. Then the object must be turned over and again cemented by heating the shellac as before, and pressing the prepared surface flat against the glass. Now, as the grinding progresses the qualities of the section become apparent, and the degree of thinness determined by direct inspection of the section under the microscope.

Large sections, as of shells, can be made with as much precision as smaller ones; but no one can hope to emulate the late Mr. W. Glen, of Cambridge, unless he have extraordinary skill, coupled with most extensive experience.

As to the manner of working the lathe and its wheels, I feel obliged to refrain from speaking; for nothing but repeated essays with that instrument, or personal instruction of an adept, can assist the beginner more than the bearing in mind of a few rules of universal application. First, produce and even, steady and not too rapid motion of the disc; second, charge the wheel, whether side or edge, with a moderate quantity of emery, or diamond dust, at a time; third, hold the object lightly against the cutting surface; and fourthly, change the position of the object by rotating it upon its flat surface, and at short intervals, as the grinding progresses.

When ground and polished the specimen may be separated from the shellac and glass by immersion in hot alcohol, and mounted, either by simply fastening it with balsam to a slide, or embalming it in that substance and covering with a thin glass.

It is worthy of note that many objects which may technically be classed among the hard substances, require for their reduction the intervention of a cutting powder between themselves and the reducing surface, whether wheel or stone. As instances I may mention biliary and other calculi, the dried crystalline lens and phthisical or other calcareous concretions. No hone can smoothly cut these bodies, for its grit soon becomes smoothed out by the adherent debris, and the specimen is either not further affected or it is destroyed by breaking. The powders I employ are the fine “silex” of the dentists, and the very fine dust of pumice made even by rubbing while moistened between glass plates. A first surface should be secured by rubbing the specimen upon a hone made flat by means of emery and water and a flat marble slab, and the coarser and then the finer powder are to be employed and kept moist with water. Now the object must be dried and after-
wards attached by moderately hard balsam to the slide on which it is to remain, and the final surface will be reached by a repetition of the process of grinding. And here I would call attention to some points in the manipulation, which are that in reducing any substance to the condition of a lamina, it should be poised securely with the fingers, whether it be free or cemented upon glass; propelled along the face of the hone with a long, even and steady sweep; and turned repeatedly upon its horizontal axis. A polish may be given or not, according to the nature of the substance, and the section may be regarded as finished if it bear a satisfactory examination under the microscope. And it should not be forgotten that many specimens are best prepared by working them up to the power under which they are destined to be studied.

Hardened organic substances, as the crystalline, do not bear the heat necessary for attachment to a glass slide, wherefore the second surface must be produced by fixing the first surface upon a bit of white wax by gentle pressure.

Finally, after the grinding shall have been completed, it will be necessary to clean the slide with water; and after drying, to wash away the powder and debris adherent to the surrounding film of balsam with chloroform passed lightly over the slide by the finger covered with soft linen, or, if the section will endure such treatment, the whole of the margined balsam may be cleared away by pouring over the slide a stream of chloroform. But turpentine should be used to detach a finished section from wax.

To mount such sections it will be found advantageous to moisten them with turpentine before dropping on the thin balsam. The cover glass is to be applied warm, and a small weight, as an inch or even a half inch screw placed on it as eventually to press out superfluous balsam. I say eventually, because such slides are unfit for use for several weeks.

When the balsam shall have become sufficiently tenacious the slide may be cleaned by passing a knife blade, held flat, from the cover glass into the circumvallate cement, and then boldly away over the slide. What remains is to be removed with a solution of caustic potash, which itself calls for a free watery ablation, and then the slide needs nothing but the label.

This method of mounting sections is applicable to a great variety of objects, and will be found to yield the best results in the case of urinary crystals, of the so-called hematin crystals, or of the chitinous skeletons of insects as actually practised by the incomparable Mr. T. W. Starr, of Philadelphia.

The preparation of objects of the second class is attended with difficulties, some of which are to be overcome by means similar to those employed in manipulating objects belonging to the former, and some, by reason of the nature of the objects themselves, are to be surmounted by a resort to various expedients. Thus, sections of spines of Echinodermata, as also of biliary and other calculi, may be made in the same way as sections of harder substances; that is, by grinding down a true surface by means of fine silix and finer pumice with water, fixing that side, when dry, upon a slide with Canada balsam hardened until it has become very "tacky," and then finishing the second surface in the same manner as the first. But the calculi, generally, must not be removed from the slide, although the marginal balsam may be cleaned away by drops of chloroform; and they must be covered with soft balsam in situ and so covered. The spines, however, may and must be entirely cleaned by repeated drops of chloroform, in which they are to be floated away from their early attachment; whereupon the slide being wiped clean in the middle, the section is to be floated back to the central spot, suffered to dry, then moistened with turpentine, and immediately overflowed with soft balsam. Heat may or may not be employed before applying the cover glass.

The trick of sectionizing a very small spine of Echinus, or similar object, consists in perforating a disc of a large spine, saturating it with hardened balsam, and inserting the capillary spine into the perforation, aided by heat. The two substances ought to be the same. Now grind down the large piece; and when finished and washed out, find, separate and mount the particle.
But structures such as recent teeth and bone, the hardened albumen of kernels of such nuts as that of *Phyteuma macrororpa*, brain, sand, &c., bear heat indifferently. They crack, but more provokingly warp, when attempts are made to fix a first surface. Indeed, when not properly dried after the performance of the first step of the process already described, they usually warp so much as to render the making of a uniformly thin section impossible. To remedy the defect of the heat process I found a matter of much difficulty; so I employed a new one, which I claim to be easy, certain and original.

To make sections by the method I have so successfully employed but little apparatus is required. A couple of Arkansas hone, the one coarser, the other very fine, and both kept flat by rubbing upon a hard marble flag with flour of emery and water, are of first necessity. I also recommend that the hone while being "faced" should be pushed steadily along diagonally, first one way and then the other, so that the surface will be "set" or finished quintually.

In the next place I mention fine Russian isinglass for glue, to be boiled, strained, and dried in flasks upon a polished metal surface. Then thin letter paper is to be provided; several bits of thick mirror glass, for holders, ground on the edges, of different sizes, from one inch square upwards, according to the size of the projected section, as also sweet oil and a little chloroform. And finally there will be needed some alcohol, and a small quantity of electriated polishing putty, oxid of tin, as used by stone cutters.

As a preliminary it is desirable that some definite idea as to the plane of the section be entertained, and this is possible for all except minute fragments. Then the saw cuts out a small block, say of one-eighth inch in thickness, or the file reduces a mass to near the desired level. Now the object is moved steadily and rather lightly along over the coarser hone, wet with water, and then over the finer one, the operator being careful not to pass the object evenly backwards and forwards, to turn it about from time to time, and to examine the surface frequently with a lens to detect invicidus scratches. Teeth and similar objects should be pushed along in one direction only, the enamel forward in the case of teeth, so as to avoid and prevent separation of their different constituents.

When a perfect surface shall have been obtained let the specimen be washed in water and then immediately dropped into alcohol, which, abstracting water from every part alike, dries the object—so far as aqueous wetting is concerned—and no warping occurs. Next, strain a bit of chamois skin upon a block, sprinkle upon it a little of the polishing powder, moisten all with alcohol, and polish the first surface by rubbing it with gentle force upon the prepared skin. After receiving polish the specimen is to be restored to its alcoholic bath.

The succeeding step of the operation consists in melting a little of the isinglass in a silver spoon, or other more convenient metallic receptacle, making a fluid of the consistence of cream, and adding, at the end, a few drops of alcohol to increase the tenacity by making the thin glue take better to the polished surface. Warm one of the glass holders very slightly, with the finger varnish one of its faces over with the glue, prepare a bit of the thin paper in like manner, and quickly cement the paper evenly upon the glass. Trim away the edges with scissors and the paper is ready for the guides, which are two little rabbet of paper about a quarter of an inch wide, and to be glued on the paper-facing on opposite sides and touching the margins. The thickness of the guides determines the thickness of the future section, for between them is left a gutter in which this section will lie. Now with the finger place a film of glue upon the paper between the guides; and, having previously wiped the object quickly dry, slightly moisten its surface and edges with the isinglass, apply the specimen dexterously, make forcible pressure, and confine it by wrapping it tightly with strong thread. It is to be observed that the isinglass should not exceed the area limited by the guides, nor should
it much surpass the contour of the specimen, otherwise difficulty will be experienced in grinding the second surface.

In ten or twelve hours remove the binding string, and with a fine saw cut away a portion of the block of matter, or with a file rasp down the adherent piece. But here again method is everything; for a tooth, for example, must be filed from the enamel towards the ivory, otherwise separation will occur. And the same rule is to be observed in grinding down to the second surface.

In once more resorting to the bones, which, by the way of reminder, ought from time to time to be dressed afresh after the manner already pointed out, it becomes apparent that oil and not water should be used to moisten and clean the surface. Consequently, the second grinding is done in oil, and in perfect safety, for as that fluid exerts no influence upon the glue, the section is retained in position upon the glass throughout the process. When, at length, the desired thinness is reached, it will be perceived that the guide papers as well as the section lie equally close upon the surface of the "trued" fine hone, and that they somewhat resist the action of the stone; and the ground edge of a clean slide applied across the face of the holder will assure the equal thickness of the guide papers and the section itself. If an attempt be made to push the operation farther the holder will be found to adhere somewhat tenaciously to the hone.

The holder must now be carefully wiped clean on all sides; whereupon, after careful examination of the surface for scratches, a polish is to be given. But scratches may be ground off with caution, or suffered to remain if they do not compromise essential parts of the specimen.

With a bit of fine silk stuff borne upon the finger end, and moistened with oil, take up a little of very fine polishing putty, and rub the adhering section quickly as well as briskly, for no heat must be evolved by continued friction, otherwise portions of the specimen will rise in consequence of warping, and be broken off; or else the polish may be given by means of a small bit of chamois skin fastened upon the end of a phial cork, dampened with oil, and armed with polishing powder.

Again wipe off the holder with clean soft cambric; then with the same charged with alcohol; next wash the holder rapidly in soap and water, using the finger the while; pour clean water over section and glass, and finally deposit the holder in a glass dish filled with clean water.

Here let us pause while the water is detaching the section from the paper, and softly liberating the unbroken contour of its margin. The guides are set free, the subjacent paper quits the holder, and the section is left alone by the withdrawal of both paper and glass.

Before proceeding further I desire to show how sections of very slender rods, spicules, or teeth, such as those of the Bat, may be prepared with facility. As these minute or delicate objects cannot be held by the fingers, the expedient of gluing them to larger objects must be resorted to. But to secure equality in the grinding, the two structures, the supporting and the supported, must be the same. Thus, tooth must be attached to tooth, bone to bone, &c.

And as very fragile cancellated tissue will hardly bear the friction of the bones, the meshes are to be filled up with isinglass glue, and the specimen dried before the saw or the hone can be employed. Such specimens must be ground in oil for the first surface; after which, when wiped off and robbed of this oil by maceration in chloroform, they may be cemented with glue upon the paper-faced holder, and the production of the second surface is accomplished after the manner already pointed out.

The support afforded to cancellated tissue by isinglass in the class of objects at present under consideration may be found equally in hardened Canada balsam for objects of another sort. The spines of some Echinoderms are so brittle as not to endure handling in their natural state, but the most ghostly of these, such as the hollow spines of Diadema, may be readily and safely held and subjected to the process of grinding if their cancelli be filled with hardened balsam, introduced, of course, while hot. And, to repeat, these small bodies
must be cemented upon larger ones of the same kind if anything like trueness in the plane of the section be attempted or required.

Our specimen exists, but is still unfit for mounting, because it is saturated with oil and retains small particles of the putty. To rid it of the latter it may be removed to a slide by forceps, or, if too delicate, must be floated on the water by tilting the vessel, and then dipped up on a slide. A camel's hair pencil full of water readily washes away all particles of paper or dust, especially if the lamina be held upon the slide by the flattened end of a match stick; and the other surface, being made uppermost by turning in water, is to be prepared in the same way. Once more drop the section in water; then with fine forceps remove and let it fall into the alcohol; now transfer it to chloroform; and finally place it between bits of smooth birefringent paper, which again lie between a couple of clean slides. A pair of spring forceps will maintain flatness until the now finished section is required for mounting.

After so much trouble it were a pity to lose a fine specimen by bad mounting; wherefore, and to prevent a loss of time and labor and much disappointment, I beg leave to offer a few suggestions as to the manner of casing or embalming the results of our successful efforts.

In any case choose the better side of the section as the uppermost, and this is commonly the first. Have ready, for the dry method, a slide cleaned with dilute alcohol, and upon it a shallow circle of shellac, applied in alcoholic solution by the aid of the Shadbolt turn-table. The shellac should be nearly hard after a day's exposure. Wipe the slide with dry cambric over the circular area, and clean a suitable cover glass which has been lying in dilute alcohol. Warm the slide over a flame of a spirit lamp to drive off moisture; suffer it to cool perfectly; place the section in the cell; warm and cool the cover; lay the latter upon the cell; on the cover put a bit of thin paper, and over this a piece of a slide, finally clamping all together by spring forceps. The slide must be held over the spirit flame until the softened shellac adheres all around the circle to the cover and the section is pressed and held flat.

When cold, the work is done.

The embalming process, like the one just described, requires a little practice to ensure success. As soft balsam pervades almost all structure, it is generally inapplicable to the mounting of tissues, such as bone and tooth. At any rate I have already spoken of the manner of its use. But where tubuli, &c., are to be made conspicuous by retained air, hardened, not hard, balsam must be employed.

To mount a section in such balsam I proceed as follows: On a slide free from crocus-flaws pour a small quantity of soft balsam, and hold the same over a spirit lamp until by vaporization the balsam shall have become tacky when cold. The process is favored by tilting the slide to and fro. Let the slide cool; and upon the end of a spatula blade prepare other balsam, but a trifle less hard. The section being laid upon the cold balsam on the slide, and this held between finger and thumb, the spatula blade is to be heated until the balsam flows; whereupon the blade is suddenly turned over and made to press the hot cement upon the section for a moment. The heat striking through fixes the section; and as the blade is withdrawn the slide must instantly be held over the lamp until all the balsam melts. And here again warpage is almost entirely prevented.

At this moment the cover-glass, made warm, is laid over the specimen, not flatly but dipping at one edge, and by pressure is made to assume its proper position. It almost always happens, however, that too much balsam is included between the cover and the slide, and that air bubbles appear in the field. To remedy these evils, I resort to a process similar to that which I employ when fastening a cover-glass upon the shellac margin of a cell. I first cut away all possible hard balsam with a hot knife-blade. Then, the slide being cold, a strip of fine paper is laid over the whole of it, and upon the paper another slide. The two plates of glass are presently to be clamped together with stout forceps, closing with a slide, and, holding by the forceps, both of
The surfaces are exposed alternately to the heat of the spirit flame sufficiently to melt the whole balsam. All superfine balsam now runs out between the principal slide and the paper, and usually bears with it the air-bubbles, so that the section remains perfectly flat, and embedded in the smallest possible quantity of balsam.

When perfectly cold the upper slide may be removed, the paper readily stripped off, and the mounting is accomplished.

To clean off the marginal hard balsam with a hot knife-blade, to clear away residual streaks or border, and to wash to brightness both surfaces of the slides with aqua ammonia on a bit of rag, occupy but a few minutes; and nothing remains to be done but attach the label duly inscribed.

There are those who prefer to ornament the edge of the cover with black varnish, which certainly gives a pretty appearance to the slide; but I would recommend the previous protection of the margin of balsam below it by a thin coat of shellac varnish, which effectually prevents penetration of the black into the balsam, whether soft or in a hardened condition.

In reviewing this paper, I do not seek to excuse its prolixity, but to express the hope that the methods and processes described in it may obtain the approbation of others; and that they may continue to give the very excellent results which have rewarded my labors, as well as of those friends who have accepted my guidance in microscopical studies.

This paper was accompanied by thirty-eight preparations for exhibition, including sections of teeth, shells and calculi.

Description of Machine for Grinding Sections of Hard Substances for Microscopic Purposes.

BY COLEMAN SELLERS.

The preparation of thin sections of hard substances, such as bone, teeth, stone, &c., for microscopic purposes is usually attended with more or less trouble, and requires considerable skill on the part of the workman. The chief difficulty is in securing uniformity of thickness in the specimen. A machine lately devised by Mr. J. S. Bancroft, of Philadelphia, and in use at the establishment of Messrs. Wm. Sellers & Co., embodies a principle which, applied to this purpose, facilitates the operation. This particular machine is one of those improvements in the direction of enabling unskilled labor to take the place of skilled labor, or to enable skilled workmen to do a greater amount of good work in the same time. It is a well known fact that patient industry combined with mechanical skill will enable marvels of good workmanship to be produced, but those inventions are the most valuable which with the least outlay of capital in costly machinery enables unskilled workmen to produce the same result more expeditiously and if possible more perfect. The contrivance of Mr. Bancroft was designed to produce a truly plane surface on hardened metals. It consists of a plane metal table, the upper surface of which is made accurately true. This plane surface or plate rests on hinges at one end and is provided with an adjusting screw under the other end. In the middle of the table is an oblong rectangular slit, say one inch wide, so arranged as to allow the edge of an emery wheel placed below the table to project slightly above the surface of the plate. The emery wheel, supported in suitable bearings, is made to revolve rapidly on its axis, and its periphery becomes an abrading point in the centre of the plane surface of the metal plate. By means of the regulating screw the plate can be so adjusted as to determine the distance that the edge of wheel shall project above.
the plate. In use, the hardened metal to be ground true is pressed firmly by the hands of the workman upon the plate, and passed with a sliding motion in various directions over the wheel. The emery wheel touches the highest places, and gradually reduces all to one uniform plane. With this machine straight edges of hardened steel have been produced of such perfection that when pressed together on the edges the one will lift the other by cohesion, without the intervention of a fluid.

This machine suggested to me an application of the same principle to the preparation of microscopic objects. For the large plane table with the narrow opening in the machine, as described, I substitute a small plate of brass or iron, with a circular opening in its centre of about 1¾" diam. The emery wheel is supported on a spindle and stand, such as can be purchased at any of the dental depots, and intended for the purpose of rotating emery or corundum wheels, &c. The table hinged above the wheel has an adjusting screw to determine the height of its surface plane above the edge of the emery wheel. In use, the specimen, ground and polished on one side, is then mounted with hard balsam on the glass slide upon which it is to remain. It may then be roughly ground down or filed down to any convenient thickness short of that actually needed; then it is laid upon this grinding machine (specimen down), the slide resting on each side of the centre hole in the plate, the specimen touching the revolving emery wheel. Passing it back and forth over the wheel, it is reduced to a plane parallel with the glass upon which it is cemented, and its final thinness regulated by the adjustment of the table. When thin enough for the purpose intended it may be smoothed with a slip of Scotch stone and polished without fear of destroying the uniformity of thickness obtained by the section-grinding machine. In using the instrument in the preparation of sections of ivory or bone I have found that the grinding should be done with either a dry wheel or one moistened with oil, as water will swell the specimen and crack it loose from its cement. The wheels used by me are made of emery and glue, not the shellac corundum wheels sold at the dental depots. It is probable that a circular file, i.e., a steel wheel with teeth on its edge, would do well as a grinding wheel for bones, in place of the emery wheel.

D. H. C. Wood exhibited slides of mycelium filaments and spores of a fungus, which were found disseminated throughout a crust or scab, similar to others expectorated at different times during the past six months by a gentleman, who had sent the crust to Prof. Leidy. Dr. Wood promised to investigate the subject further, but up to the present time could not speak precisely as to the specific form. The filaments resembled those found by Virchow and others in the lungs, and called by them *aspergillus pulmonum*.

June 21st.

Director S. W. Mitchell, M. D., in the Chair.

Eight members present.

Dr. W. W. Keen read a paper on the subject, “Is Atropa an Antidote to Hydrocyanic Acid?”

Dr. Mitchell desired to know whether the quantities used were at all comparable to those of Pryer.

Dr. Keen replied that this was the point most difficult to determine, but having found by experiment that two minims of the official hydrocyanic acid of our Pharmacopoeia was a lethal dose for rabbits, he had then sought to make the quantities accord with those of Pryer.
Nineteen members present.

The Director, for the committee appointed at last meeting on Dr. Keen's paper, reported that they had asked Dr. Keen to make some further experiments.

Dr. Keen read a supplement to his paper, in compliance with this recommendation.


Dr. W. Pepper exhibited some slides of muscular fibre removed, post-mortem, from an emigrant girl, who died of typhoid fever.

The patient was a German girl, aged 22, who had been in America but six weeks. There had been six deaths from fever on board the emigrant ship in which she came to this country. She died on the nineteenth day.

Besides the ordinary lesions of the disease, the muscular tissue of both ventricles of the heart presented a marked degree of friability, and, on microscopic examination, was found to have undergone quite advanced granular degeneration, as originally observed by Zenker.

The psoas and external oblique muscles of the right side were also examined, but were found healthy.

Dr. Howell made some remarks on the application of photography to microscopy. He spoke of the inexpensiveness of the apparatus necessary to the work, and exhibited the results of his experiments with sunlight, and also the magnesim light, as applied to micro-photography. The positive prints were from photographs of sections of teeth, bone, cartilage, coal, &c.

Dr. H. Allen made some remarks upon the peculiarities in the construction of inter-orbital space of the human skull. He demonstrated by outlines upon the blackboard that these peculiarities may consist of the following plans:

(1.) Absence of nasal bones with vertical plate of ethmoid appearing between the nasal processes of the superior maxilla.

(2.) Absence of left nasal bone, its area being occupied by the nasal process of the corresponding side.

(3.) Same as (1.), with rudiments of nasal bones in position.

(4.) Ossification of inter-nasal septum.

Reference was made to Dr. Van der Hœven's paper on this subject in Siebold and Kölliker Zeitschrift.

Sept. 20th, 1869.

Vice-Director, W. Pepper, M.D., in the Chair.

Twenty-two members present.

Dr. J. G. Richardson exhibited specimens of Sarcina ventriculi found in the vomited matter of a patient.

He remarked that his observations tended to show that the divisions of the Sarcina which were formerly figured by some as having central nuclei, are now seen, under a higher power, to be divided into four parts, the junctions of their separating fissures being apparently mistaken for their nuclei.

Dr. Wm. Pepper desired to place on record the following observations:
A young man suffering with acute tuberculosis presented, for two weeks before death, mild wandering delirium, and finally became almost unconscious, with ecstatic expression and constant fumbling movements of the hands.

At the autopsy, a diffused proliferation of the cells of the perivascular sheath of the meningeal arterioles was found, though not producing at any point granulations visible to the naked eye; and in several of these vessels emboli were found impacted.

Dr. Richardson stated that in examining the blood of a dog killed by opium he had noted aggregations of white blood corpuscles floating in the blood, but thought they might have occurred post mortem.

Oct. 4th, 1869.

Director, S. W. Mitchell, M.D., in the Chair.

Twenty members present.

Dr. Mitchell read a paper by Prof. Christopher Johnson, of Baltimore, descriptive of a case of male hermaphroditism and hypospadias. See Journal of Academy,

Dr. Wm. Pepper made a verbal communication on the microscopic characters of nerve fibrils after amputation.

Oct. 18th, 1869.

Director, S. W. Mitchell, M.D., in the Chair.

Nineteen members present.

Dr. J. G. Richardson read a paper entitled "Observations and Experiments tending to prove the identity of the so-called Halford's Corpuscles with White Blood Corpuscles."

Dr. Richardson also showed some of the blood of animals poisoned by rattlesnake venom, in which the corpuscles of Halford were rendered beautifully distinct by staining with aniline, and presented all the characters of white blood corpuscles when treated by acetic acid or water.

Dr. H. C. Wool stated that he had recently been engaged in some extended observations on the effects of the recently discovered alkaloids of veratrum viride, viridia and veratroidia. With regard to the former, he had noted that when given in poisonous doses, the first change manifested by the animal poisoned, a rabbit for instance, was a disposition to be quiet,—the quietness being the result, not of any cerebral affection, but of weakness. After a while the animal begins to tremble, and this trembling soon becomes peculiar; so that when the hand is placed over the body of the creature, a succession of thrills are noticed to pass throughout it. Soon, the strength failing, the animal lies almost flat upon the ground. After this come convulsions, the animal screaming and running along the ground; extreme weakness being apparent in the position maintained, the belly almost dragging on the ground. Finally the debility becomes more marked, the animal lies on its back, and dies,—death taking place from asphyxia, induced by paralysis of the respiratory muscles. In no instance was there vomiting or purging. On placing the haemodynamometer in the femoral artery; the first effect noted is a diminution of arterial pressure, and subsequently diminution of the heart's contractions, the pulse going down from 150 to 50 or 60; but the heart always continues to act after respiration ceases; death never takes place through the circulation.
After section of the pneumogastrics, the same effects follow the administration of viridia, showing that it is a direct depressor, either to the muscular structure of the heart itself or to the ganglia contained in it. No effect follows the introduction of viridia into the muscles of the thigh of the snapping turtle, while a very small quantity introduced into the muscular structure of the heart of the same creature acted promptly, showing the action to be a local one.

*Veratroidia* produces death in the same way, but there is no trembling; while it always vomits and sometimes purges. The action of the heart is at first markedly depressed, but this is followed by a rebound, the pulsations increasing in force and frequency. Dr. Wood considers this rebound due to an accumulation of carbonic acid in the structure of the heart, temporarily overcoming the depressing effect of *veratroidia*. When the pneumogastrics are cut, the usual depression of the heart’s action takes place; but the Doctor has made but a single experiment, and with regard to the rebound this was unsatisfactory.

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Nov. 2d, 1869.

Director, S. W. Mitchell, M.D., in the Chair.

Fifteen members present.


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Nov. 15th, 1869.

Director, S. W. Mitchell, M.D., in the Chair.

Seventeen members present.

Five microscopic slides were donated to the cabinet by Mr. W. H. Walmsley.

Dr. Jos. G. Richardson exhibited a living specimen of menobranchus. He referred to the large size of its blood corpuscles, and, as a result of their study, arrives at a conclusion at variance with that of Dr. Beale, as to the existence of a distinct cell wall about the corpuscle, since he believes that he has even seen the cell wall about the crystal resulting from a single globule of the hæmoto-crystallin.

Dr. Wood also stated to the Society that, whilst making his researches upon the alkaloids *veratroidia* and veratria, he had occasion to administer these alkaloids after section of the par vagum, and had been astonished to find that they never purged or vomited when the pneumogastrics had been cut. At first he had ascribed this to idiosyncrasies in the animals operated upon, but as experiment after experiment afforded the same results, it became evident that it was impossible to explain by individual peculiarities that which always happened. The doctor had extended these experiments, using as purgatives gamboge, calomel, podophyllin, extract of jalap and croton oil, and in all cases he had been unable to purge after section of the pneumogastrics.

Dr. Wood also exhibited colored drawings and mounted slides of a variety of desmids, and made the following remarks:

The slides were prepared from a collection made by Dr. F. W. Lewis in Saco Pond, a small lake of spring water in the White Mountains, not far from the Crawford House.

This very rich collection embraced the following new and old species:
Triploceras gracile, Bailey.
Triploceras verticillum, Bailey.
Euastrum ornatum, sp. nov.
Euastrum elegans (Bréb.), Ketz.
Euastrum Ralfsii, Rabenh.
Euastrum multilobatum, sp. nov.
Cosmarium Brebionii, Menegh.
Cosmarium commissurale, Bréb.
Cosmarium cucuminis, Corda.
Cosmarium suborbiculare, sp. nov.
Staurastrum arachne, Ralfs.
Staurastrum paradoxicum, Meyen.

The doctor called attention to the fact that whilst in this neighborhood one rarely met with a desmid which was provided with large granules or spines; in this northern collection by far the majority of the specimens were so provided. Of Cosmarium commissurale, Bréb., Dr. W. stated he had only seen a single specimen, and this differed from the typical form in having the sinus very narrow in its outer portion, and in being shorter, but these differences did not seem enough to justify specific separation. Of Closterium angustatum, also, but one specimen had been found, which agreed very well with the typical forms, except that it was a little narrower, its greatest breadth not being more than 9-12000" = 00075".

The desmid which the doctor referred to Euastrum Ralfsii he stated to differ considerably from the typical form in the proportion of the breadth and length. There are also certainly four, if not more, umbonations on the face of each half-cell. These are nowhere distinctly spoken of as existing, and Mr. Archer, in Pritchard's Infusoria, states there are none visible in the front view of E. Ralfsii. They are, however, represented in the side view of the original figure, and are said to be very noticeable by Mr. Archer himself, when the desmid is so looked at. In the Saco Lake specimens they are always seen in the front view with great difficulty, and in some cases I failed entirely to demonstrate them, so that they do not afford a good character for the indication of a new species.

EUASTRUM MULTILOBATUM, SP. NOV.
E. magnum, fere duplo longiss quam latum, medio profunde constrictum, et cum sinu modice ample; a latere medio ventricosum et duplo umbonatum, ad verticem dilatatum et emarginatum; semicellulis a fronte trilobatis, lobis sinus amplissimis inter se sejunctis; lobae basale distincte late emarginato, lobo centrale obtuso, lobo polare late leviter sinuato-emarginato; semicellulis a vertice quinque lobulatis; cytidermata lavi.

Diam.—Long. 57-12000" = 00475": lat 30-12000" = 0025.

E. large, about twice as long as broad, in the centre profoundly constricted, with the sinus moderately large; from the lateral view somewhat enlarged and doubly umbonated, the lobes separated by very wide sinuses; the basal lobe broadly emarginate, the central lobe obtuse, the end lobe broadly and shallowly sinuately emarginate; semicells from the vertex five lobed; cytiderm smooth.

Remarks.—The basal lobes of this beautiful desmid are distinctly five lobulate, the lateral lobules being longer and broader than the others, which, instead of being emarginate, are obtuse. The sinuses separating lobes and lobules are very broad, with very obtuse angles. When the desmid is viewed from two-thirds round, so as to show the anterior and posterior lobules especially, it presents an outline in which all the sinuses are of similar form, and the central and basal lobes are about equal size; whereas, when viewed from the front, the basal lobe is much the broader. When the desmid is viewed from the side it is seen to be enlarged in the centre, and provided with two distinct umbonations each side of the comparatively narrow central sinus.
EURASTRUM ORNATUM, sp. nov.

E. oblongum, diametro duplo longius, profunde constrictum, sinu angusto linearis; semicellulis a fronte trilobatis; lobis basibus latissimis, nonnihil sinuato-emarginatis, angulis plus minus productis et rotundatis; lobo polare medio profunde lineare inciso, segmentis late rotundatis; semicellulis a lateribus bilobatis, lobis basibus profunde emarginatis et cum angulis plus minus acutis; cytiodermate distincte ordinatim punctato.

Diam. — 35-12000′ ≈ 0.0029.

E. oblong, twice as long as broad, profoundly constricted; semicells from the front trilobate; basal lobe very broad, slightly sinuately-emarginate, angles more or less produced and rounded; polar lobe medially profoundly linearly incised, segments broadly rounded; semicells bilobate at the sides, basal lobes profoundly emarginate and with the angles more or less acute; cytioderm distinct and regularly punctate.

Remarks. — This species is close to E. erasum, from which it differs in the proportionate length, being only twice instead of three times as long as broad: in the size being only three-fourths as large; and especially in the peculiar lateral splitting, as it were, of the basal lobes.

ARTHODESMUS QUADREXENS, sp. nov.

A. late ovalis, vel suborbicularis, paulum longius quam latum, cum margine crenato-undulato; semicellulis nonnihil reniformibus, utroque fine aculeo subulato, modice robusto, acuto, recurvio, armatis; cytiodermate cum verruculis paucibus modice minutis in seriisbus paucibus dispositis instructo; semicellulis a vertice acute ellipticis, et cum margine crenatae et superficie sparse verruculosa.

Diam. — Lat. 3-4000′ ≈ 0.0075; long. 5-4000 ≈ 0.0125′.

Broadly oval or suborbicular, a little longer than broad, with the margin crenately undulate; semicells somewhat reniform, at each end armed with a subulate, moderately robust, acute, recurved large spine; cytioderm with a few smallish tubercles arranged in three or four rows; semicells from the vertex acutely elliptical, with the margin crenate and the surface sparsely warty.

Remarks. — This species approximates A. divergens, from which it differs in the arrangement of its granules, its attaining not one-half the size. and, I believe, in the larger and more robust spines.

STAURASTRUM MUCITUM, sp. nov.

S. submagnam, tere ½ plo longias quam latum, medio leviter constrictum; semicellulis a fronte exornititer hexagonis, angulis in processus rectis et divergentibus productis, dorso processibus similibus 4—5 instructo; semicellulis a fronte polygonis vel suborbicularibus, margine processibus numerosis, plenumque 9 instructo; dorso processibus 5—8 instructis; processibus omnibus similibus granulato-dentatis, apice achorro simplicibus, bifurcatis vel fissis.

25-12000′ ≈ 0.002.

Diam. a vertice cum processibus.— 51-12000′ ≈ 0.00475. Sine process.

S. rather large, about one-half longer than broad, slightly constricted in the middle; semicells from the front irregularly hexagonal, the angles prolonged in straight divergent processes, and the surface furnished with four to five similar ones; semicells from the front polygonal or suborbicular, the margin furnished with numerous processes, mostly about nine, and also with 5—8 on the dorsum; processes all similar, granulate-dentate, their transparent apices simple, bifurcate or torn.

Remarks. — This species is most closely allied to St. fuscigerum, Bréb., from which it is at once distinguished by the orbicular vertex. The constriction between the semicells is also very different. In St. munitum it is a gradual, not very deep, hour-glass contraction; in St. fuscigerum it is very narrow and linear.
STACRASTRUM LEWISII.

S. laeve, sinu amplissimo, spinulo parvo armato et cum angulo obtuso; isthmo nullo; semicellulis a fronte late triangularibus, a vertice triangularibus et cum angulis nonnihil tumidis, et rotundatis; angulis spino maximo, robusto, acuto armatis.

**Diam.**—Long. cum spin. 1-400" = .0025; lat. cum spin. 27-12000" = .00225". Sine spin.: long. 1-600 = .001666; lat. 13-12000 = .001666. Spin.: long. 1-1500 = .000666.

Smooth, with a very ample sinus, which is armed with a small spine and has a very obtuse angle; isthmus absent; semicells from the front broadly triangular, from the vertex triangular, with the angles somewhat tumid and rounded; angles armed with a very large acute robust spine.

**Remarks.**—This desmid is most closely allied to *St. aristiferum*, Ralfs., but differs from it in outline as seen from the front, there being no mamellation of the ends. The spines in the sinuses are also wanting in the European species.

COSMARIIUM SUBORBICULARE, sp. nov.

C. parvum, suborbiculare, paulo longius quam latum, cum marginis corrugatis vel crenatulum; semicellulis a latere orbiculibaris, a vertice ellipticis; sinu extra angustissimo sed intra nonnihil excavato; clytiodermum crasso, sparse verruculoso; granulis in semicellulis singulis subdistantibus et in seriebus elongatis, duobus (interdum unica) externis curvatis, et in seriebus duobus internis brevibus et rectis.

**Diam.**—Lat. 14-12000" = .0012; lat. 16-12000 = .0013.

Small, suborbicular, a very little longer than broad, with the margin irregularly crenate, or crenate undulate; semicells from the side orbicular, from the vertex elliptical; sinus very narrow, but within somewhat excavated; clytioderm thick, sparsely coarsely granulated; granules subdistant, in each cell arranged in one or two curved marginal series and in a central group of two or three short rows.

**Remarks.**—The arrangement of the granules in this desmid is peculiar, one or sometimes two rows of large obtuse pearly granules placed at rather wide intervals along the whole outer margins, and then in the centre of each semicell a group of two or three, or even more short straight rows of three or four similar but rather smaller granules. The isthmus is rather broad and short; sometimes it has on it one or two granules.

The doctor also exhibited drawings and specimens of the following new species:

Genus PLEUROTÉMIUM.

P. breve.

P. robustum, diametro 4—8 plo longius, in medio distincte constrictum sed haud undulatum, utroque polo nonnihil attenuatum; apicibus truncatis et nonnihil rotundatis; clytiodermate crassissimo, dense granulato-punctato; marginibus vel rectis, vel breve undulatis.

**Diam.**—.0008—.00095.

Robust, 4—8 times longer than broad, distinctly constricted but not undulated in the middle, slightly attenuated towards the ends; apex truncate and somewhat rounded; clytioderm very thick, densely minutely granulate; margins either straight or shortly undulate.

**Remarks.**—This species was sent to me by Dr. Billings, who obtained it near Washington, D. C. The margins are sometimes straightish, but in others there are three or more distinct short undulations, or rounded projections in each half margin. The cell wall is excessively thick, especially at the end. In many cases much thicker than the drawing.
Genus TETMEMURUS.

T. giganteus, n.

T. maximus, oblongus, diametro 3 plo longior; apice haud attenuato, late rotundato; suturis profundis, linearibus; cytopidermate irregulariter granulato-punctato.

Diam. = 24-7500 = 0031.

I found this beautiful desmid in a stagnant pool in Bear Meadows, Centre Co., in the month of August. It is very different in its outline from its nearest ally, T. granulatus. The diameter is preserved uniform until, at the very end, where there is an alteration in the line of the margin, so as to cause some contraction. This is, however, wanting in some specimens. The ends are therefore broad and obtuse. The size is also double that of T. granulatus.

Dr. Mitchell exhibited a perfect egg, with shell, enclosed in a larger egg. The outer egg contained albumen and a partial yolk. The hen from which the specimen was obtained had produced several similar ones.

Dr. W. F. Norris was chosen a member of the Section.

Dec. 6th, 1869.

Director, S. W. Mitchell, M.D., in the Chair.

Eleven members present.

Mr. Walmsley donated three preparations of the lung, liver and kidney of the rattlesnake injected.

Dr. S. W. Mitchell exhibited specimens of hydrate of chloral in solid, and in aqueous solution. He had administered hypodermically to a pigeon 10 grains, producing immediate death. Three grains similarly administered resulted in death at the expiration of between two and three hours; the pigeon having, however, several times apparently expired before death actually took place. To a rabbit 15 grains were administered hypodermically, death occurring in an hour. In each instance, rigor mortis supervened rapidly.

The election for officers for the ensuing year was held, which resulted as follows:

Director, S. W. Mitchell, M.D.
Vice Director, Wm. Pepper, M.D.
Recorder, Jas. Tyson, M.D.
Treasurer, C. N. Pierce, D.D.S.
Curator, W. H. Walmsley.

Publication Committee,—Recorder, ex offic., Chairman; F. W. Lewis, M. D.; W. Pepper, M. D.; M. W. McAllister; W. S. Bolles, M. D.; J. G. Hunt, M. D.

Curators,—W. H. Walmsley, ex offic., Chairman; J. G. Richardson, M. D.; T. W. Starr; F. W. Lewis, M. D.; W. F. Norris, M. D.

Auditors.—H. M. Bellows, M. D.; W. McFadden, J. W. Queen.

1869.]
Dec. 20th, 1869.

F. W. Lewis, M.D., in the Chair.

Seventeen members present.

Dr. J. G. Richardson donated two slides of blood of the menobranchus, mounted dry.

Dr. H. C. Wood exhibited specimens of Nostoc cristatum, Bailey, from the Alleghany range, and also others from the Rocky Mountains. He stated that he believed this species was identical with N. Alpinum, of Europe, and remarked upon the three widely separated localities in which it had been found. He thought the key to the mystery was in a little plant described under the name of N. Dickiae, from Northern British America, apparently identical with N. cristatum, and which he thought indicated a connection between the mountain localities through the cold northern regions.

Dr. J. G. Hunt called attention to some previously undescribed glands in the Drosera rotundifolia, and remarked—

In addition to the well-known oval glands on the leaves of this interesting plant, I have detected others presenting some features of interest and beauty. These new glands are cylindrical in shape and slightly curved, and are about one quarter of a line in length. Beautiful spiral cells occupy the central parts of the glands, and on these spirals rest the columnar cells which excrete the peculiar liquid of the plant. But these excreting cells occupy only one side, whereas they entirely surround the oval glands. I have found them only on the circumference of the leaves, on long filaments; they unfold, therefore, earlier than those of oval shape, and fade sooner.

Dr. Hunt also exhibited certain vegetable specimens mounted in carbolic acid solutions, which had kept remarkably well, and expressed his preference for these solutions in preserving vegetable tissues.

Dr. Tyson stated that in the preservation of animal tissues he had found carbolic acid the most satisfactory medium, usually in the proportion of 1 part to 50, with the addition of glycerin sufficient to bring up the sp. gr. to 1028, about that of the fluid by which tissues are bathed in health. For tube casts, a proportion of about 1 to 100 was sufficient, and care must be taken not to add too great a bulk at the beginning, lest the albumen of albuminous urine be thrown down, and the specimen thus ruined.

Dr. Wood thought that the impression held by some, that creasote possessed preservative properties 6 or 7 times as great as those of carbolic acid, lay in the fact that much of the creasote of the shops is really impure carbolic acid, containing a certain proportion of creyllic acid, which may possess much greater preservative property.

Dr. Lewis desired to know the experience of members with acetate of alumina.

Drs. Wood and Hunt both found a precipitation of the salt to take place in the preparations mounted in it.

Dr. Hunt said that for preserving entomological specimens, solutions of chloride of zinc were better even than carbolic acid, and also said that successful preservation of delicate specimens, of animal or vegetable nature, was at best relative, and that even the most successfully preserved tissues soon exhibited changes which distinguished them from fresh specimens, though they might little impair their beauty or utility.

Mr. Walmsly referred to some remarks he had some time ago made, with regard to the preservative properties of glycerin jelly, which he still found useful, but not so generally so as carbolic acid solution, on account of its transparency.

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OF THE

ACADEMY OF NATURAL SCIENCES

OF

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