PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1879.

PUBLICATION COMMITTEE.

Joseph Leidy, M.D., Geo. H. Horn, M.D.,
Wm. S. Vaux, Thomas Meehan,
J. H. Redfield.

Editor: EDWARD J. NOLAN, M.D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
S. W. Corner Nineteenth and Race Streets.
1880.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA,
March, 1880.

I hereby certify that printed copies of the Proceedings for 1879 have been presented at the meetings of the Academy, as follows:—

Pages	9 to 24	March 25, 1879.
"	25 to 56	April 15, 1879.
"	57 to 136	May 13, 1879.
"	137 to 152	July 29, 1879.
"	153 to 184	August 12, 1879.
"	185 to 200	November 4, 1879.
"	201 to 216	December 2, 1879.
"	217 to 280	January 6, 1880.
"	281 to 376	February 17, 1880.
Page	377 et seq.	March 9, 1880.

EDWARD J. NOLAN,
Recording Secretary.

PHILADELPHIA:
COLLINS, PRINTER.

LIST OF CONTRIBUTORS,

With reference to the several articles contributed by each.

For Verbal Communications see General Index.

Bergh, R. On the Nudibranchiate Gasteropod Mollusca of the North Pacific Ocean, with special reference to those of Alaska 71

Binney, W. G. On the Land Shells of the Mexican Island of Guadeloupe, collected by Dr. E. Palmer............................ 16

Chapman, H. C. On the Structure of the Chimpanzee.............. 52

Notes on the Amphiuma... 144

Placenta of Macacus Cynomolgus 146

Cope, E. D. On the Genera of Felidæ and Canidæ.................. 168

Ellis, J. B. On the Variability of Sphæria Quercuum, Schw......... 66

Reply to Dr. M. C. Cooke's criticism of paper on "Variability of Sphæria Quercuum, Sz."................................... 381

Garrett, Andrew. List of Land Shells inhabiting Rurutu, one of the Austral Islands, with Remarks on their Synonymy, Geographical Range, and Descriptions of new Species 17

Description of a new Species of Goniobranchus.................... 31

Greene, Wm. H., and A. J. Parker. Note on Hyraceum......... 12, 379

Heilprin, Angelo. On some new Eocene Fossils from the Claiborne Marine Formation of Alabama................................ 211

A comparison of the Eocene Mollusca of the Southeastern United States and Western Europe in relation to the determination of identical Forms 217

Kingsley, J. S. On a Collection of Crustacea from Virginia, North Carolina, and Florida, with a Revision of the Genera of Crangonidæ and Palæmonidæ.. 383

Lockington, W. N. On a new Genus and Species of Scombridæ...... 133

Lyon, Victor W. Description of three new Species of Calceolidæ from the Upper Silurian Rocks of Kentucky........................ 43

Ryder, J. A. Morphological Notes on the Limbs of Amphiumidæ as indicating a possible synonymy of the supposed Genera........ 14

Further Notes on the Mechanical Genesis of Tooth-forms.......... 47

Description of a new Species of Chirocephalus.................... 148

Description of a new Branchipod................................ 200

Wachsmuth, Chas., and Frank Springer. Revision of the Palæocrinoidea.. 226

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1879.

JANUARY 7, 1879.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-seven persons present.

A paper entitled "Description of a New Species of Goniobranchus," by Andrew Garrett, was presented for publication.

The death of the Rev. Dr. E. R. Beadle was announced.

A committee consisting of Mr. J. H. Redfield, Dr. R. E. Rogers, and Dr. Jos. Leidy was appointed to draft a resolution expressive of the Academy's esteem for the late Rev. Dr. Beadle.

JANUARY 14.

The President, Dr. RUSCHENBERGER, in the chair.

Forty persons present.

A paper entitled "List of Land Shells inhabiting Rurutu, one of the Austral Islands," by Andrew Garrett, was presented for publication.

The Committee appointed to prepare a resolution upon the death of the late Rev. Dr. Beadle presented the following, which was unanimously adopted:—

Resolved, That in the death of our late associate, the Rev. Dr. Elias R. Beadle, we have to mourn the loss of an ardent, reverent, and sincere seeker for truth, whose attainments in knowledge were so broad, and so diversified, as to command our respect and admiration, and whose large and loving heart was so manifest in all his deportment and intercourse with us, as to win our esteem and affection. We, therefore, join our sympathies with all those who have been bereft of his instruction, his example, and his fellowship, and we direct that these sentiments be placed upon our records, and a copy of the same be transmitted to the family of the deceased.

January 21.

The President, Dr. Ruschenberger, in the chair.

Thirty-four persons present.

A paper entitled "Notes on some Pacific Coast Fishes," by W. N. Lockington, was presented for publication.

Solidago odora as a "Tea" Plant.—Mr. Thomas Meehan drew attention to some samples of dried leaves that had been sent for identification, and which are represented to be in extensive use in Berks Co., Pa., as a beverage under the name of "Blue Mountain Tea." Mr. Meehan found the leaves to belong to *Solidago odora*, The infusion had a slight taste of fennel, by no means disagreeable, but yet with little more attractions than catnip, or any ordinary "herb tea," might present.

January 28.

The President, Dr. Ruschenberger, in the chair.

Thirty-two persons present.

A paper entitled "Further Notes on the Mechanical Genesis of Tooth-forms," by Jno. A. Ryder, was presented for publication.

On Gordius, and on some Parasites of the Rat.—Prof. Leidy exhibited a curious knotted mass of living hair-worms, *Gordius robustus?* which had been sent to him by Dr. S. T. Roman, of Conowingo, Cecil Co., Md. The mass had been picked up in a gutter at the edge of a forest near Conowingo, on a rainy morning of Dec. 15, 1878. It contained 52 male individuals, and 7 females. The former ranged from 8 to 25 centimetres in length, by $\frac{1}{2}$ to $\frac{2}{3}$ of a millimetre in thickness; the latter range from 14 to $19\frac{1}{2}$ centimetres in length, by 1 millimetre in thickness. The females are generally of much lighter color, and more robust character than the males. In both sexes the body is most attenuated anteriorly, but in the female the body is nearly as thick at the posterior extremity as it is at the middle. Some of the smaller males are pale brownish-white, but most of them, from the smallest to the largest, are of various shades of brown to chocolate-brown. The females are pale brownish to darker brownish. In both sexes the head forms a convex, whitish eminence, encircled by a narrow black ring, from which a band of brown extends dorsally and ventrally along the body. The posterior end of the body is likewise of darker color than the part just in advance.

The tail of the male makes a spiral turn inwardly, and is furcate. The forks are short, curved, slightly divergent, blunt conical processes. Just in advance of their conjunction internally, there exists an inverted crescentic fold of browner color than the contiguous parts, and immediately in advance is the genital pore. The interval of the caudal forks is smooth, or free from papillæ.

The tail of the female appears truncated; is bluntly rounded, feebly clavate, or slightly thicker than just in advance, and nearly as thick as the middle of the body. It presents a terminal pore, marked by a brown spot, and encircled with a brown ring.

Under a moderate magnifying power, the brown integument is minutely mottled with whitish spots, and it exhibits fine longitudinal and diagonal striation. In sunlight it is beautifully iridescent as in the earth-worm.

The worms are still quite lively. When disentangled and left alone they soon become again knotted together in a compact rounded mass as at present, with the heads divergent, and writhing so as to remind one of the head of the fabled Medusa.

Prof. Leidy then directed attention to several other specimens which had been sent to him for information. One of these is a bunch of tapeworms, 15 individuals of *Tænia diminuta*, from the intestine of a rat. The other is the liver of a rat, with a multitude of cysts, the size of large peas, containing *Cysticercus fasciolaris*. In a letter, accompanying the specimens, Dr. John R. Hewett states, that last spring he had examined about 500 rats (*Mus decumanus*), in Carroll Co., Mo., and only in half a dozen instances did he find the liver free from the parasite.

Messrs. Geo. A Binder, Jacob Binder, Charles Henry Hart, and H. Dumont Wagner were elected members.

The following papers were ordered to be printed:—

NOTE ON HYRACEUM.

BY WM. H. GREENE, M.D., AND A. J. PARKER, M.D.

Among the native remedies from the Cape of Good Hope, exhibited at the Centennial Exhibition, was a peculiar substance called hyraceum, which was supposed to be the inspissated urine of the Cape Hyrax (*Hyrax capensis*).

The material was obtained from Dr. Leidy, who, in the Proceedings of the Academy, December, 1876, p. 325, gave a short account of it. According to this account, "the Hyrax is reputed to inhabit gregariously rocky places at the Cape of Good Hope, and the accumulated urine in the hollows of rocks, gradually evaporating, is supposed to give rise to the product in question. It is reported as having been employed in medicine with the same effect as castoreum."

Prof. Cope remarked that "a material resembling the concretion made by the urine of the Hyrax was found in the fissures of the rocks of New Mexico. It is probably the fecal and renal deposit of the wild rat, *Neotoma*."

About two years ago, we made an exhaustive examination of this substance. It is a dark-brown, brittle, and resinous material, having an aromatic odor, and a bitter taste. About 56 per cent. of it is soluble in water, and nearly one-third of the residue from the aqueous extraction is soluble in alcohol, ether, and chloroform.

The soluble material amounts in all to about 70 per cent., and the remainder is composed of 14 per cent. of woody fibre and insoluble organic material, and 16 per cent. of sand and other inorganic substances.

On ignition, hyraceum yields about 34 per cent. of ash, which is composed of chlorides, sulphates, phosphates, and carbonates of the alkaline metals, and of lime and magnesia. It also contains nitrates in small proportion.

On precipitating the organic material contained in the aqueous extract with lead acetate, and afterwards decomposing the suspended precipitate by means of sulphuric acid, a substance was obtained which constitutes the greater portion of the organic material soluble in water. It was hard, horny, and of a resinous character, transparent, and of a bright brown tint. It probably consists of several substances, but we were unable to obtain a sufficient quantity for separation, and an ultimate organic analysis. It gives out a fecal odor, and seems to be derived from fecal matter.

The analysis, the details of which are subjoined, shows that the substance is a mixture of various salts and organic matter, the latter constituting about one-half, and containing traces of urea, together with uric, hippuric, and benzoic acids. We also obtained from the material a small quantity of a substance having a sweet taste, and which is probably glycocol (?) derived from the breaking up of hippuric into benzoic acid, and this substance.

Hyraceum is undoubtedly derived from the urine of some animal, but the large amount of lime (6 per cent.) in proportion to the other salts, and the character of the organic matter contained, indicates that it also contains fecal matter.

Analysis of Hyraceum.—Water, by dessication, 7 per cent.

A microscopical examination revealed nothing of importance. Woody fibres, particles of sand, and a general granular appearance were found.

DRIED MATERIAL.

Ash	34.15
Organic substances soluble in water	37.44
" " " alcohol, ether, and chloroform	14.54
Woody fibre, and insoluble organic substances; residue	13.87
	100.00

ASH.

Soluble in water	19.20
Insoluble "	14.95
Potassa	2.95
Soda	8.95
Lime	6.00
Magnesia	2.10
Iron	.12
Sand	2.00
Sulphuric acid	.60
Carbonic "	3.64
Phosphoric acid	.97
Chlorine	6.45
Traces of nitric acid, and loss	.37
	34.15

MORPHOLOGICAL NOTES ON THE LIMBS OF THE AMPHIUMIDÆ, AS INDICATING A POSSIBLE SYNONYMY OF THE SUPPOSED GENERA.

BY JOHN A. RYDER.

Little attention has apparently been given to the comparative history of the limbs of the known species of *Amphiuma*. Very young specimens do not seem to have been usually collected for museums. I have had the opportunity to study such a series varying from 6 to 8 inches long, and about $\frac{1}{4}$th inch, or a little more, in diameter; they were obtained in the vicinity of Biloxi, Mississippi, and are the property of the Smithsonian Institution at Washington.

From these it appears that the digital elements of the limbs are variable, or liable to variation in the same individual, so that in some the number of digits (two) is characteristic of *Amphiuma*, and in others (three) they are characteristic of *Muraenopsis*. This blending of the characters of the two genera may be illustrated as follows, indicating the number of digits on each limb by numerals, arranged in fours, the first pair representing the digital formula of the four limbs, thus: (1) $\frac{2}{2}\,\frac{3}{3}$; (2) $\frac{2}{2}\,\frac{3}{2}$; (3) $\frac{3}{3}\,\frac{3}{3}$; and (4) $\frac{2}{2}\,\frac{2}{2}$; there was also a form which exhibited no outward indication of toes on the front pair of limbs, the digits being inclosed in a common investing integument; this fifth form may be represented in this manner $\frac{\{2\ 3}{\{2\ 3}$. It is plain from the foregoing, that at no very remote period the two forms which are now believed to characterize distinct genera were probably one and the same. The three-toed form (*Muraenopsis*) is said to be confined to the Southern United States, whilst the two-toed form (*Amphiuma*) is more widely distributed, extending farther north, and also embracing the distribution of the former. The digital formula of (1) is *Amphiuma* in the front pair, and *Muraenopsis* in the hind pair of limbs; that of (2) is *Amphiuma* on one side in the hinder pair, and *Muraenopsis* on the other. Normal individuals of both genera also occur, as in (3) and (4); while (5) represents the beginning of the differentiation of a third generic type, if the number of digits be good and sufficient to characterize genera. Prof. Cope, who has probably handled more specimens of *Amphibia* than any other American naturalist, informs me that he thinks these variations very uncommon, as he has never in his experience met with any instance in which there was as much variation in the number of digits as exhibited in these Biloxi specimens. They can hardly, however, be regarded as monstrosities, as the percentage of varying specimens in this series is entirely too high. I am inclined to believe that they are simply instances on the one hand of reversion toward a still older, and more unspecialized type, and on the other of a tendency to become specialized or reduced, as in the case where the two digits are covered by a common tegumental investment. If the distribution of species will in any case serve to throw light upon the differentiation of genera, I think that in this instance we may assume, with much show of reason, that the individuals most remote from the centre of maximum development of species and individuals exhibit the greatest tendency towards digital reduction. The most northern form, *Amphiuma*, seems to be constantly didactyle, whilst the more southern forms are both di- and tridactyle, which would seem to indicate that the forms most remote from the centre of distribution have been under conditions tending to produce didactylism synchronously with di- and tridactylism at the centre aforementioned. This, however, is only a hypothetical view of the case.

The admission of *Muraenopsis* and *Amphiuma* to generic rank on account of a difference, which is here shown not to be constant, is doubtful. The digits, which from the fact of their having undergone reduction, seem to be not so much rudiments as vestiges of former digits, render the legitimacy of the distinction even more open to question. For I think it cannot be doubted that such a tendency to degenerate, accompanied with a consequent tendency to produce synthetic characters, shows clearly that nature has not yet concluded that they shall be genera, notwithstanding the dicta and definitions of systematists.

ON THE LAND SHELLS OF THE MEXICAN ISLAND OF GUADELUPE, COLLECTED BY DR. E. PALMER.

BY W. G. BINNEY.

The island of Guadelupe is about 220 miles from San Diego, off the west coast of Lower California. Its molluscous fauna has for the first time been made known by the researches of Dr. Edward Palmer, who visited it in 1875. He found numerous fragments of snail shells which had been devoured by a species of mouse, the only inhabitant of the island. These fragments appear to belong to *Arionta Rowelli*, Newcomb (see L. & F. W. Sh. of N. A. I. p. 185), a species found in Lower California. Some perfect shells were found, among them a smaller variety. *Arionta facta*, Newcomb, was also found, the variety with open umbilicus, like that form found fossil on San Nicolas Island, California.

The most interesting discovery, however, is that of living specimens of *Binneya notabilis*, a species found also on the California island of Santa Barbara. There is strong reason for believing the Mexican genus *Xanthonyx* to be synonymous with *Binneya*. We may suppose, therefore, that from Mexico the genus has been introduced by the usual means of distribution to this island of Guadelupe, and thence to Santa Barbara. Thus, its presence on the latter island is accounted for, which was not the case when we had only the mainland of California to look to, as its absence there has been proved. So, also, in the case of *Arionta facta*, we may account for its distribution by supposing it to have been introduced from some unknown locality on the mainland to Guadelupe first, and thence to the California islands.

The specimens collected are in the Museum of the Boston Society of Natural History.

Four species of Orthoptera were collected also. One of these is shown by Dr. Scudder to be identical with a Mexican species, and two of the others have also been found at San Diego.

LIST OF LAND SHELLS INHABITING RURUTU, ONE OF THE AUSTRAL ISLANDS, WITH REMARKS ON THEIR SYNONYMY, GEOGRAPHICAL RANGE, AND DESCRIPTIONS OF NEW SPECIES.

BY ANDREW GARRETT.

The small island of Rurutu = Oheatora of Capt. Cook, lies in south lat. 22° 34′, and west lon. 150° 13′, which is about 320 miles S.S.W. from Tahiti. As near as I can ascertain it is about eight miles in length, and has an elevation of about 1500 feet, over 100 feet of which consists of ancient coral reefs, which have been upheaved to that altitude.

Mr. Hugh Cuming was the first who visited the island for the purpose of collecting shells, and discovered two or three new species. The next experienced collector, Mr. Charles De Gage, who resides there, gathered a number of land shells, which he kindly forwarded to me for identification, and which form the subject of this paper.

Microcystis subtilis, Anton.

Helix subtilis, Anton, Verz. p. 35; Pfeiffer, Mon. Hel. vol. II. p. 33; Reeve. Conch. Icon. pl. 111, fig. 626.
Helix vitrinella, Pfeiffer, Symb vol. II. p. 41.
Helicopsis vitrinella, Beck, Ind. p. 20.
Nanina (*Microcystis*) *subtilis*, Albert, p. 60.

Oheatora = Rurutu (Cuming).

This species was not found by De Gage.

Microcystis punctifera, sp. nov.

Shell small, imperforate, orbicular, depressed, thin, smooth, shining, transparent, light-brownish horn color, dotted with white; spire convex; suture linear; whorls $4\frac{1}{2}$, depressly convex, radiately striate beneath the suture, moderately and regularly increasing; the last not descending in front, rounded on the periphery; base indented; aperture sub-vertical, orbicular lunate, wider than deep; peristome straight, simple, margins remote; columella slightly thickened with callus.

Height 3, major diameter $4\frac{1}{2}$ mill.

It is smaller, and darker colored than *subtilis*, which latter is pale horn color, and six mill. in diameter. It is more like *M. brunnea* collected by Cuming at Pitcairn's Island, which is about the same color, with white dots, but like *subtilis* is six mill. in diameter.

Patula Rurutuensis, sp. nov.

Shell umbilicate, discoid, thin, translucent, yellowish-horn color, the spire tessellated, and the last whorl with radiating flexuous fuscous stripes; radiately ribbed with small thin flexuous costæ, and decussated with microscopical raised lines; spire depressly convex; suture sub-canaliculate; whorls 5, convex, narrow, slightly turgid near the suture; slowly and regularly increasing, the last not descending in front, sub-angular on the periphery; umbilicus deep, about one-fourth the major diameter of the shell; aperture somewhat oblique, depressly lunate; parietal region with a small revolving lamina on the upper third of the wall; peristome acute, straight, with remote margins.

Major diameter $3\frac{1}{2}$, height 2 mill.

The fine spiral striæ, thin ribs, single parietal lamina, and depressed sub-angular body whorl are its most prominent characters, and will readily distinguish it from any of the south Polynesian species.

Pitys De Gagei, sp. nov.

Shell umbilicate, sub-discoid, thin, translucent, corneous or luteous, horn color, spire more or less distinctly tessellated with chestnut-brown, and the last whorl radiately strigate with the same hue, the stripes sometimes flexuous, and the base either unicolor or adorned with stripes; sculpture consisting of fine, closely-set, radiating, slightly arcuate, thin, costulate striæ, smaller and more crowded beneath; spire convex, apex planulate; suture canaliculate; whorls 6, convex, narrow, swollen next the suture, slowly and regularly increasing, the last not deflected in front, slightly depressed, and somewhat tumid; base moderately convex, with a small but deep umbilicus; aperture slightly oblique, narrow, lunate; the palate with five, and the parietal wall with three revolving lamina; peristome acute, straight, margins remote.

Major diameter 3, height $1\frac{1}{2}$ mill.

Closely allied to *P. Maupiensis*, but may be distinguished by its coarser, rib like striæ, more oblique aperture, smaller umbilicus, and more depressed body whorl.

Partula hyalina, Broderip.

Partula hyalina, Broderip, Proc. Zool. Soc. 1832, p. 32.
Bulinus hyalinus, Sowerby, Conch. Ill. fig. 9.
Bulimus hyalinus, Pfeiffer, Mon. Hel. vol. II. p, 67.
Partulus hyalinus, Beck, Ind. p. 47.

Judging from the number sent this is an abundant species. A few years ago I received a large quantity from Tubuai, also one of the Austral group, and nearly 100 miles east of Rurutu. That group is, without doubt, its specific centre, or metropolis.

The most surprising feature in the geographical distribution of this species is its occurrence in three distinct groups of islands. It is found, though sparingly, in nearly every valley in Tahiti, which is over 300 miles from its metropolis. I also obtained it at Mangaia, one of the Cook's or Hervey Islands, 400 miles west of Rurutu.

Had it only been detected in one or two valleys in Tahiti, its introduction could have been attributed to human agency. But when we consider its wide diffusion we can only account for its presence either by a separate creation of the same species in three groups of islands, or speculate on its distribution in some remote period, when the three groups formed a single large island, or part of a continent.

After a careful comparison of many examples from the three groups of islands, I cannot detect the slightest variation. Shells from the same locality vary slightly in the length of the spire, in size and thickness.

It is a strictly arboreal species, and may be distinguished by its uniform white color, flat, and widely-expanded peristome, and gibbous columella lip.

Reeve's figure is too much elongated.

Stenogyra juncea, Gould.

Bulimus junceus, Gould, Proc. Bost. Soc. 1846, p. 191; Ex. Shells, p. 76, fig. 87—Pfeiffer, Mon. Hel. vol. II. p. 220.

Stenogyra upolensis, Mousson, Jour. d. Conch. 1865, p. 175.

Bulimus upolensis, Pfeiffer, Mon. Hel. vol. VI. p. 100.

This common species is very widely diffused through Polynesia. I have found it inhabiting all the groups north of the equator, and south at all the islands from the Marquesas and Paumotus to the Viti group, and, in all probability, it ranges further west.

They are found under loose stones, beneath decayed wood, and among dead leaves, and range from near the seashore to 2000 or more feet above sea-level. The animal is light yellow.

Vertigo pediculus, Shuttleworth.

Pupa pediculus, Shutt., Bern. Mitth. 1852, p. 296—Pfeiffer, Mon. Hel. vol. III. p. 557—Mousson (Var. *Samoensis*), Jour. de Conch. 1865, p. 175.

Vertigo pediculus, Pfeiffer, Vers. p. 177.
Pupa sphyradium (*Samoensis*). Paetal, Cat. Conch. Sam. p. 108.
Pupa nitens, Pease, Proc. Zool. Soc. 1860, p. 459—Pfeiffer, Mon. Hel. vol. VI. p. 329.
Pupa hyalina, Zelebor, Pfeiffer, Mon. Hel. vol. VI. p. 329.
? *Vertigo nacca*, Gould, Proc. Bost. Soc. 1862, p. 280.

The few specimens received differ none from Tahitian and Cook's Islands examples.

At the latter location I found them in vast numbers on stony ground in a grove near the seashore, but comparatively rare in the mountain ravines. It occurs in more or less abundance at all the Polynesian Islands, also at the Viti group, and perhaps extends further west.

I obtained Mr. Pease's type specimens of *nitens* at Ebon, a low coral island in the Caroline or Marshall group. When he described that species he was not aware that Mr. Shuttleworth had anticipated him in his *pediculus*, described from Tahitian and Marquesian examples.

It is evident from Mr. Pease's remarks on page 463, Proceedings of the Zoological Society for 1871, that he entertained doubts of the specific weight of his *nitens* and Gould's *nacca*.

Many years ago I collected a species of *Vertigo* near Hilo, Hawaii, where Dr. Gould's types were obtained, and as near as I can recollect they differed none from *pediculus*.

The description of *nacca* is so brief and unsatisfactory that I cannot decide with certainty, so have marked it doubtful.

The following is Gould's diagnosis:—

"T. ovata, lucida, alabastrica, tennuissima, striata; anfr. 4 + ventricosus apice obtuso; sutura profunda; apertura subcircularis dente palatali (interdum bifido) dente columellari, dente basali denteque labiali armata; peritremate valde reflexo; umbilico rimato.—Axis $\frac{1}{10}$, diam. $\frac{1}{12}$. poll" (Gould).

With respect to Zelebor's *hyalina*, which is elaborately described, I do not hesitate to add it to the synonymy of *pediculus*.

The variation of *pediculus* consists in the more or less oblong form, distinctness of striation, more or less turgid whorls, compression of the base, and size of the rimate umbilicus. The parietal lamina is usually double, though often single, or bifurcate, and like the columellar tooth is constant. The palate is usually furnished with three teeth, which may be considered the normal number, though they frequently vary, and may be altogether absent. Sometimes they are duplicated, or double, and more rarely may be seen rudimentary or secondary denticles besides the normal number.

Tornatellina oblonga, Pease.

Tornatellina oblonga, Pease, Proc. Zool. Soc. 1864, p. 673—Pfeiffer, Mon. Hel. vol. VI. p. 264.

Tornatellina bacillaris, Mousson, Jour. de Conch. 1871, p. 16, pl. 3, fig. 5.

A common species, ranging from the Marquesas and Paumotus to the Samoa Islands, and perhaps extends further west to the Viti group.

Prof. Mousson gives an accurate description of *oblonga* under the name *bacillaris*, from Samoa examples collected by Dr. Graffe.

They are found among dead wood and leaves, and sometimes on the fronds of ferns. They range from near the seashore to 2000 or more feet above sea-level.

Mr. Pease's type specimens were collected at the Society Islands.

Tornatellina conica, Mousson.

Tornatellina conica, Mousson, Jour. de Conch. 1869, p. 342, pl. 14, fig. 8; l. c. 1870, p. 128; l. c. 1871 (Var. *impressa*), p. 16.

Cionella (*Leptinaria*) *conica*, Paetel, Cat. Conch. Sam. p. 106.

Tornatellina oblonga, Pease (Part), Proc. Zool. Soc. 1864, p. 673.

This species, which is not uncommon, ranges from the Marquesas to the Viti Islands, and was collected by Dr. Graffe on the low coral islands of Ellice's group in central Polynesia.

Mr. Pease received from me some of these shells intermixed with *oblonga*, and supposing the two to be identical he included them in his diagnosis of that species. Since then I have collected thousands of specimens of both species at the various groups; and have hundreds now before me of all ages, and do not hesitate to pronounce them quite distinct. The shell under consideration I refer to Mousson's *conica*. His variety *impressa* is not uncommon in S. E. Polynesia.

As compared with *oblonga*, it is lighter colored, more robust, the spire more tapering, body whorl larger, and frequently with a marked depression in the middle, which is sometimes slightly concave. The parietal lamina is larger, and the columella more tortuous.

Tornatellina Philippi Pfeiffer.

Tornatellina Philippi, Pfeiffer, Zeitsch. Malak. 1849, p. 93; Mon. Hel. vol. III. p. 524.
Pupa Philippi, Kuster, pl. 18, fig. 20, 21.
Leptinaria Philippi, Ad., Gen. Mon. p. 141.
Achatina Philippi (*Leptinaria*), Pfr., Vers. p. 170.

There were several examples of this species among Mr. De Gage's shells, which differed none from Tahitian specimens. It also occurs at the Cook's and Marquesas Islands, though not common at any of the above-mentioned locations.

It may be readily distinguished by its swollen whorls, globose body, large compressed parietal lamina, and somewhat tortuous columella, which in young examples is biplicate.

Tornatellina simplex, Pease.

Tornatellina simplex, Pease, Proc. Zool. Soc. 1864, p. 673—Pfeiffer, Mon. Hel. vol. VI. p. 266.

Not uncommon at Rurutu, and we found it at the Marquesas, Society, and very abundant at the Cook's Islands.

It agrees precisely with Mr. Pease's description of *simplex*, except having one more whorl, and *all* have the usual, though smaller parietal lamina, which he must either have overlooked or omitted to mention. I collected his type specimens at Tahaa, one of the Society Islands, and am positive this is the shell I sent him. At least I do not know of any species without the parietal lamina. Moreover, this is the only umbilicated species he received from me.

Tornatellina nitida, Pease.

Tornatellina nitida, Pease, Proc. Zool. Soc. 1860, p. 439—Pfeiffer, Mon. Hel. vol. VI. p. 264.

This common species inhabits all the islands in southeastern Polynesia, and extends its range through the small islands in central Polynesia to the Caroline or Marshall's group, where I obtained Mr. Pease's type specimens.

His diagnosis not being very satisfactory, I subjoin the following description:—

Shell small, imperforate, oblong, or elongate-conic, thin, smooth, shining, transparent, brownish-horn color; spire more or less elongate-conic, with sub-planulate outlines, and obtuse apex; suture well defined, linear; whorls 5–6, strongly convex, slowly and regularly increasing, the last not descending in front, sometimes slightly flattened near the peristome; aperture oblique, oblong, in adults about a third the length of the shell; parietal region with a thin, prominent lamina, which runs nearly parallel with the suture; peristome straight, acute, with the margins remote; columella tortuous, the lower margin armed with a thin, acute, slightly oblique fold; the palate frequently with one or two spiral rows of small compressed denticles.

Length 3, major diameter $1\frac{1}{4}$ mill.

A thin transparent species, with a more tapering spire than *oblonga*, with the twisted columella of *conica*, but readily distinguished from either by the acute plication in the columella, which can only be distinctly seen when looking obliquely into the aperture. Owing to the transparency of the shell, the sutural line appears to be narrowly margined. The palatal denticles, though sometimes wanting, were overlooked by Mr. Pease.

It is worthy of remark that the above author in his list of Paumotus shells received from me, and published in the French Journal of Conchology for 1871, refers the S. E. Polynesia species to his *nitida*.

Tornatellina affinis, sp. nov.

Shell small, imperforate, ovate-conic, thin, smooth, shining, transparent, light brownish-horn color; spire oblong-conic, with planulate outlines; apex obtusely rounded; suture narrowly margined; whorls six, plano-convex, slowly and regularly increasing, the last not deflected in front, rather large; aperture oblique, irregularly abbreviate ovate, a little more than a third the length of the shell; parietal wall with a strongly compressed prominent lamina; peristome acute, straight, regularly curved, margins remote; columella tortuous, not plicate or dentate.

Length $2\frac{3}{4}$, major diameter $1\frac{1}{2}$ mill.

This species, which we have ventured to record as new, is shaped very much like *Philippi*, but the whorls of the spire are flattened, and the body is not so turgid as in that species. The columella has the peculiar twist of *conica*, but our shell is smoother, more shining, the spire more tapering, and the whorls much more depressed.

Tornatellina micans, sp. nov.

Shell small, imperforate, ovate-conic, transparent, thin, polished, faintly striate under the lens, pale brownish-horn color; spire sub-acute, oblong-conic, sides planulate; suture distinctly and narrowly marginate; whorls six, sub-planulate, slowly and regularly increasing, the last rather large, not descending in front; aperture oblique, ovate-lunate, more than a third the length of the shell; parietal wall with a prominent, strongly-compressed lamina; peristome thin, simple, regularly curved; columella slightly twisted, depressed, armed with a sub-median, nearly horizontal, acute tooth-like fold; palate with numerous irregularly disposed denticles.

Length $2\frac{1}{2}$, major diameter $1\frac{1}{2}$ mill.

The single example before me differs so much from any other species, that, after some hesitation, I have concluded to describe it as new.

It is shaped almost precisely like *affinis*, but has the palatal denticles, and acute, columellar, tooth-like plait of *nitida*.

Tornatellina perplexa, sp nov.

Tornatellina bilamellata, Schmeltz (not Anton), Cat. Mus. Godeff. No. 5, p. 90.

Shell small, oblong-conic, imperforate, fragile, glossy, pellucid, smooth, pale brownish-horn color; spire oblong-conic, with sub-planulate outlines; apex obtusely rounded; suture distinctly linear; whorls six, convex, moderately and regularly increasing, the last convexly rounded, not deflected in front; aperture oblique, ovate-lunate, about one third the length of the shell; peristome thin, straight, regularly curved; columella depressed, tortuous, bi-dentate, the basal tooth small, the upper, which is submedial, is large and prominent; parietal region with a large, prominent, curved lamina; palate garnished with more or less numerous irregularly disposed denticles.

Length $2\frac{3}{4}$, major diameter 1 mill.

Mr. De Gage sent a number of these shells of all ages, and I have myself collected the same species at the Cook's and Society Islands.

Its close resemblance to *nitida* has perplexed me so much that I have long hesitated about the propriety of separating the two as distinct.

It may, however, be distinguished from that species by its more dilated and bidentate columella. The upper tooth is also larger, and less acute than in *nitida*. Some examples have the palatal denticles mounted on delicate, longitudinal lines of callus. Others have the internal teeth so distinct as to give the aperture a ringent appearance.

Cook's Island examples sent to the Museum Godeffroyanum were erroneously referred to Anton's *bilamellata*, a species twice the size of this.

Tornatellina serrata, Pease.

Lamellina serrata, Pease, Proc. Zool. Soc. 1860, p. 439.
Tornatellina serrata, Pfeiffer, Mon. Hel. vol. VI. p. 265.
Lamellina lævis, Pease, Proc. Zool. Soc 1864, p. 672.
Tornatellina lævis, Pfeiffer, Mon. Hel. vol. VI. p. 266.

This species has the same extensive range through Polynesia as *nitida*. Many years ago I found the same, or a closely allied species on low bushes near the seashore at Guam.

They, like nearly all the species, are usually found adhering to the under surface of loose stones, dead wood, among decayed leaves, and sometimes on the leaves of low bushes.

I obtained Mr. Pease's type examples of *serrata* at Ebon, in Micronesia; and his *lævis* at Huahine and Tahiti. Mr. Cuming, who received specimens of both species, considered them identical.

After a careful examination of a large number of all ages from the different groups of islands, I find the palatal lamina much more frequently serrated than smooth. They are, in fact, all smooth at certain periods of their growth.

The description of *serrata* is somewhat obscure; that of *lævis* is more accurate.

It cannot well be confounded with any other Polynesian species; its ovate-conic form, swollen whorls, deep suture, acute columellar tooth, and, more particularly, the remote longitudinal, prominent, smooth, or serrated palatal laminæ will readily distinguish it from any other.

The last character induced Mr. Pease to establish his genus *Lamellina*. In his list of Polynesian land shells published in the Proceedings of the Zoological Society for 1871, he records only two species, his *serrata* and *lævis*, while he overlooked the same, but less conspicuous character in *Hidalgoi*, Crosse, inhabiting the Gambier Islands. The accurate figure of that species in the Journal de Conchyliologie for 1865, exhibits a small bidentate lamina. Specimens from the same locality, now before me, either possess the same feature, or have simply from one to two spiral rows of denticles in the palate.

Petit's *globosa*, from Rapa or Opara is described as having two obsolete plicæ in the palate. In *micans*, *perplexa*, and *nitida* we find short plicæ or denticles, and frequently rudimentary longitudinal lamina. Some specimens of *nitida* have the latter character as strongly developed as in *serrata*. Prof. Mousson has described a Viti species under the name of *columellaris*, which is either the same or very closely allied to *nitida*, and possesses denticles in the palate.

If the genus *Lamellina* is accepted, it should be modified so as to include all the species with either denticles, plicæ, or laminæ in the palate, though the character on which the genus is based is not, in my opinion, of sufficient importance to rank as generic.

There are several other species described, from other parts of the world, which possess the same characters.

Succinea De Gagei, sp. nov.

Shell ovate, pale to dark-amber color, or ferruginous, thin, fragile, pellucid, scarcely shining. more or less rugose with lines of growth; spire moderately produced, sub-acute, less than a third the length of the shell; whorls 3–3½, convexly rounded, the last large, obliquely produced; aperture sub-vertical, large, regularly ovate, acute above, sides nearly equally curved, rounded below; columella thin, gently arched; peristome acute, regularly curved.

Length 11, major diameter 7 mill.

Mr. De Gage sent about 100 examples of all ages: it is the first species recorded from the Austral Islands.

It is closely allied to Gould's *pudorina*, a Tahitian species, but is smaller, less elongate, and the spire is less produced.

Melampus violus, Lesson.

Auricula viola, Lesson, Voy. Coquille, p. 342.
Melampus caffer, Var. *B.*, Pfeiffer, Mon. Auric. p. 40.
Melampus viola, Pfeiffer, Mon. Auric. p. 58.
Melampus caffer, Pease (not of Kuster), Jour. de Conch. 1871, p. 93—Schmeltz, Cat. Mus. Godeff. n. 5, p. 88.
Melampus violus, Pease, Proc. Zool. Soc. 1871, p. 477.

The Rurutu shells received differ none from those I collected at the Paumotus and Society Islands.

From the above synonymy and references it will be seen that there is some confusion in respect to the interpretation of Lesson's species, which he obtained at Borabora, one of the Society Islands.

There are only five species of *Melampus* inhabiting that group, and they are common to all the islands. Of these, *striata*, as far as known, has not been discovered elsewhere; while of the remaining four species, *luteus* and *fasciatus* are very widely diffused through Polynesia, Melanesia, and the Indian Seas. *M. Philippi* seems to be confined to southeastern Polynesia. All the abovementioned four species are correctly determined. We now have only the species under consideration to identify.

In 1871, Mr. Pease published in the French Journal of Conchology a list of Anaa (Paumotus Isl.) land shells, collected by me in 1865, and recorded this species as *caffer*, Küst. Adopting his view I distributed the shells to my correspondents, under that name.

The same year he published his list of Polynesian land shells in the Proceedings of the Zoological Society, and excluded *caffer*, but recorded *violus* from Borabora.

Dr. Pfeiffer's *caffer*, var. β, which Mr. Cuming collected at Rurutu, is undoubtedly the same as our shell.

It is a very common species, and is confined to the Paumotus, Society, and the Austral Islands. Its limited range also proves its distinctness from *caffer*, which is recorded as a south African and Philippine species.

In shape, it resembles *fasciata*, and the last whorl is sub-angulate above. The spire is convexly conoid, mucronate, and nearly one-third the length of the shell; the upper whorls usually have a few faint radiating incised lines. The well-impressed suture is more or less lacerated by large wrinkles of growth on the last whorl. The base is sub-rimate, and sometimes decussated with a few faintly-defined impressed striæ. Parietal region with two, sometimes three plicæ on the basal half, and the brownish-violet columella has a rather small oblique fold. The inner margin of the peristome is always deep chestnut-brown, approaching black, and the palate has 4–6 bluish-white plicæ.

Living shells are uniform fuscous; frequently the belly or front of the last whorl is brownish-yellow, with a transverse fuscous band just beneath the middle. Sometimes, though more frequently in immature examples, the ground-color is brownish-yellow, with the spire and upper portion of the last whorl, together with a sub-basal band, fuscous.

Length 12, major diameter 7 mill.

Melampus luteus, Quoy et Gaimard.

Auricula lutea, Q. et G., Voy. Astrol. vol. II. p. 163, pl. 13, fig. 25–27.
Melampus luteus, Pfeiffer, Mon. Auric. p. 36.
Conovulus luteus, Anton., Verz. p. 48.

This species is abundant at all the Polynesian Islands, except the Sandwich and Marquesas groups.

The only variation is in size, and depth of color; it is never banded. This, and the preceding species, are found just above high-water mark.

Omphalotropis curta, sp. nov.

Shell small, rimate, abbreviately ovate, solid, faintly striate, cinereous under a thin yellowish-olive epidermis; spire obtuse, short, convexly-conical, more or less decorticated; suture deeply impressed; whorls five, convex, the last very large, rounded, nearly half the length of the shell, the periphery with a stout rounded keel; basal carination large; aperture nearly vertical, roundly-ovate, whitish or reddish yellow; peristome rather thick, straight, and continuous.

Length 5, major diameter 3½ mill.

Quite distinct from any other Polynesian species, and may be readily distinguished by its short stout shape, and large rounded keel.

Chondrella striata, Pease.

Chondrella striata, Pease, Proc. Zool. Soc. 1871, p. 477.
Hydrocena striata, Schmeltz, Cat. Mus. Godeff. No. 5, p. 100.

Mr. De Gage sent several examples of this species, which differed none from Cook's and Society Islands specimens.

They inhabit dry localities in forests, and are found adhering to rocks, dead wood, and the under surface of loose stones.

They vary slightly in size, height of spire, distinctness and size of the spiral, raised lines, which in some examples are obsolete. The color is usually reddish-brown, sometimes ruddy corneous, rarely pale yellow.

The genus *Chondrella* was established by Mr. Pease in 1871, the type of which is his *Cyclostoma parvum*. In his list of Polynesian land shells he records three species, his *parva*, *striata*, and *minutissima*, Sowb. The last inhabits Pitcairn Island. *Hydrocena insularis*, Crosse, from the Gambier Islands, which Mr. Pease referred to his sub-genus *Atropis*, is a *Chondrella*, closely allied to *parva*, or, more correctly, intermediate between the latter and *striata*. *Cyclostoma exigua*, Homb., also from the Gambiers, probably belongs to the same genus.

Mr. Pease, in his description of the genus, remarks, from observations made by me that the animal was destitute of tentacles. Since the above was published, I have verified my former observations by a careful study of many examples of both *striata* and *parva*.

The animal is translucent, and, excepting the large conspicuous black eyes, is colorless in both species. The foot is small, oblong, rounded behind, and during locomotion is nearly or quite concealed by the shell, which is carried diagonally. The head, which is entirely destitute of tentacles, is produced into a short blunt muzzle, which sometimes assumes a slightly bi-lobed appearance. When creeping, only the extreme tip of the muzzle is seen from above, while the conspicuous eyes are plainly visible through the transparent shell.

Helicina minuta, Sowerby.

Helicina minuta, Sowerby, Proc. Zool. Soc. 1842, p. 7; Thes. p. 13, pl. 1, fig. 40-41.

This small species is very abundant, and agrees in every respect with Tahiti and Moorea examples. It is not found on any of the other islands of the Society group, though several species inhabiting the other islands are usually confounded with *minuta*, one of which is described by Dr. Pfeiffer under that name.

Sowerby's type specimens were collected at Rurutu by Mr. Cuming. His diagnosis, though very brief, accords well with the shells before me. The size he gives is also precisely the same. The shell described by Pfeiffer, which is larger, is, as near as I can determine, one of Mr. Pease's unpublished species, which inhabits Raiatea.

Assiminea nitida, Pease.

Hydrocena nitida, Pease, Proc. Zool. Soc. 1864, p. 674.
Hydrocena parvula, Mousson, Jour. de Conch. 1865, p. 184.
Assiminea nitida, Pease, Jour. de Conch. 1869, p. 165, pl. 8, fig. 11.
Assiminea lucida, Pease, Jour. de Conch. 1869, p. 166, pl. 8, fig. 10.
Omphalotropis parvula, Paetel, Cat. Conch. Sam. p. 124.
Hydrocena similis, Baird, Brenchly's Cruise of the Curacoa.

This small species ranges from the Marquesas and Paumotus to the Viti Islands.

They are found under dead wood, among decayed leaves, and range from near the seashore to about 2000 feet above sea-level.

The only variation is in size, more or less produced spire, and color, which varies from a light to dark corneous, rarely brownish, with faint indication of a band on the body whorl.

I obtained Mr. Pease's type specimens of *lucida* in beach sand at Anaa, one of the Paumotus Islands. They were worn, and discolored by salt water. Living shells, which I subsequently found at the same locality, differed none from *nitida*.

DESCRIPTION OF A NEW SPECIES OF GONIOBRANCHUS.

BY ANDREW GARRETT.

Goniobranchus albopunctatus, Garr.

Animal elongate-oval, depressed, the two ends equally rounded, a little the widest at the middle, and, when in motion, it becomes more elongate, and the sides nearly parallel. The dorsal region is depressly convex, smooth, and the margins of mantle thin. The upper surface is bright orange-yellow, with crowded opaque white dots, and minute annulæ; the mantle with a band of small irregular lemon-yellow spots near the margin, which latter is edged with violaceous.

The dorsal tentacles, which issue from simple orifices, are elongate ovate, sub-mucronate, somewhat trigonal, purple-brown, profusely dotted with opaque white, and marked with two vertical lines of the latter color.

The branchial plumes are rather large, twelve in number, connate at their base, decreasing in size posteriorly, and encircling the prominent anal tube; they are colored and dotted similar to the tentacles, and each ornamented with two longitudinal white lines.

The under surface of the mantle and foot are pale lemon-yellow, the former margined the same as above.

The head is small, and furnished with moderate, obtuse, cylindrical tapering labial appendages.

The foot is elongate, narrow, obtusely rounded in front, sides parallel, rounded behind, and, when in motion, extends considerably behind the mantle.

Length, 62; diameter, 20 millimetres.

Hab.—Huahine, Society Islands.

A very rare species found on weedy bottom in the upper region of the laminarian zone, and is the only example which has occurred to my notice during ten years collecting in the group.

FEBRUARY 4.

The President, Dr. RUSCHENBERGER, in the chair.

One hundred and nine persons present.

Fossil Remains of a Caribou.—Prof. LEIDY directed attention to several fossil specimens which he had received for determination from Prof. F. M. Witter, of Muscatine, Iowa. They were found together, with others apparently of the same animal, in the Loess on which the city of Muscatine is built.

Two of the fossils consist of fragments of the left side of the upper and lower jaws, retaining most of the molar teeth in good condition. Another specimen is an uncharacteristic bone fragment. Other bones were too much decomposed for preservation.

The specimens with teeth indicate a species of deer, of an individual past maturity, as the crowns of the teeth are half worn away, exhibiting broad, comparatively flat surfaces. The character of the fossils appeared unfamiliar, and at first were suspected to have pertained to an extinct and undescribed species. The proportionately large size of the premolars, in comparison with those of ordinary forms of deer, appeared as a distinctive feature.

Observing that the fossils were larger than the corresponding parts of the barren ground caribou, *Rangifer groenlandicus*, it was suspected that they may have pertained to the woodland caribou, *Rangifer caribou*. In this view, not having the latter for comparison, the specimen of the upper jaw with the teeth was sent to Dr. Elliott Coues, of Washington, with the request that he should compare it with specimens of the woodland caribou in the collection of the Smithsonian Institution.

Dr. Coues reports that the fossil was carefully compared with numerous specimens of caribou, and he adds: "I think you may safely announce *Rangifer caribou* from the Loess of Iowa." He further remarks, that "the specimen is more worn as to the teeth than any I find to compare with it, being ground away so that almost the broadest looking set of surfaces presents. Making due allowance for this, I find nothing incompatible with the specific characters of the living woodland caribou. The lengths of the whole molar series, as well as of the premolars and molars, are substantially identical; bend of the series and set of the teeth also the same."

Comparative measurements of the upper molar series of the fossil caribou, with the corresponding series of a woodland caribou from Fort Anderson, given by Dr. Coues, are as follows:—

Rangifer caribou.	Fossil.	Recent.
Length of space occupied by the upper six molars,	98.5 mm.	98.5 mm.
" " " " " three true molars,	53 "	53 "
" " " " " three premolars,	50 "	46.5 "

The fossil remains of the deer, at first supposed to belong to an extinct species, for which the name of *Cervus muscatinensis* was suggested, were discovered in grading a street in the city of Muscatine. From the Loess of the same locality Prof. Witter has collected the following fossil shells: *Helix striatella*, *H. fulva*, *H. pulchella*, *H. lineata*, *Pupa muscorum*, *P. blandi*, *P. simplex*, *Succinea obliqua*, *S. avara*, *Limnea humilis?* and *Helicina occulta*.

FEBRUARY 11.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-one persons present.

Natives of Botel Tobago.—The President read the following extract from a letter by Dr. CHARLES A. SIEGFRIED, U. S. N., dated December 20, 1878: "We visited an island called Botel Tobago, while surveying a rock, 80 miles east of South Cape of Formosa. We found a race of aborigines, probably from Malay stock. They knew nothing of money, rum, or tobacco. They gave us goats and pigs for tin pots and brass buttons, and would hang around us all day in their canoes, waiting for a chance to dive for something thrown overboard. They wore clouts only; ate taro and yams mainly, though they have pigs, goats, chickens, and fish, and cocoanuts also. Snakes abound, of the boa variety I judge. Their thatch houses are low, with much overhang of the roof, surrounded by stone walls, strongly made of laid stone to protect them from monsoons. Their paddy fields contain immense quantities of taro, *Colocasia aroidea* my botany says. They are peaceful and timid, do not mark the body or deform the face or teeth, and seem happy enough in their condition. I found them fairly healthy. They had axes, spears, and knives, but all of common iron, the axe being made by imbedding the handle instead of the handle piercing the iron, as with us. Their canoes are beautiful, made without nails, and are ornamented usually with geometrical lines. The hair is worn naturally, the men partly clipping theirs. I saw no valuable metal. They wore the beards of goats, with small shells, as neck ornaments."

Cutting or Parasol Ant, *Atta fervens*, Say.—The Rev. H. C. MCCOOK stated that he had in course of preparation a detailed account of the architecture and habits of the Cutting Ant of Texas. The observations, of which he proceeded to give an abstract, were made during an encampment for purposes of study, south of Austin, Texas.

1. *Exterior Architecture.*—Two forms were noted. The first, seen at a point distinguished as Camp Wright, was that of a

mound, 21 feet long, and about 4 feet high. which had been accumulated around the trunk of a double live-oak tree, *Quercus virens*, which stood on the side of a road. The second form was located at a point distinguished as Camp Jeanes. It was on a high, flat, upland prairie, and was a bed of denuded earth, in the midst of the grassy open, 8 feet 9 inches long, and 7 feet, more or less, across. Over this denuded surface were scattered between twenty and thirty circular, semicircular, and S-shaped elevations of fresh earth-pellets. The circular moundlets had the appearance of an American spittoon, the resemblance being stronger by reason of a round open entrance or gallery door in the centre. All had apparently been naturally formed by the gradual accumulation of the pellets of sandy soil, as they were brought out, and dumped upon the circumference of the heap. The moundlets were massed at the base, and gradually sloped off towards the top. They were from 3 to 4 inches high. This "bed" (as the natives call it) was quite free from grass, as was also the mound at Camp Wright. Another nest of the same character was found at Camp Jeanes; this was situated in a grove, but was fully exposed to the sun. A fourth nest was found about a mile distant from this spot, of the same character. This is, therefore, probably the normal form of the external architecture of the formicary, the mound at Camp Wright being probably formed by accumulations around the tree, caused by the bordering road, which restricted the limits of the gates, and so threw the separate moundlets back upon each other.

2. *Gates or Doors.*—His first view of the mound at Camp Wright led him to fear that he had made a mistake, and pitched his camp near an abandoned nest. There was not a sign of life. The mound was covered over with earthen knobs or warts of various sizes, but the action of a recent shower upon the black soil gave the hill the appearance of an old one. Here and there were scattered over the surface small irregular heaps of dry leaves, bits of leaves, and twigs. Otherwise, the mound seemed lifeless, deserted. As the evening began to fall the scene was wholly changed. Hosts of ants, of various sizes, and in countless numbers, were hurrying out of open gates into the neighboring jungle, and two long double columns were stretched from the bottom to the top of the large overhanging live oak. The ants in the descending columns all carried above their heads portions of green leaves, which waved to and fro and glanced in the lantern light, giving to the moving column a weird look, as it moved along. It seemed like a procession of Lilliputian Sabbath-school children bearing aloft their banners. It is this habit which has given this insect in some quarters the popular name of the "Parasol Ant." It is also called in Texas the "Brazilian Ant," but is quite universally known as the "Cutting Ant," certainly a most appropriate name.

The opening and closing of the gates occurs before and after every exit from the nest. The process is a long, careful, and complicated one, and was studied fully. Towards evening the gates are gradually thrown open, and so remain until morning, when they are gradually closed, the process continuing in some cases until 10½ A. M. The closing is done by carrying into the gallery bits of dry twigs of various lengths, some as long as 1½ inch, dry leaves, and other refuse. A number of closed gates were opened to note the depth to which this refuse was placed. It varied from one-half inch to an inch and a half from the surface. In some cases the gallery had been sealed up with sand pellets *below* the refuse. The galleries quite often slant inward from the gate, and at as great an angle as 45°. They also sometimes divide a short distance from the surface. These conformations allow more readily the process of closing. In carrying in the refuse the larger forms of the ant are engaged; as the hole gradually closes, only the very smallest appear. The last touches are carefully and delicately made by the minims, who, in small squads, fill in the remaining interstices with minute grains of sand, and finally, the last laborer steals in behind some bit of leaf, and the gate is closed. It then presents to the causual observer the appearance above described of a little heap of dry chips accidentally accumulated upon the mound. The galleries at Camp Jeanes were closed in the same manner.

When the gates are opened at dusk, this process is reversed. The minims first appear, deporting from the heap particles of sand. Larger forms follow, carrying away bits of refuse, which they drop a couple of inches more or less from the gate. This is a slow process, and apparently little is accomplished for a long time. But evidently the whole mass of refuse is thus loosened. Then comes the final burst, with soldiers, majors, and minors in the lead, who rush out bearing up before them the rubbish, which flies here and there, and in a few moments is cleared away from the gallery, and spread around the margin of the gate. These chips are evidently gathered together for this purpose, and are among the "treasures" of the ants, being kept near by for this use. The pieces were easily identified as being thus used several days in succession.

The above observation points out at least the use found for the extremely small forms peculiar to this species. At least ten distinct castes (forms or sizes) were exhibited to the Academy. They vary as follows, the measurements being in sixteenths of an inch, viz., ♀, 14; ♂, 11; soldier 7; worker major 6; minor 5; and the remaining castes in the proportion, 3½, 3, 2½, 2, 1½, 1. A more careful comparison may possibly reduce this series one or two. But the result, as above, will probably stand.

The gates first opened are the first closed, and those last opened are the last closed.

3. *Leaf-cutting Habit.*—The whole process of cutting and car-

rying leaves from trees and shrubs was observed at Camp Wright, and at a vegetable garden near Austin. In order better to see the mode of cutting, small tender branches of live-oak were thrust into the mound near the gates. These were soon covered with ants, and as the lantern could thus be used conveniently, the operations of the cutters were completely in view. The cutter grasps the leaf with outspread feet, and makes an incision at the edge by a scissors-like motion of her sickle-shaped toothed mandibles. She gradually revolves, steadily cutting as she does so, her mandibles thus describing a circle, or the greater portion thereof. The feet turn with the head. The cut is a clean one, quite through the leaf. The cutter will sometimes drop with the excision to the ground, sometimes retire when the section has dropped, sometimes (it is inferred) seize the section and carry it down the tree. A division of labor was apparent. At the foot of one tree was a pile of cut leaves, to which clippings were continually being added by droppings from above. Carriers on the ground took these up, and bore them to the nest. The loading of the cuttings is thus: the piece is seized by the curved mandibles, the head is elevated, the piece is thrown back by a quick motion, seeming to be lodged on its edge within the deep furrow that runs along the entire medial line of the head (except the clypeus), and supported between prominent spines on the edge of this furrow and on the prothorax. The furrow and spines thus appear to serve a very useful end. The cutting and carrying were not done (so far as noted) by the smaller castes. The soldiers rarely engaged in this work, but were seen to precede the excursion columns as they moved out and up the tree, and afterward to return, as though engaged as scouts or pioneers.

The principal leaves gathered at Camp Wright were those of the live-oak. The young saplings in the neighborhood of the mound were in great part or entirely defoliated. The great tree above was in parts stripped to the very top. So also was some wild vine unknown to him. In beginning work the cutters seem to aim first at the topmost leaves. A nest on the grounds of an intelligent nurseryman and gardener near Austin was visited, and from the proprietor many facts were learned. Ants were here seen at work late in the afternoon. They had come up through the garden from the formicary, three hundred feet distant. They prefer trees with a smooth leaf; are severe upon grapes, peaches, the China tree, radishes; take celery, beets, young corn and wheat, plum, pomegranate, honeysuckle, cape jessamime, crape myrtle, althea. They do not like lettuce, won't take the paper mulberry, nor figs and cedar, except the bud ends in the scant days of winter. They love sugar, grain, and tobacco! This proprietor assured Mr. McCook that the ants made foraging excursions into his house, entered his desk-drawers, and carried away a portion of his chewing tobacco before he discovered the robbery. He had to be very careful thereafter where he deposited the delectable weed. Mr. McCook saw at another plantation an immense column engaged in plundering a granary of wheat, which was being carried away to the nest.

4. *Interior Architecture.*—The use of this leaf material, in part at least, was unfolded when the work of excavation began. Two trenches were made, one ten feet long, five feet deep, and a second at right angles to it, and wide enough to allow free entrance and study. The number of insects that swarmed to the defence of their home is simply amazing. They were, however, not so difficult to manage as sometimes when disturbed at their night work, as the swift use of the spade by the assistants and the general convulsion of their emmet world quite dazed most of them. However, when the speaker himself entered the trench to work with trowel, knife, rule, etc., the ants rallied, and attacked so fiercely that the men were compelled to brush them off. The wound inflicted by them was sharp, but nothing to compare with the severe sting of the agricultural ant. The interior of the formicary may be briefly described as an irregular arrangement of caverns communicating with the surface and with each other by tubular galleries. These caverns or pockets were of various sizes, 2 feet 10 inches long and less, and 12 inches deep and 8 inches high and less. Within these chambers were masses of a very light, delicate leaf-paper wrought into what may properly be called "combs." Some of the masses were in a single hemisphere, filling the central part of the cave, others were arranged in columnar masses $2\frac{1}{2}$ inches high, in contact along the floor. Some of these columns hung, like a rude honey-comb or wasp nest, from roots which interlaced the chamber. The material was in some cases of a gray tint, in others of a leaf-brown. It was all evidently composed of the fibre of leaves which had been reduced to this form within the nest, probably by the joint action of the mandibles and salivary glands. On examination they proved to be composed of cells of various sizes, irregular in shape, but maintaining pretty constantly the hexagon. Some of the cells were one-half inch in diameter, many one-fourth inch, most of them one-eighth inch, and quite minute. Large circular openings ran into the heart of the mass. Some of the cells were one inch deep; they usually narrowed into a funnel-like cylinder. Ants in great number, chiefly of the small castes, were found within these cells. In the first large cave opened were also great numbers of larvæ. The material was so fragile that it crumbled under even delicate handling, but a few specimens of parts of the ant comb, with entire cells, were preserved and exhibited. Reference was made to the late Mr. Bell's opinion that these leaf paper masses were used as a sort of "mushroom garden," a minute fungus being purposely cultivated upon them, which the ants used for food. Mr. McCook's specimens, when submitted to the microscope, did

indeed show the appearance of such growth, which, however, is only what might have been expected under such environment. The belief was expressed that the ants fed upon the juices of the leaves. But (if investigations in progress shall succeed) it was hoped that the subject of the true food of the cutting ant would be hereafter solved.

5. *Tunnelled Tracks.*—The ability of these emmet masons to excavate vast halls and subterranean avenues is remarkable. Several holes in the vicinity of Austin were visited, out of which "beds" or nests of ants had been dug, by an old man who used to follow the business of ant killing. These holes were nearly as large as the cellar for a small house. One such excavation, about three miles from Austin, was 12 feet in diameter and 15 feet deep. At the lowest point had been found the main cavity, quite as large as a flour barrel, in which were found many winged insects, males and females, and quantities of larvæ. This nest was situated 669 feet from a tree that stood in the front yard of a house which the ants had stripped. Mr. McCook took the range of the underground way traversed by the ants to reach this point, from which an accurate route was constructed and exhibited. The course varied very little from a direct line. Two branch tunnels were made to a peach orchard 120 feet distant. Reference was made to a paper by Dr. Lincecum in the Proceedings of the Academy, which gave an account of the tunnelling of a stream by these ants. There is nothing improbable in this, as the tunnel above referred to went down in places as deep as 6 feet, the average, however, being about 18 inches. At the exit hole the tunnel was 2 feet from the surface. The digging operations were described, in which the small forms alone seemed to take part. The large forms would therefore appear to assist in opening the gates, make the excursions, and do the cutting; the small forms to do the digging, or at least the carrying out of excavated earth, while the minims, or least forms, assist in opening and closing doors and keeping charge of the larvæ. The minims are quite ferocious in attack, and gallantly support the large headed soldiers.

6. *Origin of Castes by Evolution.*—This wide differentiation of form among the insects of one species and nest is one of the most serious special difficulties which the English evolution hypothesis has encountered. Dr. Darwin, with that candor which always wins him the respect and confidence of all sincere minded opponents, fully admits this, and endeavors at some length to meet it. The knot of the difficulty lies in the fact that the worker castes are sterile, and are produced from eggs laid at different periods by the female. Supposing therefore that profitable or other modifications had occurred in the workers, how, on the principle of natural selection and hereditary transmission could these operate upon such workers? All modifications of structure must be wrought and transmitted through the female alone, effecting thus

the worker-life enwrapped in the egg. But it appears quite impossible to comprehend how any structural modifications could act from the worker upon the queen in order to thus react upon a succeeding generation of workers. The illustrations which Dr. Darwin cites,[1] the variation of domestic cattle by interbreeding, and M. Verlot's experiments with certain double annual flowers, if admitted to throw some light upon the inquiry, yet require an efficient superintending human intelligence, which cannot be supposed to have its analogue in the perpetuation and development of ant forms, unless, indeed, we may believe that the evolution hypothesis implies and requires the interposition of a Personal Intelligence infinitely superior to that of both ant and man.

The precise sense in which the workers may be called "sterile" admits of some question. Sir John Lubbock has recently shown that parthenogenetic eggs are sometimes produced by worker-ants in artificial formicaries, from which males alone are hatched. This is according to the analogy of other Hymenopters, as for example, bees and wasps. Here, then, there may be possible escape from Dr. Darwin's difficulty more satisfactory than that which he himself suggests; for it is conceivable that an opportunity might thus be opened for the transmission of a profitable variation which might arise in a worker. Still, the difficulty appears impassable. One must suppose the growth and maturity of one such parthenogenetic male, produced from a worker with such useful modification, to have been contemporaneous with the maturity of the females of a "swarm;" this male, together with the males hatched directly from eggs laid by the queen shall have gone forth, as is the habit of ants, in the regular marriage flight, or "swarming;" and therein shall have met a virgin queen. As the modification thus supposed to be transmitted, must, on the hypothesis, be very minute, it could have been saved from obliteration, only by supposing it fortified by the recurrence of other contingencies of like character in succeeding generations. Mr. McCook therefore concluded that the development by natural selection, according to Dr. Darwin's hypothesis, of so many and widely varied forms as exist in the cutting ant, requires a series of contingencies so multiplied and remote as to forbid a reasonable hope of its probable occurrence, even with the additional favoring circumstance of occasional males parthenogenetically produced.

He added that some of the points which Dr. Darwin had raised as to the structure of the driver ant of Africa were being carefully examined by him in the case of *Atta fervens*, with the best microscopic helps at his command. Thus far, however, after a quite careful examination, nothing that can suggest the idea of an interblending of the castes by rudimentary forms had been discovered. The lowest castes of minims, in all specimens examined, with special reference to the mouth organs and eyes, showed the

[1] Origin of Species, p. 227.

same structure, in equal definiteness and perfection, as the larger castes. Allusion was also made to the ravages of these destructive insects, and some of the modes for exterminating them were explained.

FEBRUARY 18.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty persons present.

A paper entitled "On the Structure of the Chimpanzee," by H. C. Chapman, M. D., was presented for publication.

On Bothriocephalus latus.—Prof. LEIDY exhibited specimens of a tape worm, which had been submitted to him for determination by Dr. John T. Walker. The specimens consist of about a dozen portions of what appear to have been four or five individuals, all of them unfortunately without the head. They were discharged by a man, aged 28 years, formerly a farmer, a native of Sweden, who came to this country about three months since. At irregular intervals during the last five years the patient passed fragments, of a few inches, of the worm. According to Dr. Walker, the collective measurements of the specimens presented he had estimated to be upwards of 100 feet. In their contracted condition, as preserved in alcohol, none of the mature segments measured over 4 mm. in length by 10 mm. in breadth. These are quite characteristic of *Bothriocephalus latus*. The egg pouches of the uterus centrally situated are rendered distinct from the ripe eggs which give to them a chocolate-brown appearance. The genital apertures are in the median line, nearer the anterior border of the segments. In *Tænia*, the genital apertures are at the lateral margin of the segments.

The specimens were regarded as of special interest from the circumstance that they were the first of the *Bothriocephalus latus*, that Prof. L. had had the opportunity of seeing from a person living in our country.

FEBRUARY 25.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-seven persons present.

Asphaltum and Amber from Vincenttown, N. J.—Mr. E. GOLDSMITH remarked that he had received from Col. T. M. Bryan a specimen of asphaltum, a mass of which, weighing about a hundred pounds, had been found in the ash marl, a layer above the green sand proper, about 16 feet from the surface, in the neighborhood of Vincenttown. It seems that this peculiar hydrocarbon had not been observed in the State of New Jersey before; at least no mention of it is made in the Geological Reports up to 1868. The specimen presented to the Academy had attached on one side a layer of the marl in which it was found. As the material in question is properly considered a mixture of various hydrocarbons, it seems to be obvious that the properties vary according to the predominance of one or the other substance contained therein. This kind is very brittle, black, with a resinous lustre. Its fracture is uneven, inclined to conchoidal; the streak and powder appear brown. It melts easily in the flame, like wax, and burns with a yellow smoky flame, leaving, after burning, a voluminous coal and but little ashes. In water, alcohol, and solution of caustic potassa, it is not soluble. It dissolves in chloroform and in oil of turpentine. In ether it dissolves with difficulty, forming a yellowish brown solution by transmitted and a dirty greenish solution by reflected light. Oil of vitriol dissolves it into a black liquor, which, when poured into water, shows that a part of the substance is retained in solution, whilst another subsides as a dark colored powder. Nitric acid reacts on the substance at an elevated temperature, forming therewith soluble products of oxidation.

Not far from the pit from which the asphaltum had been obtained, a specimen of yellow mineral resin was found. It occurs frequently in the marl of the cretaceous formation, but not regularly; sometimes hundreds of tons may be looked over without finding a single piece; at other times enough has been found to fill a barrel within a day. It is usually known under the name of amber or succinite.

It differed in several particulars from the typical amber found at the bottom and on the coast of the Baltic Sea. Our specimen is lighter than water, whilst the amber from the Baltic is specifically heavier. The latter fuses into a thick sluggish fluid, the Vincenttown amber into a very fluid mobile liquid; the cohesion of the Baltic product is stronger than in the specimen in question. These differences indicate its analogy to the variety of succinite called Krantzite by C. Bergeman, who reported its occurrence near Nieuberg, Germany.

It melts on heated platinum foil into a brown liquid, which runs like water. It takes fire easily, and burns with a yellowish, strongly smoking flame, leaving but little coal, which rapidly burns away and leaves a small quantity of dark colored ashes as a residue. Heated in a closed tube it melts and vaporizes into a gray cloud, which condenses easily to an oily liquid and some small crystals, which are probably succinic acid. The odor of the fumes is strongly penetrating, like acrolein. In water, alcohol, or ether, it seems to be but sparingly soluble. In chloroform, bisulphide of carbon, and in oil of turpentine, it dissolves freely. Oil of vitriol makes with it a red solution. Cold nitric acid seems not to affect it much. On warming, the yellowish powder becomes orange-red. It is partly dissolved by caustic potassa. In this yellowish brown Krantzite, Mr. Goldsmith noticed on a fresh fracture a row of white crystals arranged in radiating groups. The crystals were too small for mechanical separation, but the opinion was expressed that they were Succinellite.

The following were ordered to be published:—

DESCRIPTIONS OF THREE NEW SPECIES OF CALCEOLIDÆ FROM THE UPPER SILURIAN ROCKS OF KENTUCKY.

BY VICTOR W. LYON.

For several years past there have been found in the ferruginous clay and light-gray marly limestone of the Niagara period, which outcrops at the quarries in Jefferson County, Kentucky, on Beargrass Creek, one mile east of Louisville, many fossils, which have been considered by some collectors to be a species of coral allied to *Zaphrentis*.

Until November 25th, 1877, all the specimens which I found were in such a state of preservation that they could not be determined.

Since my attention has been called particularly to these specimens, I have collected one hundred and seventy well-preserved fossils, which I regard as true *Calceolæ*. There are four distinct species, of which three are new.

In the same bed, associated with these new forms of *Calceola*, are found *Calceola Tennesseensis* (Roemer); *Orthis elegantula*, *O. hybrida*, *O. nisis*, *O. rugæ plicata*; *Spirifer radiata*, *S. crispus*, *S. rostellum*; *Pentamerus nysius*, *P. Littoni*, *P. Knappi*, *P. nucleus*; *Rhynchonella Saffordi*, *R. Tennesseensis*, *R. neglecta*; *Cyrtia exporrecta*; *Caryocrinus ornatus*; *Eucalyptocrinus cælatus*, *E. crassus*; *Haplocrinus ovalis*, etc. The new species referred to are as follows:—

Genus CALCEOLA, Lamarck, 1801.

Calceola corniculum, V. W. Lyon, n. sp.

Shell thin; valves not articulated; ventral valve horn-shaped; area high and narrow, greatly curved to the left, flat, one inch along the shorter curve, from apex to hinge; hinge straight, four-tenths inch long, at an obtuse angle to the apex.

Draw a line from the centre of the hinge perpendicularly, and it will cut the longer curve of the area midway between apex and hinge.[1]

[1] I have before me two very perfect ventral valves of *C. Tennesseensis*, from Decatur County, Tenn., Upper Silurian. Shell triangular pyramidal, area one inch from apex to hinge; hinge line one inch wide.

If a line be drawn from cardinal process to apex, it will divide the shell

Dorsal side of ventral valve sub-semicircular, markings of growth indistinct, parallel to sub-semicircular opening; dorsal side of opening almost perpendicular to hinge line, or about one-tenth inch nearer to the apex.

Cardinal process or tooth central, round and smooth along its summit, three-tenths inch in length, three-tenths in width, gradually narrowing from the hinge backward, extending from the hinge line to the inner end of cavity.

The characters which separate this species from *C. Tennesseensis*, Roemer, and *C. sandalinæ*, Lamarck, are well marked. The semicircular margin of the mouth in *C. Tennesseensis* is one-half inch from the apex; while in *C. corniculum* it is nine-tenths inch, or almost over the hinge line.

Position and Locality.—A few good ventral valves have been obtained from the ferruginous clay, Niagara period, one mile east of Louisville, north side of Beargrass Creek.

Calceola Coxii,[1] V. W. Lyon, n. sp.

Shell thick, triangular, valves not articulated; ventral valve pyramidal; area large, flat, triangular, nine-tenths inch high, with an obscure central line; markings of growth prominent, extending around the shell parallel to hinge; hinge line straight crenulated, four-tenths inch long.

Mouth semicircular; cavity three-tenths inch deep; all around the mouth, extending centrally towards the bottom of cavity, are linear rows of punctures, not so conspicuous as in those of the European species, *C. sandalina.* The cardinal process central, prominent, short, round, and smooth along its summit.

Dorsal valve raised slightly, sub-centrally toward hinge line; valve composed of several thin semicircular plates, one above another, gradually increasing in diameter from top to bottom; area very narrow. Cardinal process not seen.

In some adult species young are seen attached to the bottom of cavity; none have been found on the outside of shell, as in *C attenuatus.*

Position and Locality.—In same beds as the preceding, also in

into two right-angle triangles. The hinge is at right angles to the apex; while in *C. corniculum* the hinge is at an obtuse angle.

[1] I take great pleasure in dedicating this elegant *Calceola* to Prof. E. T. Cox, State Geologist of Indiana.

marly limestone of Niagara period, north side Beargrass Creek, one mile east of Louisville, Jefferson County, Ky.

I have two excellent specimens with both valves united; also ten good ventral valves of this species.

Calceola attenuatus, V. W. Lyon, n. sp.

Shell thick, attenuated, valves not articulated; area of ventral valve high and narrow, curving to the right, then to the left, then to the right (some have three curves, others only two); area straight part of the distance from the aperture toward the apex, then curving gradually upward and outward (some specimens have two curves upward, others one); area two inches high, with an obscure central line; hinge three-tenths inch wide, straight.

Markings of growth in some specimens very prominent, also striæ extending around the shell, parallel to the semicircular opening or mouth. One of the most remarkable features of this species is, that along the outer edge, and sometimes the central line of the area, at almost each line of growth, and also in one or two specimens at the mouth of the shell, are one or more processes or small bodies having the appearance of foot-stalks. Some of them are one-tenth inch in length, others four-tenths. At first I thought these processes had served merely to attach the shell to some permanent body; but after cleaning one very large and elegant specimen, I discovered these processes to be young *Calceolæ*, showing all the distinct features of the older one.

In one young ventral valve, which is attached to the second line of growth of an adult, the cardinal process or tooth is perfect.

Another most singular feature in the adult of this species is, that in two places the central line of the area is lifted at the line of growth, and the cardinal process is seen at each. This specimen has the appearance as if three adults had almost swallowed each other, leaving only the hinge lines and tooth visible. Cardinal process three-tenths inch long, from two to three lines wide, round and smooth along its summit, gradually diminishing in width towards its end, not reaching the end of the cavity. In some specimens the process is larger and longer than above indicated, but it never reaches the bottom of the cavity as in *C. corniculum*. The characters of this species are so well marked that it can be distinguished at a glance from any known species of *Calceola*.

Position and Locality.—I have sixty good ventral valves from the ferruginous clay and marly limestone of the Niagara period, one mile east of Louisville, Ky., north side of Beargrass Creek.

I have no doubt that the young of *C. attenuatus* and of all other species of the *Calceolidæ* became attached immediately after germination, to the inner surface of the rim of the mouth, and remained in this position until they were large enough to support themselves. Lines of growth upon these species are nothing more or less than the margins of former mouths, which are almost always obliterated in very old adults, but in one instance two of these old mouths are seen, showing the hinge, also the central cardinal process, as well as the new one, within all of these mouths, are seen young specimens of *Calceola* attached, having the general characters of the adult. In two instances one of the vigorous young attached itself to the bottom of the cavity and eventually killed the old one, and then took complete possession.

I have one specimen of *C. attenuatus* two inches long (ventral valve), three-tenths inch wide at hinge, within the cavity of which stands another *Calceola* of the same species one and a half inch long, three-tenths inch at hinge; the apex of smaller is attached to the bottom of the cavity of the larger, and almost fills it; the cardinal process of larger is seen.

FURTHER NOTES ON THE MECHANICAL GENESIS OF TOOTH-FORMS.

BY J. A. RYDER.

In a paper published in the Proceedings of the Academy of Natural Sciences of Philadelphia,[1] in 1878, I sought to indicate the modes in which the teeth of mammals were modified by means of the movements of their jaws incident to mastication, through long series of generations. I there reached the conclusion that mechanical strains and impacts had probably been the secondary causes to which the origin of the various forms of teeth might, in large measure, be attributed. The teeth were supposed to be plastic, or at least slightly so, in all stages, notwithstanding their extreme hardness. This view was forced upon me by facts presented by vertebrate palæontology, together with my observation that the physiological act of mastication was progressively specialized, and in each case its degree of specialization was found to be in correspondence with the type of molar tooth with which it was associated. In the course of my studies it seemed clear to me that the tooth-modifying capacity resided in the powers of the animals themselves, and the ways in which they were *compelled*,[2] according to the kind of food for which they had a preference, to exert their powers. I am aware that this sort of reasoning amounts to saying that an animal causes its own structures to vary in form, by the natural operation of its own powers in overcoming resistances, which view, notwithstanding its seeming improbability, has more in its favor than that which holds that chance variations, which have been of benefit to individuals, have been preserved and transmitted to offspring and developed into organs in the course of generations by the operation of the law of natural selection, the importance of which I would be the last to underrate. The latter view gives us no causal interpretation for so-called spontaneous

[1] "On the Mechanical Genesis of Tooth-Forms," pp. 45–80.

[2] Emphatically not wholly of their own wills, because the specialization of organization presupposes a certain limitation in the power to make choice caused by habits, which have become physiological characteristics, so that the charge made against Lamarckianism that it throws all outside power out of consideration, no matter of what character, is utterly false on scientific grounds alone.

variations, which the view here advocated, in some cases at least, affords; though I do not wish to be understood as saying that it gives such an interpretation in a large proportion of instances where the history of the interacting modifying forces are as yet perhaps imperfectly known. Natural selection is quite adequate to account for the development of an organ, or part, after it has made its appearance, but it leaves the initial step causally unaccounted for, which, it must be confessed, is the point where the Lamarckian hypothesis seeks to supply the needed differentiating causes. The hap-hazard, causeless variation of organisms cannot, in the nature of things, exist; it is contrary to all known precedent as exhibited in the phenomena of the inorganic world.

In studying the teeth, one is confronted by a number of large series of forms which clearly demonstrate the fact that large numbers of allied species which have succeeded each other in geological time bear a genealogical relation to each other. The earliest forms of teeth being the simplest, the later ones seem to have been derived from them by a process easily understood, if mechanically interpreted. The tooth earliest developed of all, seems to have been a simple hollow cone superimposed upon a nutrient papilla; indeed the enamel and dentinal portion seems to be developed from its superficial (epithelial) layers of cells which elongate as they grow and crowd together, becoming columnar, whilst the excessively hard salts of lime constituting the dentine and enamel are deposited around the columnar matrix of cells or odontoblasts by secretion, leaving a fine tubular cavity in the centre, from which the odontoblasts retreat as their substance is crowded out by the formation of the hard material around them. In living teeth these are always joined to the dentine fibrils, especially in those rootless ones which are constantly growing and wearing away during the whole life-time of the animal. It is true, as an objection to my view, that the tooth is not protruded until its crown is in all respects fully developed and hardened, but it is not improbable that teeth, like bones, though apparently very hard, may be modified by strains falling upon them persistently in approximately one way for many hundreds of generations. The hardest substances are elastic, compressible, and flexible, and I think it will hardly be doubted that enamel and dentine in possessing these three qualities, though manifested in an inconceivably small degree under ordinary circumstances, may, when acted upon by forces exerted and repeated millions, perhaps billions of times in the course of generations, be effectual in transmitting the simple primary form to a more complex later one, as I have tried to show more fully in the paper already cited. That a brittle inflexible substance like marble, when in the form of thin, rectangular slabs may be bent by the force of gravity acting upon it persistently whilst lying horizontally for a long time and only supported at two of its corners diagonally opposite each other, is proved by an old marble gravestone very much bent from this cause and now belonging to the Academy. This phenomenon it seems to me is no harder to explain than the morphological phenomena presented by the teeth of mammals; for my part, I believe that both the phenomena in question will most probably bear a similar interpretation.

I now propose to offer some new evidence based upon more accurate observations of the mode in which herbivorous ungulates crush and masticate their food. A large living male rhinoceros has afforded me the opportunity to make the observations. *I distinctly saw this creature crush its food by sweeping the lower molars of the side about to be brought into action, from without inwards against the upper ones;* meanwhile those on the other side of the head were of course scarcely in contact, provided a considerable amount of food was being acted upon by the side in use at the instant. This, I concluded, for obvious reasons, was definitely the mode in which the jaws of ungulates were used which were moved in both lateral and vertical directions in the act of chewing; in other words, it seems to be the manner in which chewing is effected in all anisognathous selenodont mammals, which can be definitely traced to a bunodont ancestry.

It will be readily understood that the above observations in some measure modify the conclusions reached in my former paper, in which the belief was entertained that the motion which did the crushing was outwards instead of inwards. From facts which I have gathered, it now seems strange to me that I should have fallen into this misapprehension, since the true method promises to yield even a better interpretation of the true philosophy of tooth-modification by mechanical agencies than that first offered. It must, however, here be stated that, in no essential particular except one, do I alter my former views. I still hold the mandibular articulations to be the principal odontomorphic centres, as all mandibular movements are regulated from them as axes.

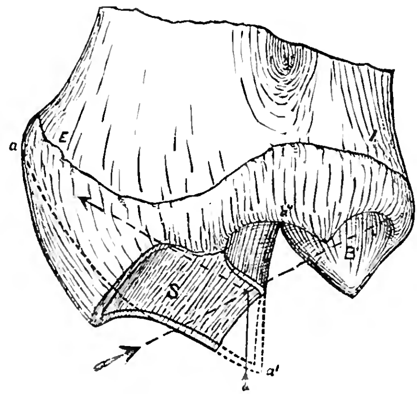
From the fact that the movements are from without inwards in selenodonts generally, the outer series of cusps, in the advent of such lateral movements, seem to be most compressed laterally and their tips most deflected in an inward direction, and I shall therefore consider the cause as acting from the outside instead of from the inside as formerly. The paleontological evidence afforded by symborodonts, where the selonodont or crescent-shaped cusp first appears in the outer row of molar cusps, whilst the inner row is still bunodont, is pretty conclusive. This singular combination of cusp characters is also exhibited by *Titanotherium*, *Palæosyops*, etc. Other series of ungulates show the almost synchronous development of the crescent-shaped cusps in both outer and inner rows, but earlier forms seem to indicate pretty unanimously that the outer or buccal series are the first to be differentiated. In *Coryphodon*, figured by Cope,[1] is exhibited the inward flexure and flattening of the exterior rows of cusps of the upper molars, in a perhaps unparalleled degree.

The change of view is simply in regard to the manner in which the modifying force is applied, and does not change the principle involved, which assumes broadly that the lateral mandibular movements produce lateral changes in dental forms, whilst on the other hand reciprocating ones produce antero-posterior and postero-anterior ones. Having definitely concluded as to the direction of the action of the forces, in evidence of which a great catalogue of facts might be adduced, more indeed than my space and means will afford, I will briefly consider that offered by the molar dentition of *Symborodon*.

In the diagram[2] which represents a rear molar of the right side seen from in front, in which E is the external and I the internal side; the simple anterior inner bunodont cusp B is seen to be but little modified, whilst the outer selenodont cusp S is seen to be much worn away, showing great disparity of development between the two. The appearance of tubercle S in vertical median transverse section, is indicated by the entire and dotted lines from *a* to *a'*

[1] U. S. Geog. Surveys West of the 100th Meridian, Vol. IV. Vertebrate Palæontology, 4to., by E. D. Cope. Washington, 1877.

[2] Prof. Cope has permitted me to make this sketch from a specimen in his superb collection of remains of these extinct animals.



and a'', the apical portion worn off being restored in outline. This shows that S has been deflected in an inward direction, and indicates that the force operative in causing the deflection has been constantly active from one side, or that upon which the large arrow is placed pointing in the direction of the dotted line. The total displacing force exerted by the jaw moving in an inward direction during the entire lifetime of the animal may be supposed to be represented by this arrow, plus that of its ancestry, during the existence of which the tooth has been brought to its present form by the mechanical process of differentiation indicated. The muscular power or crushing force exerted by the mandibular muscles (the coefficient of which is 104 pounds per square inch of section, *Haughton*) in an upward direction indicated by the lower smaller arrow pointing upwards in the direction of the entire vertical line, would tend while the mandible is moving inwards and obliquely upwards to act as a wedge upon the somewhat oblique faces of the upper molars, forcing them outwards in the direction of the dotted line and arrow pointing towards *a*. In this way the cause of the anisognathism is accounted for, whilst it is also not to be forgotten, that the influence of this peculiar combination of forces cannot be without effect in producing modifications upon the crowns of the teeth from within, so that in reality, modifying forces may be at work from both sides.

ON THE STRUCTURE OF THE CHIMPANZEE.

BY H. C. CHAPMAN, M.D.

The literature on the anatomy of the Chimpanzee is much more extensive than that on the Gorilla, the animal having been dissected by Tyson,[1] Traill,[2] Vrolik,[3] Schroeder Van der Kolk,[4] Wyman,[5] Marshall,[6] Rolleston,[7] Wilder,[8] Huxley,[9] Gratiolet and Alix,[10] Turner,[11] Humphrey,[12] Broca,[13] Macalister,[14] Bischoff,[15] Champneys,[16] and others. It may appear, therefore, superfluous to offer the results of my dissection of the female Chimpanzee, *Troglodytes niger*, which recently died at the Zoological Garden of this city. In comparing, however, the accounts of the authors just referred to, it becomes evident that the animals dissected by them must in some instances have been different species of Chimpanzees, and in others that they exhibited individual peculiarities. The above accounts are, moreover, often limited to only portions of the body. Indeed, the only elaborate modern treatises I have seen are those of Vrolik and Gratiolet. The admirable monograph of Tyson, old as it is, may still be consulted with the greatest advantage. I propose confining myself to a general account of the Chimpanzee I dissected, calling attention more particularly to the points in which it differed from those previously described, and the general resemblances and differences between it and the Gorilla and Man. The specimen dissected by me was a female, supposed

[1] Anatomy of a Pygmie, 1699.
[2] Memoirs of Wernerian Society, 1821.
[3] Recherches sur le Chimpanzee, 1841.
[4] Schroeder Van der Kolk and Vrolik, Amsterdam Verhandelingen, 1849.
[5] Proceedings of Boston Society of N. H., 1856.
[6] Natural History Review, 1861.
[7] Natural History Review, vol. i.
[8] Boston Journal of N. H., 1863.
[9] Medical Times and Gazette, 1864.
[10] Nouvelle Archives du Musée, 1866.
[11] Proceedings of Royal Society of Edinburgh, 1866.
[12] Journal of Anatomy and Physiology, 1867.
[13] Bulletin Societé d'Anthropologié, 1869.
[14] Annals and Mag. of Nat. Hist., 1871.
[15] Abhandlungen of Munich Acad., 1871.
[16] Journal of Anat. and Phys., 1872.

to be about five years old, and measured $28\frac{1}{2}$ inches from crown of head to sole of the feet. The upper extremity of right side measured from shoulder to end of middle finger 18 in.; the lower extremity measured from the head of the femur to the end of the middle toe of the right side $16\frac{1}{4}$ inches. The hand, taken from the wrist to the end of the middle finger, measured, on the right side, $5\frac{1}{8}$ in. The right foot, considered from homologous points, was $5\frac{1}{2}$ inches long. As in the young Gorilla, so in the young Chimpanzee, Plates IX. and X., the resemblance of the head to that of a human being of an uncivilized race is more striking than in the adult. The distinction between the hand and foot in the Chimpanzee is not, however, so well marked as in the Gorilla—the foot, superficially considered, resembling a hand. As we shall see, however, this is only a functional difference, the lower extremity in the Chimpanzee terminating structurally in a foot just in the same sense that a man's does, all of the apes and monkeys being anatomically bimanous and bipedous, and not quadrumanous. The hand in the Chimpanzee is larger than the foot.

Cervical Region.—On removing the skin I noticed a well-developed platysma myoides, and so far as I could see this was the only representative of the panniculus carnosus muscle of the lower animals, with the exception, perhaps, of a few scattered fibres in the fascia of the hand corresponding to the palmaris brevis of Man. The external jugular vein was quite evident. Next in order came the superficial cervical plexus of nerves and the sterno-cleido mastoid muscle, which differed from that of Man in being divided into sternal and cleidal portions, the cleidal portion arising a little lower than the sternal, and the insertions being equally distinct. The spinal accessory nerve separates the two parts of this muscle, and differs in this respect from the disposition given by Vrolik, as well as in the fact that its internal root joins the pneumogastric. From this latter nerve the superior and inferior laryngeal nerves pass off to supply the larynx, the inferior passing around the subclavian artery on the right side and the aorta on the left, as in man. There was nothing particularly noticeable in the distribution of the glosso-pharyngeal, lingual branch of the 5th, or the hypoglossal nerves, this latter winding around the external carotid artery, passing over the hyoglossus muscle and under the mylohyoid to be lost in the tongue. The digastric was well developed, as also the stylo-glossus, stylo-hyoid, and stylo-pharyngeus muscles. Anteriorly I noticed the sterno-hyoid, sterno-thyroid, and thyro-hyoid, and the little crico-thyroid artery passing across the crico-thyroid membrane. Laterally the omohyoid muscle was well developed. It was held in position by the little band of the cervical fascia, and served, with the sterno-cleido mastoid muscle, to divide the neck, topographically speaking, into the triangles. I noticed that the muscle sometimes called the omo-cervicalis was well developed. This muscle arises from the transverse process of the atlas, and is inserted into the clavicle; it was very properly described by Tyson as the elevator of the clavicle. It has been found in Man as an anomaly. Very human in its appearance was the disposition of the phrenic nerve lying upon the scalenus anticus muscle, and coming from the 3d and 4th cervicals. The muscle separated the subclavian vein from the artery, and between it and the scalenus medius the brachial plexus emerged. The whole cervical region was strikingly human in its disposition, and with the exceptions of the sterno-cleido mastoid muscle being divided into two, and in the presence of an omo-cervicalis muscle, the neck of the Chimpanzee would serve the surgical anatomist as material for a demonstration quite as well as that of a human being. On raising the clavicle the subclavius minor and coracoid ligament were seen well developed; the pectoralis muscle, however, presented a difference from that of Man, as it arose from the 2d and 3d ribs, and was inserted into the head of the humerus. The axillary region was very human in its appearance; the anterior and posterior thoracic nerves and the intercosto-humeral were well developed.

Upper Extremity.—The brachial plexus surrounding the axillary artery exhibited the outer, posterior, and inner cords, the outer coming from the fifth, sixth, and seventh cervicals, the inner from the eighth cervical and first dorsal; the posterior cord from the outer and inner ones. The plexus gave off, as in Man, the external cutaneous, median, ulnar, internal cutaneous, and musculo-spiral. I did not notice, however, the nerve of Wrisberg; the subscapular and suprascapular nerves were found in their customary human position. The disposition of the median, ulnar, and radial nerves in the hand were the same as in Man. The latissimo-condyloideus muscle was well developed, but I could see no difference in the biceps, coraco-brachialis, brachialis anticus, and triceps as compared with the same muscles in man. In the forearm the pronator radii teres arose by two heads, the median nerve passing between them as in Man, whereas I found only one head in the Gorilla. The palmaris longus was well developed: whereas it was absent in the Gorilla I dissected. Flexor sublimis digitorum and profundus were more split up than in Man, but as a whole there was no marked difference between them and those of Man. The flexor longus pollicis, joined to the perforator of the index, was to a certain extent differentiated from the flexor profundus digitorum, its tendon passed between the two heads of the flexor brevis pollicis. The other muscles of the thumb and those of the little finger compared favorably with those of Man; the lumbricales were large. The supinator longus arose from the humerus much higher up than in Man. The extensor ossi metacarpi pollicis terminated in two tendons; the secundii internodii pollicis was present, but there was no extensor primi-internodii. I found this muscle, however, in the Gorilla. The extensor indicis and extensor minimi digiti terminated in their respective digits singly, whereas in the lower monkeys the middle finger is supplied by a slip from the indicis, and the ring finger with one from the minimi digiti in addition to the tendons of the extensor communis. According to some anatomists the extensor indicus in the Chimpanzee supplies both index and middle fingers. The Chimpanzee seems, from the above brief sketch of the muscular system of the upper extremity, to be closer allied to Man than the Gorilla, inasmuch as the pronator arises by two heads and in having a palmaris longus and a flexor longus pollicis, but it differs from the Gorilla and Man in that the extensor ossii metacarpi divides into two tendons, and in there being no extensor primi internodii pollicis.

Lower Extremity.—Traill,[1] in his account of the Chimpanzee, figures a muscle, which he called the scansorius, rising from the ileum and inserted into the femur. This muscle appears to me to be simply a part of the gluteus minimus. According to Vrolik[2] the tensor vaginæ femoris had been confounded with the so-called scansorius by Traill, but in my specimen the former muscle was very well developed, and I should not have noticed any thing particular about the gluteus had not a portion of it been described

[1] Traill, *op. cit.*, Plate I. Fig. 1.
[2] Vrolik, *op. cit.*, p. 21.

separately as the scansorius. The rotators of the thigh were present. The adductors are five in number. The semimembranosus and semitendinosus, as in the Gorilla, hardly deserve names characteristic of their homologues in Man, as they are quite muscular. The gracilis is very large. The sartorius, however, rather slender. There was a well developed popliteus, but no plantaris muscle. The soleus arose by the fibular head only. As regards the anterior aspect of the leg, the tibialis anticus splits into two tendons, the extensor longus digitorum was present, but the so-called peroneus tertius was absent. The extensor longus hallucis and extensor brevis digitorum were well developed, as also the peroneus longus and brevis on the fibular side of the leg. The flexor accessorius was absent. The flexor brevis digitorum supplied the second and third toes only, the tendinous slips for the fourth and fifth came from the flexor longus digitorum; whereas in the Gorilla the slip for the fifth came from the flexor longus hallucis. In the Chimpanzee the slip for the fifth toe is very delicate, and, like that of the Gorilla, is not perforated. There is quite an intimate union between the fibres of the flexor longus hallucis and digitorum. The special muscles of the minimi digiti and hallux are well developed, and in addition to the ordinary flexor brevis hallucis I noticed a delicate muscular slip arising from the calcaneum in common with the flexor brevis, which was inserted into the phalanx of the hallucis. Its action was to flex the hallux. This little slip was also seen in the other foot. So far as I know it has not been described before in the Chimpanzee. There was no transversus pedis. The little slip, called by Prof. Huxley the abductor ossi metacarpi quinti digiti, I noticed in the left foot. There was nothing remarkable about the bloodvessels of the lower extremity, except that the saphenous vein did not pass into the femoral through the saphenous opening, which was well developed in the Gorilla, and the anterior tibial artery was very small, its place being supplied by a large vessel coming from the femoral at about the position of the anastomotica magna in the human being. I ventured to call this vessel in the Gorilla the "long saphenous artery," as it accompanied the artery and nerve of the same name to the foot in that animal. The nerves did not differ essentially from those of man.

Alimentary Canal and Appendages.—The tongue in the Chimpanzee is thicker than in man. I found the circumvallate papillæ arranged in the form of a V, as in man, and not a T, as has been found to be the case in other specimens. The parotid gland was large, the duct of Steno crossed the masseter. The submaxillary was absolutely very large. The stomach was very human in shape. The length of the small intestine was eight feet, that of the large two and a half. The vermiform appendix measured six and a half inches. The Peyer's patches in small intestine were very striking. There are no valvulæ conniventes. There was nothing peculiar about the spleen or pancreas; in reference to the liver the quadrate lobe was not well differentiated, and the caudate lobe was thick rather than caudate. I noticed an interesting fact in reference to the peritoneum: When the great omentum was raised the transverse colon was seen to be attached to its under surface, as in Man; whereas in other monkeys and the lower mammals the transverse colon is quite separate from the great omentum. This condition is also seen in the human fœtus, but, as development advances in it, the peritoneum covering the transverse colon becomes adherent to the great omentum, and ultimately in Man appears as one structure. In this respect the Chimpanzee agrees with Man and differs from the monkeys. I do not know whether this disposition has been observed before in the Chimpanzee or the other anthropoids. I suspect the same disposition obtains in the Gorilla.

Respiratory and Circulatory Systems.—As is well known, in the male Chimpanzee and the other anthropoids, the ventricles of the larynx are enormously dilated, these pouches extending up into the neck, even under the trapezius muscle and over the breast into the axillæ. Noticing during life that the voice of the female Chimpanzee was so much weaker than her mate, I was prepared to find these ventricular pouches very rudimentary, even if developed at all. According to some anatomists these pouches have no influence upon the voice.

The pouches, however, extended even in the female up to the hyoid bone and base of the tongue. The crico-thyroid, thyro-arytenoid crico-arytenoid, lateralis and posticus, and arytenoid muscles were well developed. The inferior vocal cord, or more properly vocal membrane, was of a triangular shape, and quite distinguishable from the remaining part of the mucous membrane. The right lung was divided into three lobes, the left into two, as in Man. I noticed that the left carotid and left subclavian arteries came off from a common vessel, a short innominate, differing in this respect from the Gorilla and Vrolik's[1] Chimpanzee, which in the disposition of its great bloodvessels is like that of Man.

Genito-urinary Organs.—Believing that the transitory stages through which a human being passes in utero are often permanently retained through life in the lower animals, it appeared to me that the best way of determining the question as to whether the Chimpanzee had the external and internal labia of the human female was to compare my specimen with a human female fœtus. The opportunity of examining two negro fœtuses about five months old, presenting itself at the same time that I was dissecting the Chimpanzee, I compared the generative apparatus of all three, and I am satisfied that they are morphologically essentially the same, for in the Chimpanzee there is a well-developed clitoris, with frenum and prepuce; below the frenum the internal labia are undistinguishable from the external, and these latter are undeveloped above the clitoris. The whole appearance of the uterus, vagina, and ovaries in the Chimpanzee is also similar to the internal organs of the human fœtus. The bladder was large, and the kidneys resembled those of man in their form, and differed from that of the Orang in having more than one papilla.

The Brain.—The brain of the Chimpanzee has been described by several anatomists, and figured by Tyson, Tiedmann,[2] Vrolik, Schroeder van der Kolk,[3] Gratiolet,[4] Rolleston, Marshall, Turner, Bischoff, Broca, and others. As the existence of a "posterior lobe, posterior cornu, and hippocampus minor" in the brain of the Chimpanzee and other apes and monkeys gave rise to a memorable discussion some years ago, it was with great interest that I hastened, as soon as possible after death (a few hours), to open the skull of the Chimpanzee, and to examine the brain *in situ*. The brain weighed 10 ounces 10 grains. I confess to my great surprise, I found the cerebellum uncovered by the cerebrum to the extent shown in the illustrations, Plate XI., Figs. 1 and 2, and XII., Figs. 1 and 2, and remembering Prof. Huxley's criticism that[5] "his error must become patent even to himself if he try to replace the brain

[1] Vrolik, *op. cit.*, Plate VI. Fig. 4.
[2] Philos. Transactions, 1836.
[3] Schroeder Van der Kolk and Vrolik, Amsterdam Verhandelingen, 1849.
[4] Plis cerebraux de l' Homme, 1854.
[5] Man's Place in Nature, p. 97.

within the cranial chamber," I did so, and yet the cerebellum remained uncovered. Is it possible that in my young female Chimpanzee the posterior lobe had not attained its full growth, or that in some Chimpanzees the posterior lobe covers the cerebellum, and in others it does not? According to Prof. Huxley, this is the case among the Gibbons, for in referring to the Siamang, he says: this[1] "is remarkable, for the short posterior lobes of the cerebrum which in this anthropomorphous ape do not overlap the cerebellum, as they do in all the others." On the other hand, Prof. Bischoff observes in his *Beiträge* on the Hylobates, "Dagegen kann ich Flower und Huxley darin nicht beistimmen das die hinteren Lappen des grossen Gehirns eine sehr bemerkenswerthe Reduction gegen die der Gehirne der anderen Anthropoiden darin zeigen, dass sie das kleine Gehirn nicht mehr völlig bedeckten. Bei meinem Hylobates ist das kleine Gehirn vollständing durch die Hinterlappen des grossen Gehirns bedeckt."[2] It appears to me more likely that in some Gibbons the cerebellum is covered, and in others not, than that such eminent anatomists as Professors Huxley, Flower, and Bischoff should be opposed in reference to a mere matter of observation, and so with regard to the diversity of opinion as to the cerebellum being covered by the posterior lobes of the cerebrum in the Chimpanzee.

According to Huxley, Rolleston, Marshall, Gratiolet, etc., the cerebellum is covered by the cerebrum in the Chimpanzee.

In the figures of the Chimpanzee given by Tyson, Tiedemann, Vrolik, Schroeder Van der Kolk and Vrolik, the cerebellum is uncovered by the posterior lobes of the cerebrum. Tiedemann says: "The hemispheres of the brain are relatively to the spinal marrow, medulla, cerebellum, etc., smaller than in man."[3] According to Vrolik, the Chimpanzee brain is distinguished from the human, "par un moindre developpement des hemispheres du cerveau qui ne recouvrent tout le cervelet."[4] Gratiolet, in referring to the figures of the brain of the Chimpanzee, in Schroeder Van der Kolk's and Vrolik's paper in the Amsterdam Verhandelingen for 1849, speaks of the brain as being "profondement affaisé." Now, while these eminent anatomists admit the justness of Grati-

[1] Anatomy of Vertebrates, p. 410.

[2] Beitrage, etc., Munich Aband, 1870, p. 272.

[3] Philos. Trans., p. 518.

[4] Recherches, p. 39.

olet's criticism, yet they observe in their "Note sur l'encephale de l'Orang," in the Amsterdam Verslagen for 1862, page 7, "A vrai dire, ce lobe postérieur ou occipital ne se prolonge pas autant que chez l'homme; il ne recouvre pas si bien le cervelet, du moins il ne la cache pas complêtement surtout vers les cotés; mais il n'y a rien là dedans, qui nous empêche de lui donner le nom qui lui est dû. Par rapport au développement du cervelet, nous ne croyons pas faire une chose inutile en rappelant que, d'après les mesures que nous avons publiées en 1849, le cervelet du Chimpansé et de l'Orang est proportionnellement plus grand que celui de l'homme. Cela doit avoir une certaine influence sur la maniere dont il se trouve pour une partie à découvert chez ces animaux qui ont les lobes occipitaux moins étendus que ceux de l'homme." Their plate, Fig. 1, giving the brain of the Orang, shows quite plainly the cerebellum partially uncovered by the cerebrum. In my Chimpanzee the cerebellum was extremely well developed, as may be seen from Plate XI., Fig. 2. Should future investigation show that the posterior lobes of the cerebrum do not invariably overlap the cerebellum, as in the Chimpanzee dissections just referred to, and in the Orang of Vrolik and Gibbon of Huxley, it will only be another instance of the truth that the lower monkeys in some respects are more nearly allied to man than the Anthropoids, for I have found the cerebellum entirely covered by the cerebrum in the genera *Macacus*, *Cynocephalus*, *Semnopithecus*, *Ateles*, *Cebus*, etc. Prof. Huxley observes, "if a man cannot see a church, it is preposterous to take his opinion about its altar-piece or its painted windows—any one who cannot see the posterior lobe in an ape's brain is not likely to give a very valuable opinion respecting the posterior cornu or the hippocampus minor."[1] Now it does not follow because the cerebrum did not overlap the cerebellum in my Chimpanzee that there was no posterior lobe. It is one thing to state that the posterior lobe did not entirely conceal the cerebellum, and another that the posterior lobe did not exist at all. Further, when the proper section was made of the lobe the posterior cornu of the ventricle was very evident, Plate XII., Fig. 3, as also the hippocampus minor, and indeed there was the eminentia collateralis as well. It seemed to me that it was not so much that the posterior lobe with its contents was undeveloped in

[1] Man's Place in Nature, p. 99.

the Chimpanzee as it was that the cerebellum was relatively to the cerebrum very much developed, Plate XII., Fig. 1.

Of late years the convolutions of the human brain have been very carefully described, and compared with those of the lower animals; among others, by Bischoff, Ecker, Gratiolet, Pansch, and Husche. And through the development of the theory, based upon pathological, experimental, and comparative anatomical facts, that, *cæteris paribus*, the grade of the intelligence is proportional to the number and complexities of the gyri and sulci, the comparison of the brain of an anthropoid with that of Man becomes very interesting. So far as I know, the first distinct statement that the convolutions are most numerous in the brain of Man, and that his superior intelligence is due to this, is to be found in the works of Eristratus, as quoted by Galen. In 1664 Willis called attention to the lower animals having convolutions, though fewer than Man, and that certain animals, like monkeys, had more of them than carnivorous ones, etc. Vicq. D'Azyr, in 1789, noticed the want of symmetry in the convolutions in the brain of Man. In 1794 Malacarne called especial attention to the convolution known as the gyrus fornicatus. Tiedemann, in 1816, treated of the development of the convolutions. While undoubtedly the anatomists just referred to may be said to have begun the study of the convolutions, nevertheless it appears to me that the credit of a systematic study of the folds and fissures in a group of animals, the comparison of such with those of Man, and the extension of such investigation to the mammalia generally, belongs to Prof. Richard Owen, who in 1833 distinguished in the Felidæ the folds by letters and the fissures by figures, and what is more, named them. In 1842 his views were much extended in the lectures delivered at the Royal College of Surgeons, when the homologous convolutions were brought out strikingly in the diagrams by colors. Leaving this little historical digression, and returning to the brain of the Chimpanzee, I think it may be stated that in most of the specimens examined so far all of the convolutions and fissures described in the human brain can be identified. There is no difficulty in recognizing the four lobes—the frontal, parietal, occipital, and temporal, Plate XI., Fig. 1; Plate XII., Fig. 1. The central lobe or island of Reil, which is very slightly convoluted, is entirely concealed in the Chimpanzee. The frontal lobe exhibits the upper, middle, and lower frontal convolutions,[1] separated by the upper and lower frontal fissure, the latter passing into the vertical frontal (precentral). The central fissure (Rolando) is well marked. a little more forward in the Chimpanzee than in Man, separating the anterior and posterior central convolutions. The fissure of Sylvius is in such relation with the interparietal and temporal fissures, that the supra-marginal and angular convolutions are identical with those of Man. The "ascending branch" of the Sylvian fissure also passes in between the middle frontal and precentral fissures as in Man. The first, second, and third temporal convolutions, with the first and second temporal fissures, are as distinct in the Chimpanzee as in Man, and the continuity of the occipital and temporal lobes through the lower temporal convolutions (3d and 4th plis de passage of Gratiolet) is as unbroken in our ape as in the human being. Further, the three convolutions of the occipital lobe, with its transverse occipital and inferior longitudinal fissures, do not present any very marked differences from the homologous structure in Man. Up to this point I believe I have made no statements in reference to the fissures and convolutions of the brain of the Chimpanzee which have not been substantially made before. There has, however, been, and is still, a diversity of opinion in reference to the parts of the occipital convolutions which bridge over the external perpendicular fissure, which seems to be a continuation of the internal perpendicular or parieto-occipital fissure. The convolutions which I have referred to above as the upper and middle occipital convolutions pass in Man and *Ateles* so insensibly into the upper parietal lobule and angular convolutions respectively that apparently no external perpendicular fissure exists; the parieto-occipital, however, being apparent enough. In the Chimpanzee that I dissected, the external perpendicular fissure is quite apparent, but the two occipital convolutions seem to me to be present, the upper one serving to partially bridge over the inner part of the external perpendicular fissure connecting the upper occipital with the upper parietal lobule, the middle occipital passing into the angular convolution and bridging over the outer part of the external perpendicular fissure; the difference then in the brain of the Chimpanzee and Man in this respect being one essentially of degree, the

[1] I make use of the nomenclature of Ecker in "Cerebral Convolutions of Man," English synonymes.

upper occipital convolution in Man being more superficial than in the ape. The upper occipital convolution, according to Huxley and Gratiolet, is absent in the Chimpanzee, but has been found at least on one side in the specimens described by Rolleston, Marshall, Turner, and Broca. The upper and middle occipital convolutions, so far as I have been able to compare them, seem to correspond to the convolutions described under the names of "Plis de passage," "Bridging," "Annectant gyri," and "Obere, innere und aussere Scheitelbogen-Windungen." The only other peculiarity that I noticed in the Chimpanzee was in reference to the parieto-occipital fissure of the right side, which did not reach the calcarine, being separated by the "deuxieme plis du passage interne" of Gratiolet, and that on both sides the calcarine fissure passed into the hippocampal, so that the gyrus fornicatus did not pass into the convolution of the hippocampus as in Man. In this latter respect, however, *Ateles Paniscus*, one case of *Hylobates*, and Turner's Chimpanzee agree with Man and disagree with all the other monkeys. The mesial side or the base of the brain did not present anything very different from Man, so far as they were susceptible of examination. The nerves coming from the base of the brain were, however, relatively very large. With all deference to Prof. Bischoff, I cannot agree that the "Kluft zwischen der hohen Entwicklung der Grosshirnwindung des Menschen und derjenigen des Orang oder der Chimpansé lässt sich nicht ausfüllen durch Hinweisung auf die Kluft zwischen der Entwicklung dieser Windungen zwischen dem Orang oder Chimpansé und Lemur. Letztere ist ausgefüllt durch die zwischen beiden liegenden Arten der Affen. Die Ausfüllung der ersteren muss noch gefunden werden."[1] On the contrary, it appears to me that on the whole the gap between the brain of the Chimpanzee and Man is less than that between the Chimpanzee and the lower monkeys; and, though it is not generally considered so, that the brain of the Chimpanzee resembles that of Man quite as closely as that of the Orang.

Résumé.—In considering the Chimpanzee in the totality of its organization, it appears to me to be as closely allied to Man as the Gorilla, but it must be remembered that, like it, in the absence of certain muscles, etc., the Chimpanzee and Gorilla are both less like Man than the lower monkeys.

[1] Die Grosshirnwindungen, p. 492. Munich Aband. 1868.

MARCH 4.

Mr. THOS. MEEHAN, Vice-President, in the chair.

Thirty-six persons present.

MARCH 11.

The President, Dr. RUSCHENBERGER, in the chair.

Forty persons present.

The following papers were presented for publication:—

"On the Nudibranchiate Gasteropod Mollusca of the North Pacific Ocean," by Dr. R. Bergh.

"On the Variability of Sphæria Quercuum, Schw.," by J. B. Ellis.

The death of Dr. J. H. McQuillen, a member, was announced.

Note on Opuntia prolifera, Eng.—Mr. THOMAS MEEHAN exhibited specimens of proliferous fruit of this species, sent by Mr. Jackson Lewis, of San Jose, California. The fruit of three years ago were still fresh and green, and these produced other fruit immediately succeeding the last year. Mr. Meehan remarked that similar cases were on record in Masters' "Teratology," and in connection with this species in Brewer and Watson's "Flora of California." The latter authors state that the proliferous fruit are always sterile; but in cutting open twenty from those exhibited, one was found with a perfect seed.

Mr. Meehan pointed out the value of these abnormal growths in explaining structure and function. In the succulent Cactaceæ we speak of the small green bodies which appear and early mature on the young growth, as the "leaves;" but we know from morphological law that the whole fruit is formed of metamorphosed primordial leaves, and there is no reason why the whole body of the cactus might not be formed in the same way, and we should then, perhaps, have to regard the so-called "leaves" as mere appendages. At any rate, here is a case of what should have been fruit enduring but a few months, assuming a permanent stem-character, and performing all the functions usually connected with stem. It seemed scarcely to leave room for a doubt that not only the parts of the inflorescence, but the whole stem-structure is but "modified leaf," in text-book language.

Again a lesson is afforded in relation to the essential difference between growth and reproductive force. The one of course grew out of the other, and is in a great degree co-relative; and yet they are, in a great measure, antagonistic forces, and it is as useful to recognize them as such, as to note the distinction between leaf—blade and petiole, or liber cells and wood cells. Assuming the distinction between these two forces, we are able to express the true character of this abnormal formation. The reproductive force after influencing structure towards its especial object, had been again subjected by the growth, or, more properly, vegetative force, and it was thus enabled, though in an imperfect manner, to continue in the line of its especial function. Of course all of these distinctive powers in plants come down ultimately to varying phases of nutrition, and in this direction we are to look for the secret whereby nature is enabled to make up the innumerable forms and conditions of living things.

MARCH 18.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-nine persons present.

The deaths of the following members were announced: J. B. Knight, E. Spencer Miller, Clement Biddle, Henry J. Williams.

MARCH 25.

The President, Dr. RUSCHENBERGER, in the chair.

Seventy-three persons present.

A paper entitled "Notes on Amphiuma," by Dr. H. C. Chapman, was presented for publication.

Edw. D. Cope was elected to fill a vacancy in the Council, caused by the death of Dr. J. H. McQuillen.

Wm. L. Auchincloss and Joseph Mellors were elected members.

Wm. H. Leggett of New York, John M. Coulter of Hanover, Ind., and George Bentham, F.L.S., of London, were elected correspondents.

The following were ordered to be published:—

ON THE VARIABILITY OF SPHÆRIA QUERCUUM, Schw.

BY J. B. ELLIS.

Among the Sphæriaceous fungi of Southern New Jersey, no species perhaps is oftener met with than *Sphæria Quercuum*, Schw. And perhaps, it might be added, no species is more difficult to define and classify. Fries includes it among the "Confluentes," remarking (Elench. ii. p. 84) that many species of that section approach very near to the *Dothideas*. Berkeley, in "Grevillea," places it in *Melogramma*, taking that genus doubtless as defined in his Outlines of British Fungology, p. 391, and by Fries in Sum. Veg. Scan. p. 386. Tulasne, however, who had examined this species, did not include it his genus *Melogramma* (see his Selecta Fungorum Carpologia, vol. ii. p. 81).

On examining the two genera, *Melogramma* and *Dothidea*, it will be seen that there are no salient and unmistakable characters by which they may be distinguished. Tulasne, l. c., says of his genus *Melogramma*, "Perithecia globosa ex parietibus nunc e parenchymate materno vix distinctis nec solubilibus, nunc contra sine negotio sejungendis facta;" a definition which will include two different types of perithecia, viz., those with walls not separable from the substance of the stroma, and others with walls readily separable; in the former case scarcely distinguishable from *Dothidea*, in which genus the ascigerous nucleus is contained in cavities in the stroma without any distinct perithecium. Perhaps the most obvious character separating the two genera may be found in the stroma which is more highly developed in *Dothidea;* but even here species occur, *Dothidea perisporioides*, B. & C. for example, where the stroma is so imperfectly developed as to leave the classification somewhat doubtful. Not less difficult is it to refer to their proper place the various forms of *Sphæria Quercuum*, Schw., occurring as it does now scattered and distinct, and again, on the same branch, confluent and united in a stroma more or less evident; now with hardly a trace of an ostiolum, and again with a distinct cylindric beak equalling in length one-fourth or one-third the height of the perithecium itself. The various forms, however, all agree in having normally a subcuticular origin, on the surface of the inner bark, just beneath the epidermis, which is soon ruptured with many small openings where the perithecia are scattered, or with much larger gaps where several perithecia more or less distinctly confluent, are grouped together. On peeling off the epidermis, the perithecia are generally left adhering to the inner bark, though in some cases where the cuticle is thick and tough, as in the cherry, they adhere to the inner surface of the cuticle itself.

The mycelium which spreads over and penetrates the matrix consists of variously branched and anastomosing dark brown septate threads which are more luxuriant in proportion as the substance of the matrix is of a soft and spongy nature. This mycelium assumes at length a darker shade, so that the substance of the bark and the subjacent surface of the wood becomes finally almost black. The perithecia are always filled at first with a white grumous mass which is closely attached to the inclosing walls, and from which are slowly developed the organs of fructification. The mature perithecia at length become black within, and the upper portion breaks away, leaving the cup-shaped base attached to the matrix. Having now for several years studied these various forms I am satisfied that *Sphæria Quercuum*, Schw. includes all the following so-called species, viz., *Sphæria mutila*, Fr.;[1] *S. ambigua*, Schw.; *S. Meliæ*, Schw.; *S. entaxia*, C. & E. in Grevillea, vol. 6, p. 14; *S. eriostega*, Id.; *S. viscosa*, Id., vol. 5, p. 34; *S. erratica*, Id., vol. 6, p. 95; *S. thyoidea*, Id., vol. 6, p. 14; *S. pyriospora*, Ell. Bull. Torr. Bot. Club, v. p. 46; *Botryosphæria pustulata*, Sacc. Fungi Veneti, Ser. IV. p. 3; *Dothidea venenata*, C. & E. in Grev., vol. 5, p. 95; *D. Cerasi*, Id., vol 5, p. 34; *Thümenia Wisteriæ*, Rehm in Mycotheca Universalis, No. 971; (*Melogramma Wisteriæ*, Cke., Grev. vol. 7, p. 51), and probably *Sphæria Hibisci*, Schw.; *S. Persimmons*, Schw.; and *S. Cratæg,i* Schw. *Valsa mahaleb*, C. & E. in Grev., vol. 6, p. 11, is also, according to my specimens, only the young and imperfectly developed state of the same thing. *Melogramma Aceris*, C. & E., Grev., vol. 7, p. 8, is also, without much doubt, to be included in the above list, though this species and *S. eriostega*, C. & E., are unknown to me except from the descriptions in Grevillea. Of all the others I

[1] At least as that species is represented in Rav. Fungi Caroliniani Exsiccati, Fasc. III. No. 62. See also remark in Grevillea, vol. 4, p. 97, under *Melogramma Quercuum*, Schw.

have examined authentic specimens, most of them in all stages of growth.

In all these different forms the character of the fructification is the same, or at most there is only a slight variation in the size of the asci and sporidia, so that from a microscopical examination of the fruit alone it would be impossible to say to which of the above species any particular specimen should be referred. This similarity will be readily seen on examining the figures in Grevillea illustrating the species cited. All have the same broad clavate, obtuse, stipitate asci which are often subject to a kind of deformity, being bent almost double. The paraphyses are simple or sparingly branched, of a gelatinous nature, and, like the asci, soon dissolved.

The sporidia are two-ranked, mostly broad navicular, without septa, hyaline or filled with granular matter mixed with oil globules and become at length brown. Some of the sporidia are of a regularly elliptical shape; these are generally shorter and broader while the navicular sporidia are often much longer and narrower. The average size of the sporidia is about $.03^{mm}$ long by $.013^{mm}$ broad. In all the different forms the ascigerous perithecia are accompanied by others producing stylospores of the *Diplodia* or *Sphæropsis* type. (*Sphæropsis fibriseda*, C. & E , Grev. 5, p. 89. *Diplodia thyoidea*, C. & E., Grev. 5, p. 32.) These stylospores never assume the navicular form, but are always regularly elliptical, smaller than the ascospores, sub-hyaline and granular at first, soon becoming brown. Other perithecia are filled with minute hyaline oblong or subglobose microstylospores (spermatia) of which *Phoma fibriseda*, C. & E., Grev. 6, p. 2, is an example. The stylosporous perithecia may generally be distinguished from the others by their short cylindric ostiola, which in the ascigerous perithecia are oftener nearly obsolete.

By referring to the description of *Sphæria eriostega* in Grev. 6, p. 14, it will be seen that mention is there made of certain brown biseptate free spores, supposed to be ascospores. These brown biseptate spores are found in all the aforesaid forms; sparingly indeed for the most part, but always present and easily recognized among the generally hyaline sporidia. I have never seen these peculiar spores contained in asci, though I have examined during the past four years probably some hundreds of specimens. I consider them however to be true sporidia, and have supposed that the formation of septa is only the first step in the process of germination; though unfortunately I can only conjecture this, as the sporidia which I have tried to cultivate on slides of moistened glass have thus far refused to germinate.

From an examination of the above notes it will be seen that, disregarding the somewhat variable ostiola, the various forms above noted differ from each other only in the fact that in some the perithecia are confluent and united in a partial stroma, while in others they are scattered and without any distinct stroma. The only question then is whether this variation alone is sufficient to constitute a specific difference? Were this variability in the vegetative character accompanied by a corresponding variation in the fruit, there could be but one answer; but as has been already stated, and as may be seen by referring to the figures published in Grevillea, and as I hope to show by the publication of actual specimens in the North American Fungi, the fructification in all these different forms is essentially the same. With just as much reason might a specific distinction be made between the cluster of culms sprung from a single grain of wheat planted in a good soil and the single culm from another grain growing in a poorer soil. This same variation in an allied species, *Sphæria gyrosa*, Schw., was not considered by Fries as by any means sufficient to warrant a specific distinction. In his Elenchus Fungorum, vol. ii. p. 84, under *S. gyrosa*, he says: "Erumpunt hæc tuberculosa composita e rimis corticis Quercus; sed in ligno decorticato, eadem adest omnino simplex, conferta, subconfluens, punctiformis absque stromate distincto; singularis morphosis sed in hac tribu non rara." These remarks apply as accurately, at least to the form on *Rhus venenata*, i. e., to *Dothidea venenata*, C. & E., as if made with reference to that particular case. If then these different forms are to be united, it only remains to decide whether they are to be referred to the genus *Sphæria* or to *Melogramma* or *Dothidea;* or whether it would be better to follow the example of some of the transatlantic mycologists and create a new genus for this particular case. But as the number of new genera, many of them with characters sufficiently obscure, is every day increasing, it would seem better to avoid this latter alternative. Throwing aside next, in this case, the generic name of *Sphæria*, from which genus the fungus under consideration may perhaps with propriety be excluded on account of the peculiar character of its perithecia, there remains either *Dothidea* or *Melogramma* to be adopted. As remarked in Grevillea, vol. 5, p. 34, under *Dothidea Cerasi*, C. & E., that species is scarcely a good *Dothidea* for "the cells often approximate to perithecia; this remark applies equally well to *Dothidea venenata*, C. & E., and to all the other species enumerated.

There remains the genus *Melogramma*, with the characters of which our fungus, at least in its confluent forms, agrees sufficiently well; nor are the varieties in which the perithecia are scattered and single properly to be excluded. The fact that with age the upper portion of the perithecium falls away, leaving the base attached, shows that in every case there is at least the rudiments of a stroma to which the basal portion of the perithecium is permanently attached. A careful microscopic examination reveals the presence of this rudimentary stroma, formed from the condensed fibres of the mycelium at those points where the perithecia originate. Nor yet is the form of the sporidia inconsistent with the characters given by Tulasne to the sporidia of his genus *Melogramma*, viz.: "Sporæ sæpius distichæ, lineari-lanceolatæ vel ovatæ et utrinque obtusissimæ, curvæ rectæve, pluriloculares aut continuæ, fucatæ, vel pallidæ." The sporidia in our fungus are not ovate it is true, but the elliptical form approaches so near to that shape that it hardly seems best to exclude the species on that account.

According to Tulasne, l. c., and Fries, Elench. ii. p. 85, *Sphæria Quercuum*, Schw. is the same as *Sphæria fuliginosa*, Pers., at least as that species is represented in the Exsiccata of Mougeot and Nestler, though Fries (l. c.) does not consider it the same as the *Sphæria fuliginosa* of Persoon's Synopsis. Without undertaking to determine whether the *Sphæria Quercuum*, Schw., is really identical with the original *Sphæria fuliginosa*, Pers., we are warranted in assuming on the aforesaid authority that it is at least the same as the *Sphæria fuliginosa* of the Exsiccata of Mougeot and Nestler, so that it will be proper to adopt "*fuliginosa*" as the specific name for our variable species, especially as the specific name *Quercuum*, given by Schweinitz, is only applicable to a single form. The name *fuliginosa* also is peculiarly appropriate on account of the sooty color of the old mycelium. If, then, the foregoing conclusions are correct, all the above-mentioned species should be reduced to one which it is proposed to designate as *Melogramma fuliginosa*.

ON THE NUDIBRANCHIATE GASTEROPOD MOLLUSCA OF THE NORTH PACIFIC OCEAN, WITH SPECIAL REFERENCE TO THOSE OF ALASKA.

BY DR. R. BERGH, COPENHAGEN.

PART I.

The fauna of the North Pacific in general has been but little explored. The number of the so-called Nudibranchiate Gasteropod Mollusca found in this region up to this time is rather small. But a few species have been mentioned or described, chiefly by Tilesius, Eschscholtz, and Gould, and the number of forms is much smaller than that which is known from the North Atlantic in the same latitudes. There does not, however, seem to be any reason for a smaller number in the Pacific than in the Atlantic.

Mr. Dall has been engaged since 1865 in prosecuting researches in regard to the marine invertebrates of the region lying between America and Asia, from latitude 50° to latitude 70° N., including the coasts of Alaska, formerly Russian America, the Aleutian Islands, Bering Sea and Strait, and a part of the Arctic Ocean north of the strait.

Mr. Dall kindly invited me, who during a series of years have been engaged with studies upon Nudibranchiates, to examine and describe the collections relating to this group; these were received in the summer of 1876. It has been necessary to include, for comparison, the results of the examination of some few Atlantic species. Dall did not give particular attention to the Nudibranchs; yet, while a comparatively small number of forms and specimens have been obtained during his cruises, the number is sufficient to give some idea of the character of this particular fauna and to enrich our knowledge of the groups with several new forms. This will be obvious from the following list:—

NUDIBRANCHIATA OF THE NORTH PACIFIC.

1. *Aeolidia papillosa* (L.).
2. *Aeolidia* (? var.) *pacifica*, Bergh, n. sp. ?
3. *Coryphella*, sp.
4. *Flabellina iodinea* (Cooper).
5. *Hermissenda opalescens* (Cooper).

6. *Fiona marina* Forsk., var. *Pacifica*, Bergh.
7. *Dendronotus purpureus*, Bergh, n. sp.
8. *Dendronotus Dalli*, Bergh, n. sp.
9. *Tritonia tetraquetra* (Pallas).
10. *Archidoris Montereyensis* (Cooper).
11. *Diaulula Sandiegensis* (Cooper).
12. *Cadlina repanda* (Ald. & Hanc.).
13. *Cadlina pacifica*, Bergh, n. sp.
14. *Chromodoris Dalli*, Bergh, n. sp.
15. *Chromodoris californiensis*, Bergh, n. sp.
16. *Acanthodoris pilosa* (O. F. Müller), var. *albescens*, Bergh.
17. *Acanthodoris pilosa* (O. F. Müller), *var. purpurea*, Bergh.
18. *Acanthodoris coerulescens*, Bergh, n. sp.
19. *Lamellidoris bilamellata* (L.), var. *pacifica*, Bergh.
20. *Lamellidoris varians*, Bergh, n. sp.
21. *Lamellidoris hystricina*, Bergh, n. sp.
22. *Adalaria pacifiea*, Bergh, n. sp.
23. *Adalaria virescens*, Bergh, n. sp.
24. *Adalaria albopapillosa* (Dall).
25. *Akiodoris lutescens*, Bergh, n. sp.
26. *Triopa modesta*, Bergh, n. sp.
27. *Polycera pallida*, Bergh, n. sp.

An examination of the foregoing list[1] first shows *a quite northern character* of the forms examined, excepting the two species of *Doridæ* (*Chromodoris*) which actually come from and are usually characteristic of a more southern region than the others. Secondly, the species examined *agree with North Atlantic forms*, being either identical or mere varieties of them, or at least nearly allied species.[2]

AEOLIDIIDÆ.

The *Aeolidiidæ*[3] have representatives in all the seas of the world, but seem, as far as can be judged from the rather meagre accounts

[1] Besides Nudibranchs, there were included in the material sent also a *Marsenia*, an *Onchidiopsis*, a *Gasteropteron*, three or four species of *Bullidæ*, and a *Pleurobranchus*, which will be published later.

[2] According to R. E. C. Stearns a striking feature in the conchological fauna of that part of the Pacific coast included in the Californian and Oregonian zoological provinces, when compared with the molluscan fauna of the Atlantic coast from the Arctic seas to Georgia, is the preponderance in the former of those forms of molluscan life which are embodied in the *Scutibranchiata;* cf. Proc. Cal. Acad. Sci., Oct. 1872, and Ann. Mag. Nat. Hist., 4th ser., xii. pp. 185–186, 1873.

[3] The generic name (*Aeolus* Virgil) was established by Cuvier (in the Tabl. Elém. p. 388, 1798), and originally written "Aeolide (*Aeolidia*);" on the fifth plate of the illustrations of the Léç, d'anat. comp., vol. i., it is written *Eolia;* later, in the Règne Animale, he changed the denomination to *Eolidia*, since then the name has been written *Eolis*, *Aeolis* (Lam'k, Lovén,

of them, to be less abundantly distributed through the warm and tropical regions. This seems evident from the information given by Van Hasselt, Kelaart, Alder and Hancock, Collingwood and Pease, as well as by Semper.[1] Van Hasselt has only three forms of *Aeolidiidæ*, Elliott (Alder and Hancock) four or five, Kelaart nine. Collingwood was rather astonished at the small number of species and individuals which were found on the coasts of China: Formosa, Labuan, and Singapore, and which included no *Aeolidiidæ* at all. The Pacific seems especially poor in *Aeolidiidæ*, particularly in its northern and eastern part. The exploration of Alaska, under the direction of Mr. W. H. Dall, has only furnished five or six forms of this group belonging to the genera *Aeolidia*, *Fiona*, *Coryphella*, *Flabellina*, and *Hermissenda*.

I. AEOLIDIA, Cuvier.

Aeolidiana Quatrefages, Ann. Sci. Nat. Zoöl., Sér. i, t. iii. p. 134, 1844.
Aeolidia (Cuvier), R. Bergh, Anat. Bidr. til Kundsk. om Aeolidierne, Danske Vidsk. Selsk. Skr. 5 R. vii. 1864, p. 199.
Aeolidia, R. Bergh, Beitr. zur Kenntn. der Aeolidiaden, I. Verh. der K. K. zoöl.-bot. Ges. in Wien, xxiii., 1873, pp. 618–620; ii. l. c. xxiv. 1874, pp. 395-396.

Corpus sat depressum, rhinophoria simplicia, papillæ[2] caducæ, compressæ. Podarium antice angulatum mandibulæ applanatæ, processu masticatorio non denticulato. Radula dentibus uniseriatis, regulariter arcuatis, pectiniformibus instructa.

This genus is easily distinguished by its depressed form, the simple rhinophoria, the flattened papillæ, and the straight front margin of the foot, with nearly rounded edges. The mandibles are rather short, very much flattened, the cutting edges simple;

Menke), *Eolida*, *Eolidia*, and *Aeolidia* by different authors. It may be best, as I have done for many years, to adhere to the original Cuvierian way of writing it. Cf. my Unders. af *Fiona atlantica*, Natur. Hist. Foren. Vdsk. Meddel. for 1857, p. 276, 1858.

[1] Cf. my Malacol. Untersuch. (Semper, Reisen im Archipel. der Philippines II. ii.) Heft 1, 1870, p. 1.

[2] I always use the term *papillæ* instead of the more usual one of *branchiæ* or *cirrhi*, partly because it is the Linnean term, partly because the organs do not exclusively serve for respiration, which is partaken of by the whole surface of the skin, that over the papillæ as well as elsewhere, among all the *Nudibranchiata*.

the teeth of the radula comb-shaped, not emarginated in the middle. The genus is unarmed.

The spawn of the typical species is known,[1] and something of the development.

Only a few species of this genus are hitherto known, and very likely the Pacific forms will not prove specifically distinct from the typical species, which is found widely spread over the northern part of the Atlantic, on the coasts of America as well as of Europe.

1. *Aeolidia papillosa* (L.).

Gould, Inv. Mass., ed. Binney, p. 240, Pl. XVIII. f. 258, 1870.
Meyer and Möbius, Fauna der Kieler Bucht, I. p. 29, f. 9, 10, 1865.

Hab. Oc. Atlant. septentr.

2. *Aeolidia serotina*, Bergh.

R. Bergh, Beitr. zur Kennt. der Aeolidiaden; Verh. der K. K. Zoöl-bot. Ges. in Wien, xxiii. 1873, p. 619.

Hab. Oc. Atlant. septentr.

1. **Aeolidia papillosa** (L.).

Hab. Oc. Pacificum (Sanborn Harbor, Nagai, Shumagin Islands, Alaska Territory).

Only one specimen of this species was taken by Dall in July, 1872, in Sanborn Harbor (Shumagin Isl.) at low water on rocky bottom.

According to Dall the color of the living animal was yellowish-white; the color of the animal preserved *in spirits* was also uniformly yellowish-white. The length was about 15.0 mm., with a breadth of body of 9.0 and a height of 5.0 mm., the breadth of the foot 5.5, the length of the papillæ 4.5, the length of the rhinophoria and of the tentacles about 2.0 mm.

The form of the (rather contracted) animal was nearly that of the *Ae. papillosa*, in general and in most particulars; the papillæ were set in very many oblique rows, closely crowded.

The central nervous system showed the cerebro-visceral ganglia rather elongated, the pedal ones of rounded form, more than half as large as the former; the subcerebral, the pedal, and the visceral commissures as usual, the latter with the *N. genitalis*. The buccal ganglia elongate, of nearly semi-oval form, the commissure

[1] Alder and Hancock, Mon. Brit. Nud. Moll., Part VI., fam. 3, pl. 9, f. 6.

between them short, equalling about one-sixth of the longitudinal diameter of the ganglion; the gastro-œsophageal ganglia nearly one-sixth of the buccal ones in size, with one very large and two rather large cells, their stalk a little longer than the commissure between the buccal ganglia.

The *eye* has quite black pigment, and a yellowish lens. The otocyst is situated some distance behind the eye, and is filled with otoconia of the usual kind.

The *bulbus pharyngeus* is of the usual size, about 5.0 mm. long, 3.0 mm. broad, 3.5 mm. high; its form is as usual. The jaws exactly as in the typical *Ae. papillosa.* The radula contained thirteen teeth, beside seven mature and two immature teeth in the sheath, twenty-two altogether. The anterior plate was about 0.25 mm. broad, the posterior one about 0.75 mm.; yellowish horn colored; there were thirty-two denticles on the former and forty-two on the latter.

2. **Aeolidia papillosa,** var. *Pacifica,* Pl. I. f. 1–6.

Colore e flavido albescens.

Hab. Oc. Pacific septentr. (Chignik Bay, Aliaska Pen.).

Three specimens of this form were taken by Dall on mud flats at low water in Chignik Bay, Aliaska, July, 1874.

According to Dall the color of the living animal was pale yellowish-white.

The alcoholic specimens were all of nearly the same size, about 20.0 mm. long, 7–8.0 mm. broad, and 6–6.5 mm. high. The tentacles and rhinophoria measured about 2.0 mm. in length, the papillæ of the back reached 3.0 mm. in length, and the breadth of the foot 5.0 mm. The color was yellowish-white, the papillæ a little grayish, and generally with white points. The viscera were not visible through the side walls of the body.

The form of the animal was typical, somewhat depressed; the head rather large, the tentacles short and strong, stronger than the rhinophoria, the eyes not visible through the wall of the back. The foot was rather large, somewhat pointed behind, the anterior margin straight, with a very distinct transverse groove. The sides of the body rather elevated, with the genital papilla beneath the eighth and tenth row of papillæ. The back was naked in its broadest part; in the much narrower side parts covered with closely set oblique rows of papillæ, which, on the hindmost part, cover the back entirely. The number of rows was about twenty-five to thirty-two, the foremost shorter, with about seven to nine papillæ; the hindmost the shortest, with about three to four papillæ, the rest longer and much more oblique, with about twelve to thirteen papillæ. The papillæ flattened, quite as in other true *Aeolidiæ*. The anus is between the outer part of two rows behind the middle of the back (at about the thirteenth or fifteenth row). The intestines were seen very distinctly shining through the wall of the back.

The cerebro-visceral ganglia were somewhat elongated, reniform, thinner and broader in the fore part, thicker in the hindest part; the pedal ones rounded, triangular, as thick as the confining part of the visceral ganglia. The buccal ganglia were about one-quarter of the size of the pedal ones; the gastro-œsophageal ganglia rounded, about one-quarter of the size of the buccal ones, with three large cells.

The eye was furnished with black pigment and yellow lens. The otocysts could not be found.

The buccal tube short, rather wide, with strong longitudinal folds on the inside. The *bulbus pharyngeus* rather short, somewhat compressed; in length about 3.5 mm. by a height of 2.75, and a breadth of about 2.0 mm. The form-relations for the rest quite as in the *Aeolidia serotina* (cf. l. c.). The mandibles (fig. 1) were very strong, flattened, yellowish, or brownish-yellow; the articulation strongly developed, on the anterior outer side somewhat twisted, slightly bilobed; the keel on the inside (*crista connectiva*) short, somewhat prominent (fig. 1*a*); the cutting blades (*processus masticatorius*) rather prominent (fig. 1*b*), the margin with very fine longitudinal lines (fig. 2). The tongue rather short and strong (on the under side, the end, and the upper side), with 13 plates, under the narrow *tectum radulæ* and further backward in the sheath (*vagina, pulpa radulæ*) seven developed and two immature teeth; the total number of teeth was twenty-two. The plates similar in form (fig. 3, 4) to those of the two other species; light brown-yellowish; on each side of the nearly imperceptible median impression and prominence — in the foremost plates thirteen, in the hindmost as many as seventeen lancet-formed denticles; the breadth of the foremost teeth was about 0.3 mm.; of the hindmost nearly 0.68 mm.

The salivary glands were as in the typical form.

The œsophagus, the stomach, the biliary ducts, and the intestine, as in other species; the stomach on each side receiving a biliary duct, and the posterior chief duct receiving from each side three strong and one to two finer ducts; the length of the intestine was about 9.0 mm., with fine longitudinal folds along the inside. The liver papillæ (in the dorsal papillæ) rather nodose. The *bursa cnidophora* in the largest papillæ measured one-seventh to one-eighth of the length of the papilla, containing a mass of cnidæ, elongate-pyriform or staff-shaped, reaching 0.026 mm. in length (fig. 6).

The heart and renal syrinx as usual.

The hermaphroditic gland is large and yellowish, of the usual structure; in the centre of the zoöspermic lobules were oögene cells in peripheral nodosities. The anterior genital mass short and clumsy, about 5 to 6.0 mm. long by 2.5 to 3.0 mm. broad, and 4 to 4.5 mm. high. The *gl. mucosa* and *albuminifera* white and whitish. The *vas deferens* (fig. 5*a*) yellowish, very long, rolled up in a tight coil on the fore end of the genital mass; the penis (retracted) short, bag-shaped, about 2 mm. long, nearly filled by the conical glans (fig. 5), through the whole length of which the continuation of the sperm duct could be traced.

There was a peculiar aspect in the interior of this *Aeolidia* (as well as in the *Ae. serotina*) as far as observations on alcoholic specimens go, which seemed to indicate a possible specific difference from the typical *Ae. papillosa*, although the anatomical examination could not bring out any very reliable specific characters.

II. CORYPHELLA, Gray.

Coryphella, Gray, Figures of Moll. Anim, IV. 1850, p. 109. Gray, Guide, i. 1857, p. 224. Alder and Hanc. Monogr., Part VII. 1855, p. 49; Appendix, p. xxii. R. Bergh, Anat. Bidr. til Kundsk. om Aeolid., l. c., 1864, p. 226. R. Bergh, Beitr. zur Kenntn. d. Aeolidiaden. iii., l. c. xxv. 1875, p. 633.

Corpus elongatum. Rhinophoria simplicia. Podarium antice angulatum vel angulis productis.

Processus masticatorius *mandibulæ* seriebus denticulorum praeditus. Radula dentibus triseriatis; dentes laterales margine supero (interno) denticulati. Penis inermis.

The genus contains *Aeolidiidæ* of an elongated form, with simple rhinophoria and with the anterior margin of the foot angulated or with the angles rather produced. The edge of the cutting-blades of the mandibles with several rows of knobs or denticles. The lateral plates of the tongue have the superior (interior) margin not smooth (as in the *Galvinæ*) but denticulated. The penis is unarmed.

In my last memoir upon this genus, to which the reader is referred, I have given a list of nineteen species which seem to belong to this genus. Four of them are from the Pacific ocean.

1. *C. Foulisi* (Angas).
2. *C. semidecora* (Angas).
3. *C. parvula* (Angas).
4. *C. athadona*, Bergh.

1. Coryphella, sp. Pl. I f. 13–14; Pl II. f. 7–8.

Hab. M. Pacif. (Ins. Aleut.).

Only the *bulbus pharyngeus* of this form has been found by Dall in dredging at Adakh Island (Aleutians) in mud, at a depth of 9–16 fathoms, in June, 1873.

The length of the organ was 5.0 mm., with a height of 4.0 and a breadth of 5.0 mm.: the form short, much broader in the hindmost part; the radula sheath a little prominent behind the buccal ganglia. The labial disk of usual oval form;[1] the greatest part of the *bulbus* covered by the mandibles; the *m. transv. sup* rather large. The mandibles (fig. 7) large, nearly as long and as high as the *bulbus*, of yellow horn-color; the articulation rather small (Fig. 7*a*); the edges of the cutting blades with 4 to 6 (fig. 8, 13) rows of low knobs, which on the anterior margin, except in the uppermost parts of the cutting blade, rise to denticles of the height of 0.1 mm. The *tongue* rather short; on the upper side nine rows of plates, further backwards seven rows of developed and two of not quite developed teeth; the total number of rows was eighteen. The teeth as usual of horn-yellow color, very strong; the breadth of the foremost medial ones about 0.16, of the hindmost 0.25 mm. The medial ones with five to seven denticles on each side of the strong point (fig. 14); the lateral ones with a long point, and five to six denticles on the inside at the base (fig. 14*aa*).

The cerebro-visceral ganglia short, reniform, somewhat broader at the anterior end; the pedal ganglia rounded, scarcely smaller than the former. The buccal ganglia are of oval form, about one-

[1] In the mouth, half hanging out, was found a fine *Caprella*, the body having the length of 6 mm.

third the size of the pedal ones, the commissure between them measuring about one-third the length of each ganglion.

III. FLABELLINA, Cuvier.

Flabellina, Cuvier, Règne An. ed. ii[a], 1830, iii. p 55. Alder and Hancock, Mon., Part VII. p. xxi. 1855. Trinchese, Rendic. della Acad. della Sci. di Bologna, 7, 1874. R. Bergh, Beitr. zur Kenntn. d. Aeolidiaden, iii., Verh. d. K. K. Zool.-bot. Ges. in Wien, xxv. p. 647, 1875.

Corpus sat elongatum, subcompressum. Rhinophoria perfoliata. Papillæ (dorsales) non caducæ, pedamentis brachioformibus insertæ. Podarium angulis tentaculatim productis.

Margo masticatorius mandibulæ seriebus denticulorum præditus. *Radula* triseriata, dentibus medianis denticulati, lateralibus interno margine denticulatis. Penis stylo armatus.

As for the history of the denomination of this genus the reader must be referred to my above cited paper. The *Flabellinæ* have nearest relation to the *Calmæ*,[1] but differ by the perfoliate rhinophoria and in the denticulation of the lateral teeth. They show an elongate, somewhat compressed form of the body; perfoliated rhinophoria; dorsal papillæ caducous, inserted upon arm-shaped foot-stalks the foot with produced anterior angles. The cutting edges of the jaws with rows of small denticles. The tongue with three series of teeth; the median denticulated in the usual way, the lateral ones only on the inner edge. The penis with a stylus (as in the *Calmæ*).

To this genus belong:—

1. *F. affinis* (Gm.), Bergh, l. c. p. 649, Taf. XV. f. 6-19; Taf. XVI. f. 3-4. M. Medit.
2. *F. flabellina* (Ver.), M. Medit.
3. *F. ianthina*, Angas, M. Pacificum.
4. *F. ornata*, Angas, M. Pacificum.
5. *F. Newcombi*, Angas, M. Pacificum.
6. *F. iodinea* (Cooper), M. Pacific. orient.

1. **Flabellina iodinea** (Cooper), Plate I. f. 15 to 17; Plate II. f. 16.

Aeolis (Phidiana?) iodinea, Cooper, Proc. Calif. Acad. ii. 1862, p. 205;[2] iii. 1863, p. 60.

---

[1] Cf. my above cited paper, l. c. p. 643.

[2] "Rich, violet purple, narrow, wedge-shaped, high in front, tapering to an acute point behind, slightly constricted in five parts of the body corresponding to divisions of the branchiæ. Foot very narrow, slightly expanded.

Phidiana iodinea, Cooper, Bergh, Beitr. zur Kenntn. d. Aeolidiaden, i., l. c. xxiii. p. 615,[1] 1873.

Color corporis e violaceo purpureus, rhinophoria aurantiaca, papillæ aurantiace-rubra (Cooper).

Dentes mediani sicut laterales, multidenticulati.

Hab. Ocean. pacific. orient. (San Diego, Cal. to Puget Sound.)

A single specimen was collected by Capt. Hall alive, on algæ, at low water in Puget Sound, Washington Territory, Aug. 1873. According to Cooper (l. c. p. 205) the species is found "among algæ, outside of San Diego Bay, rarely inside." According to Cooper's description and a drawing kindly lent by Dall, the color of the living animal is violet purple, the rhinophoria orange colored, the papillæ orange-red.

The length of the individual (most badly) conserved in spirits was about 15.0 mm., with a breadth of the body of 2.0, and a height of 2.5 mm.; the length of the papillæ reaching to about 4.0 mm.; the length of the tentacula about 1.5 of the rhinophoria, about 2.3 mm. The color rather dirty chocolate.

The *form* is elongated, rather compressed, the tail rather short. The head rather small, the tentacula elongate, also the apparently closely perfoliated rhinophoria. The back rather narrow; the groups of papillæ situated on the side parts of it, firmly affixed on the edge of foot-stalks, whose form and number could not be determined, owing to the state of the specimen; their number seemed to be much greater than referred to by Cooper. The foot rather narrow, the angles of the foremost margin much produced, longer than the tentacula, strong; the groove in the anterior margin continued along the angles.

The eyes are rather large, with black pigment.

The *jaws* more rounded at the posterior end than in the *Fl. affinis* (l. c. Pl. XV. f. 13), otherwise as in that species; the cutting edge with several rows of small rounded denticles (fig. 15). The state

Head obtuse, with four tentacles, the upper longer and turned upwards, the lower deflexed. Two club-shaped, orange-colored appendages a little behind the upper tentacles. Branchiæ short, in a double row, close together near the median line, their color orange-red. Length two and a half inches, breadth one-fifth of an inch." Cooper, l. c.

[1] The "descriptions" of Cooper are of the kind which have caused so much confusion in science, so light and trifling that there properly should no notice at all be taken of them.

of the specimen examined[1] did not permit the determination of the number of plates of the tongue and the posterior continuation of the radula. The *median plates* (Pl. II. fig. 16*a*) with a greater number of denticles, mostly with about 12–13; the lateral ones with a rather produced outer limb (fig. 16*b*, Pl. I. figs. 16, 17), the inner edge with a rather great number of (about 25–27) fine denticles.

As far as could be determined, a Penis-style existed, as it seemed, of about the same form as in *Fl. affinis* (cf. l. c. Pl. XVI. f. 3, 4).

IV. HERMISSENDA, Bgh.

Hermissenda, Bgh., Beitr. zur Kenntn. den Aeolidiaden, vi.; Verh. d. K. K Zool.-bot. Ges. in Wien. xxviii. 1878, p. 573.

Corpus gracilius elongatum. Rhinophoria perfoliata, tentacula elongata. Papillæ dorsales in series obliquas et transversas confertas areis præsertim compluribus collatas dispositæ. Podarium antice angulis elongatis.

Margo masticatorius *mandibulæ* singula serie denticulorum præditus. *Radula* dentibus uniseriatis, denticulis elongatis præditis et cuspide infra serrulata. Penis inermis.

In many respects this new genus seems to agree with the *Phidianæ*, as far as these are now known.[2] The general form of the body, the rhinophoria and the tentacula are as in that genus, also perhaps the disposition of the dorsal papillæ. But the *Hermissendæ* differ in the rather produced angles of the front of the foot, in the form of the teeth of the tongue, but especially in the want of a hook on the penis.

The body is rather elongated, slender The rhinophoria are perfoliate, the tentacula long. The dorsal papillæ seems to be arranged in oblique and transverse rows, which form several more or less separated groups. The angles of the front of the foot are rather elongated.

The cutting edge of the jaws has a single row of strong pointed denticles. The teeth are in a single series; each tooth with five

[1] The individual seemed to have been found dry in the glass and put in new alcohol in such a state. Even the outer form could not be determined before the specimen was softened.

[2] R. Bergh, Neue Beitr. zur Kenntniss der Aeolidiaden. I. Verh. d. K. K. Zool.-bot. Ges. in Wien. xxiii. 1873, pp. 613-618.

denticulations on the under side of the trigonal point and long denticles of the cutting edge at the base of the point. The penis is unarmed.

Only one species of the group is hitherto known.

1. **Hermissenda opalescens** (Cooper). Plate I. fig. 9; Pl. II. f. 1–6.

Aeolis (Flabellina?) opalescens, Cooper, Proc. Cal. Acad. ii. 1862, p. 205; iii. p. 60, 1863.

Hermissenda opalescens, Bergh, l. c.

Color corporis e caerulescente albescens, pellucidus; rhinophoria opalina, nucha stria longitudinali aurantiaca; papillæ lutescentes, apice purpurascenti.

Hab. San Diego Bay, Cala. to Sitka, Alaska Territory.

Of this species Dall found two living specimens at Sitka, on algæ at a depth of 6–10 fathoms, Aug. 18th, 1865.

Cooper saw "this elegant species" numerous in the San Diego Bay in the winter, living among the (sea) grass and "depositing its ova on any fixed object it meets with."

According to Cooper's description and drawings kindly lent me by Dall the living animal is nearly transparent, bluish-white, the rhinophoria of opaline color, with an orange stripe between them; the papillæ of yellowish color with a purple or blood-red spot near the end. Dall regards the animals, found by him, as identical with the species of Cooper,[2] although the colors according to some (4) colored sketches of Dall are rather different from those mentioned by Cooper. For these sketches the color is grass-green, much paler on the under side (foot), the rhinophoria whitish, the liver-lobes purple-red shining through the papillæ,

[1] "Bluish-white, pellucid, somewhat quadrangular, posteriorly wedge-shaped ending in a sharp point. Foot anteriorly with two short spreading appendages, laterally thin and flattened. Head short, tentacles two, long, acute (the lower pair replaced by the appendages of the foot); two erect club-shaped appendages (dorsal tentacles) on the anterior part of the back, of an opaline color, with an orange stripe between them. Branchiæ in five pairs of fasciculi along the upper edges of the back, each bundle of about four rows, longest above, their color yellowish with a purple or blood-red spot near the end. A rosy tint often visible from the string of ova shining through the abdominal walls. Length one and a half inch, breadth one-quarter inch (Cooper).

[2] My specimens and drawings were examined by Dr. Cooper in 1866, who referred them to his species, the types of the latter being now lost or destroyed.—W. H. D.

on the lateral part of the back along the papillæ yellow vessels (hepatic ducts?) shining through the walls of the back. According to Cooper the *length* of the living animal reaches about one and a half inch. Dall's specimens were only about seven lines in length.

The length of the individuals preserved in spirits was about 12.5–13.0 mm. by a breadth of 4–4.5, and a height of 3–4.25 mm.; the length of the tentacula was about 2.5–3.0, of the rhinophoria 2.5 mm., that of the papillæ reaching 4.0 mm.; the breadth of the front part of the foot 4.0 mm.; the length of the produced angles about 2 mm. The color was uniformly brownish-white; the intestines nowhere shining through the skin.

The head is rather large, the tentacles long and strong, the oral aperture as usual; the rhinophoria are strong, the club with about twenty to twenty-five leaves. The back is rather broad; the papillæ set in transverse or oblique rows, that were crowded in about four groups. The *first* group of papillæ is the largest of all, compressed—horse-shoe shaped, with about five to seven oblique rows in the foremost and four to five in the hindmost limb; the number of papillæ in the rows seemed not to surpass ten or twelve. The *second* group had about six to seven oblique rows; the number of papillæ in the rows seemed not to exceed eight or nine. The space between the first and second groups was larger than that between the second and third, in the uppermost part of the latter space is the rather prominent, goblet-formed or more applanate anal papillæ; more forward and downward was the renal pore, which in one individual was rather prominent. The *third* group on one (right) side composed of several (five to seven), on the other of fewer (three to four) rows, but never very distinct from the *fourth* group, which had about ten to fourteen densely set rows, which by degrees decrease in size backwards and cover the whole of the rest of the side parts of the back; sometimes the rows of this fourth group stand in pairs; the innermost parts of the rows are separated by very narrow spaces.[1] The papillæ conical, somewhat contracted in the inferior parts. The sides not low; the genital papillæ in the usual

[1] The state of conservation of the individuals did not permit me to ascertain the relations of the groups and the rows with full certainty, so much the more as the greater part of the papillæ had dropped off.

place (under the region between the two extremities of the first group of papillæ), contracted. The foot is strong, broader than the back, the muzzle rather broad and produced into angles anteriorly; their length about one-third of the breadth of the foot; the groove of the anterior margin is continued along the margin of the angles, the tail measuring about a third of the whole length of the foot.

The cerebro-visceral ganglia are rather short, not much larger than the short pyriform pedal ganglia.

The buccal ganglia are rounded, connected by a commissure which is a little longer than the diameter of the ganglia. The gastro-œsophageal ganglia are not long-stalked and have about 0.18 of the size of the last mentioned, with one large and two rather large cells.

The eye has black pigment and yellowish lens. Immediately behind the eye is the otocyst, scarcely larger than the eye, with thirty-five to forty-five otoconia of the usual form. The rhinophoria are as in related forms of *Aeolidiidæ*.

The bulbus pharyngeus is shaped as usual, and is from 2.75 mm. to 4.5 mm. in length. The jaws (fig. 9), as commonly among the *Phidianæ* are yellowish-horn colored. The articulation (fig. 9*a*) is rather small; the cutting blades arched (fig. 9*b*) their edges with a series of about fifty strong, sharp pointed denticles (fig. 10), the uppermost short (fig. 10*a*), by degrees increasing in size to about the length of 0.06 mm.; the hindmost are serrulate (fig. 10*b*) on the posterior margin. The accessory buccal cavity behind the articulation of the jaw rather large, and filled with indeterminate animal matter.

The radula is rather long and keel-shaped, the edge nearly covered with twelve to fifteen teeth; behind these are eight to eleven developed and two not quite developed; the total number about twenty-five. The color of the teeth horny-yellowish or more brownish; the height of the oldest about 0.09, of the youngest 0.16 mm.; the length of the basal part reaching 0.3 mm.; the form (fig. 11, one to four) nearly as in the *Coryphellæ*, but the denticles (four to six on each side) longer and more slender and (what hitherto scarcely has been observed in any form of the group of *Aeolidiidæ*) the trigonal points of the teeth are finely denticulated on the under margin (fig. 11, one to four).

The œsophagus is short. The stomach has rather strong folds.

The intestines are rather short, with a strong longitudinal fold through its first half, with many fine longitudinal folds in the anal papillæ. In the digestive channel were stems of Hydroidæ and different forms of Diatomaceæ.

The liver papillæ have a rather smooth surface. The *bursæ cnidophoræ* rather short, pyriform, with masses of small cnidæ (fig. 12), partly of oval form and generally measuring in length about 0.013 mm., partly shorter, staff-shaped, and rarely surpassing the length of about 0.01–0.07 mm.

The hermaphroditic gland is very large, the lobes and lobules as usual; in the centre of the last were zoosperms; in the peripheric (fig. 5) acini (which in very different numbers cover the central part) were oögene cells. The anterior genital mass was large, 2.2 to 4 mm., with a breadth of 1.2 to 2.75, and a height of 1.2 to 3 mm.; the whole, in great part formed by the *gland. mucosa et albuminosa.*

The *Spermatotheca* seemed rather peculiar; it was sac-shaped, rather short, and short-stalked; the free end of the *vas deferens* was only two or three times as long as the penis, somewhat thicker in the middle, strong, continued (fig. 6*a*) through the whole length of the penis. The retracted *glans penis* in its sheath (fig. 6*bb*) which had a length of about 3.5 mm., as also the glans, which was strong, short, sausage-shaped, with a round opening at the end (fig. 6*c*). A layer of rather short sacculate glands filled the end of the penis around the orifice. One of the drawings represents the spawn of *Ae. opalescens* as a rather long corkscrew-shaped coil of reddish hue.

V. FIONA, Hanc. et Embleton.

Fiona, H. et E. Forbes and Hanley, Brit. Moll., iii. 1853, p. x. Ald. and Hanc., Monogr. Brit. Nudibr. Moll., Part VII., 1855, pp. 52, 53, fam. 3, Pl. 38*a*. R. Bergh, anatom. Unders. af *Fiona atlant.* Vdsk. Meddel. fra naturh. Foren, i Kjobenhavn for 1857, pp. 273–337 (279–283 !), 1858, Tab. II.–III. R. Bergh, Contrib. to a Monogr. of the Gen. *Fiona*, H., 2 w. pl. Copenhagen, 1859. R. Bergh, Journ. d. Mus. Godef. 2te Heft, 1873, pp. 80–88, Tab. XII. fig. 4, 5. R. Bergh, Beitr. zur Kenntn. der Aeolidiaden, I; Verh. d. K. K. Zoöl.-bot. Ges. in Wien, xxiii. 1873, pp. 605–610. V, l. c., xxvii. 1877, pp. 823–824.

Hymenaeolis, F. Costa, Annuario del Mus. zool. di Napoli, iii., 1866, pp. 64, 80; iv. 1867, p. 28.

Rhinophoria et tentacula subsimilia, simplicia. Papillæ (dorsales) cuti firmius affixæ, elongatæ, ab membranam branchialem quasi alatæ, bursa cnidophora nulla. Anus dorsualis dextrorsum, apertura genitalis gemina. *Mandibulæ* cymbiolatæ, processu masticatorio breviore subhamato, margine masticatorio sat grosse denticulato. Lingua elongata, compressa, serie dentium unica; dentes arcuati, cruribus angustis, acie cuspide prominulo et utrinque denticalis compluribus.

For the general characters of the genus the reader is referred to my monograph (1857) and to the above cited publications (1873).

The animals are pelagic, but few species are yet known, which besides are not well distinguished, and may perhaps prove to belong to one circumæquatorial and cosmopolitan form.

They are:—

1. *F. marina* (Försk.) M. Atlant. mediterr.
2. *F. pinnata* (Eschsch.) M. Pacific. sept.
   Bergh, l. c. xxiii. p. 606, 1873.
3. *F. longicauda* (Quoy and Gaim.) M. Pacificum.
4. *F.? alba* (Van Hasselt) M. Indicum.

I. Fiona marina (Försk.), var. *pacifica* Bergh. Plate I. fig. 7–8.

Limax marina, Förskal.
Fiona nobilis, Hancock and Embleton, l. c.
Fiona atlantica, Bergh, l. c.
Hymenaeolis elegantissima, A. Costa, l. c.

Color caerulescente-purpureus (Dall).

Hab. Oc. Pacificum, Atlanticum, Mediterraneum.

A single individual of this species was taken by Dall in 1873, in the open sea five hundred miles west of San Francisco, California, feeding on *Velellæ*.

According to Dall the color of the living animal was blue purple (*like Janthina communis;* D.).

The individual, not too well preserved in spirits, was about 12.0 mm. long, 5.5 high, and 6.0 mm. wide in the broadest part. The front of the foot was 3.75 mm. broad, the tentacles 1.0 mm. long, the rhinophoria 1.25 mm., the papillæ of the back 2.5 mm. The color (in spirits) light yellowish-brown, the viscera indistinctly perceptible through the walls of the body.

The form of the body was rather stout;[1] the head flattened, rather broad, broader than tentacles,[2] which are pointed and some-

[1] Cf. l. c., 1858, Tab. I. f. 1. [2] Cf. l. c., 1858, Tab. I. f. 1–2.

what flattened. The rhinophoria are smooth, scarcely longer than the tentacles. The eyes are not visible externally. The back throughout its whole length naked on the broader middle part; laterally closely set with oblique rows of papillæ,[1] about seven to eight in each row, fewer in the fore and hindmost rows; the papillæ conical, somewhat compressed, particularly in the inferior parts, with the usual gill-membrane along the inner edge.[2] The anus in the usual place. The sides of the body rather high, the genital openings quite contracted. The foot in the foremost part rather broad, anteriorly rounded; backwards gradually narrower, the margins projecting a little from the sides; the tail rather short (about 1.5 mm. long), merely projecting a little behind the body.

The *central nervous system* is of the usual form,[3] rather flattened; the cerebro-visceral ganglia rounded, triangular, the pedal ones a little larger, of oval form, the buccal and gastro-œsophageal ganglia as usual.

The eye is as usual, with black pigment, and with a rather large lens. The otocysts could not be detected.

The oral tube (retracted) about 1.5 mm. long, rather wide. The oral glands[4] long as usual, opening in the oral tube; whitish. The *bulbus pharyngeus* 3.0 mm. long, with a breadth of about 1.8 mm., as formerly described.[5] The mandibles also quite as in the typical form.[6] The tongue long and narrow, as in the last;[7] on the under side twelve, on the end two, and on the upper side twelve teeth; also in the sheath of the radula eleven developed teeth and two not fully developed plates; the number of teeth was consequently thirty-nine.[8] The form of the teeth (fig. 7, 8) was as usual; on

[1] Cf. l. c., 1858, Tab. I. f. 1-3.

[2] Cf. l. c., 1858, Tab. I. fig. 4-5.

[3] Cf. l. c., Tab. I. fig. 7.

[4] These glands, which have been formerly described by me as salivary, cannot be so homologized, because their ducts do not pass over the commissures of the central nervous system. Glands of the same kind have been found in other forms of *Aeolidiidæ*, in the genus *Aeolidiella*, Bgh. (Cf. my. Beitr. zur Kenntn. d. Mollusken des Sargassomeeres. Verh. d. k. k. Zoöl.-bot. Ges. in Wien, xxi. 1871, Taf. XIII. fig. 20*b*, and Beitr. zur Kenntn. d. Aeolidiaden, ii. l. c. xxiv. 1874, p. 399, Taf. VIII. fig. 11*bb*).

[5] Cf. l. c., Tab. I. fig. 8.

[6] Cf. l. c., Tab. I. fig. 9-13.

[7] Cf. l. c., Tab. I. fig. 16-18.

[8] Cf. l. c., Tab. I. fig. 23-28. The author found in twenty-two specimens of the *F. atlantica* thirty-eight to fifty teeth; the number of denticles was mostly six to eight, sometimes eleven to twelve, on each side; later (Beitr.

the cutting edge were on each side seven to nine denticles; on the foremost teeth often nine; the breadth of the foremost teeth was about 0.13, of the twelfth 0.18 mm., the width amounting to 0.37 mm. or less.

True salivary glands do not exist. The œsophagus, the stomach, the intestine and the hepatic system, as far as could be determined, were quite as in the typical form.[1]

The vascular system and the renal organ are as formerly described by me.[2]

The hermaphroditic gland[3] is quite as in the typical form, also the hermaphroditic duct with its ampulla, and the spermato-duct with its two parts, one thicker and brownish, the other thinner and whitish. So also is the long (about 7 mm.) whip-like penis, which is drawn back and bent up and down in the thinner sheath-like part. The latter showed rather strong, circular, muscular belts, and had a *M. retractoris* attached near the neck; the continuation of the spermato-duct could be followed through the whole length of the penis to its point. The *spermatotheca* forms a short bag about 1.–3.0 mm. long, filled with sperma. The anterior genital mass is rather compressed, and about 4.25 mm. in length.

DENDRONOTIDÆ.

The *Dendronotidæ* form, like the *Scyllæidæ* and *Bornellidæ*,[4] in certain respects a connecting link between the large group of *Aeolidiidæ* and the still larger group of *Dorididæ*. In those families the liver forms, as in the *Dorididæ*, a large compact mass, but branches are given off from the same, that penetrate (as very much reduced hepatic lobules) the dorsal appendages, which in this way become homologous with the papillæ of the *Aeolidiidæ*. In most other respects these groups agree with the *Aeolidiidæ*, especially in the nature of the bulbus with its strongly developed mandibles, and in the presence of only one *spermatotheca*.

zur Kenntn. d. Moll. des Sargassomeeres, l. c., 1871, p. 1287), he saw thirty-seven to forty-two teeth (in two individuals) with six denticles.

[1] Cf. l. c., Tab. II. fig. 30.

[2] Cf. l. c, Tab. II. fig. 31-32.

[3] Cf. l. c., Tab. II. fig. 34-35.

[4] These two families have been examined by the author in his Mal. Untersuch., Heft vii. 1874, pp. 287-308 (*Bornellidæ*), and Heft viii. 1875, pp. 315-343 (*Scyllæidæ*).

The *Dendronotidæ* differ externally very distinctly from the *Scyllæidæ* and *Bornellidæ*, especially in the form of the dorsal papillæ; in the anatomical relations of the form of the mandibulæ and by the character of the *gl. hermaphrodisiaca*, which is not (as in the *Dorididæ*) separate from, but connected with the liver.

Only two generic forms of the family have hitherto been known.

1. *Dendronotus*, A. and H.
2. *Campaspe*, Bgh. Naturhist. Tidssk., 3 R. J., 1863, pp. 471–478, Tab. XII. figs. 1–17.

DENDRONOTUS, A. and H.

The true *Dendronoti* differ from the *Campaspæ* by the much more composite form of the frontal appendices, of the appendices of the margin of the sheath of rhinophoria, and of the dorsal papillæ. The lateral teeth of the tongue of the former especially are longer than in the *Campaspæ*.

Only a few species of the genus are hitherto known.

1. *D. arborescens* (O. F. Müller). M. Atlant.
2. *D. luteolus*, Lafont, Act. Soc. Linn. de Bord. 28, 1872. M. Atlant.
3. *D. robustus*, Verrill, Amer. Journ. of Sci. and Arts, n. s. L., 1870, p. 405. M. Pacif.
4. *D. iris.*, Cooper, Proc. of the Cal. Acad. of Sciences, ii. 1862, p. 59, 1863. M. Pacif.
5. *D. purpureus*, Bgh. n. sp. M. Pacif.

1. **Dendronotus purpureus**, Bergh, n. sp. Plate I. fig. 18–20; Plate III. fig. 7–12.

Color purpureus.

Dentes medianæ (linguales) minutissime serrulati altamen non usque ad apicem.

Hab. M. Beringianum (Port Möller, Aliaska Peninsula).

Only one specimen of this species was taken by Dall at Port Möller on the north shore of Aliaska Pen., in September, 1874, at a depth of seventeen fathoms, sand. He notes only that the animal when living had the "mantle purple."

The color of the alcoholic specimen, which was not in the best condition, was reddish-brown, the head and foot yellowish. The length of the (partly mutilated) animal was aparently about 20.0 mm. when perfect, with a height of the body of about 6.5 and a breadth of nearly 5.0 mm. The height of the dorsal papillæ reached 3.0 mm. the breadth of the foot 3.5 mm.

The form resembled that of the typical species, the veil had two median arbusculi, and on each side three lateral ones, the median little larger than the laterals; between the median a small, simple, rather prominent papilla. A similar papilla seemed to exist between the two lateral arbusculi. Under the veil, on the upper lips of the simple muzzle were a series of small, simple, truncate papillæ; the most lateral one larger (representing the tentacle??).[1] The sheath of the rhinophoria high; above this was the usual larger branched appendage, divided at the top into five nearly similar appendages; the club not large, with about twenty rather thin, and very broad leaves (on each side) mostly alternating in breadth.[2] The body of the typical form had the arborescent papillæ, as in the typical species; the two foremost pairs seemed more branched and more divaricate, between them (in the region of the heart) lower arborescent tufts.[3] Between the first and second papillæ of the right side was the large truncate anal prominence,[4] and at its root in front the very fine renal pore. The sides of the body were rather high; the genital opening in the usual place in front of the region of the first (dorsal) papilla, with two fine apertures. The foot was rather narrow, scarcely divided from the sides of the body; the front end rounded, a groove between this and the under part of the mantle.

The cerebro-visceral ganglia were nearly as figured by Alder and Hancock (l. c., fig. 9), the cerebral part a little larger than the visceral; the pedal ganglia more rounded, and the commissure between them longer. The olfactory ganglia in the root of the club of the rhinophoria were nearly spherical, rather large. The buccal ganglia were of oval form, the commissure between them

[1] This is very likely the slight tentacular prolongation mentioned by Alder and Hancock. Meyer and Moebius (Fauna der Kieler-Bucht. i., 1865, Taf. V. fig. 3) neither mention nor represent any tentacles.

[2] Alder and Hancock mention in the *D. arborescens* "five or six large plates and intermediate smaller ones." Meyer and Moebius (l. c., p. 43) indicate twelve leaves. The number is still greater, reaching up to about thirty.

[3] The animal examined had been mutilated by an enemy, the intestines were all left intact, but the walls of the body failed from behind the second papilla.

[4] Neither Alder and Hancock nor Meyer and Moebius mention the situation of the anus.

a little shorter than the longest diameter of the ganglia; the *ganglia gastro-œsophagalia* in size were about one-eighth of the last, rounded, with a very large cell and several smaller ones. The commissures, as in the *D. arborescens*.[1]

The *eye* was as usual, the pigment black.[2] The *otocyst* of the diameter of about 0.1 mm., crowded with otoconia of very (from about 0.004–0.0255 mm.) varying size. The leaves of the club of the rhinophoria without spicula, and also the skin of the body, which is easily detached from the subcutaneous muscular layer; on the dorsal papillæ especially, were masses of small yellowish sac-shaped glands containing fatty matter. The anal tube was short and wide, with longitudinal folds; the *bulbus pharyngeus* formed as in the typical species, 5.0 mm. long, 3.0 high. and 3.0 mm. broad. The insertion of the œsophagus was before the middle of the upper side. The labial disk or ring strong, radiately furrowed, of deep brown color internally; this inner portion formed a narrow prehensile collar, composed of rather irregular closely and obliquely set erect (fig. 18–20) spines, somewhat like those of the labial plates in so many *Dorididæ*, of dirty light yellowish-brown color,[3] and about 4. mm. in height.

The mandibles were yellowish-horn color, except that the articulation was very dark-brown; the form was exactly as in the typical[4] and in the following species (cf. Pl. III. fig. 2–3).

The *processus masticatorius* was rather short (fig. 7*a*), with a single series of small denticles exactly as in the *D. arborescens* (Pl. II. fig. 13; Pl. IV. fig. 1); the cavities behind the articulation of the mandibles were rather large (Pl. III. fig. 3). The tongue exactly as in the typical and in the next species (cf. Pl. II. fig. 9, 10); the *tectum* (fig. 9*a*) *radulæ* much extended forwards, and the superior (fig. 10*a*) part of the rasp therefore very short; the

[1] The visceral commissure has not hitherto been seen even by Ihering (l. c., p. 176); it is the foremost of the commissures, rather thin, the *N. genitalis* very distinct.

[2] In the *Dendron. arborescens* the end of the *n. opticus* is sometimes black.

[3] A similar somewhat broader collar was found in the larger specimens of *D. arborescens*, but whitish like the rest of the labial disk, the spines (Pl. IV. fig. 2) were in more numerous rows (they hardly exceeded twenty in *D. purpureus*), and were light yellowish and longer. In two smaller individuals no trace of the collar could be found.

[4] Cf. my above cited paper, Tab. XII. fig. 28–30.

rasp-sheath very obliquely descending between the muscular masses of the tongue, and appearing on the lowest part of the back side of the *bulbus pharyngeus* (fig. 10*c*). The rachis (fig. 9*b*) with nineteen rows of teeth on the anterior margin, and with one on the superior; besides three loose median teeth laying in the pocket on the inferior end of the tongue; in the sheath twenty-two developed rows and two undeveloped, the total number of rows was thus forty-four. The color of the median teeth horn-yellow, that of the lateral much brighter yellowish; the breadth of the eldest median teeth about 0.16 mm., of the eighth about 0.18, and of the latest developed 0.20 mm. The form of the teeth exactly as in the *D. arborescens* (cf. Pl. II. fig. 14). The median ones (fig. 8–10) with a very fine denticulation on the margin, much finer than in the typical species, and not reaching so far (cf. Pl. II. fig. 14, and Pl. III. fig. 10) out toward the point. The lateral plates number also about fourteen, of typical form; the first sometimes with traces of a slight serrulation on the inside of the hook, the following mostly with about five to six (sometimes even seven to nine) sharp denticles on the outside (fig. 11); in the three to four (rarely five) external plates the free hook disappearing more and more together with the denticles; the outermost, or the two outermost, were very thin[1] (Pl. III. fig. 5). Variations in the form of the lateral teeth, and coalescence of two teeth were often observed, quite as in the typical species (cf. Pl. III. fig. 1*a*).

[1] According to Alder and Hancock (l. c.) the number of rows of teeth in the *D. arborescens* is about forty, with nine lateral teeth on each side. Meyer and Moebius mention (l. c. p. 44) a "Radula," with forty-four rows (by which is probably meant the total number of rows on the rhachis and in the sheath), and with ten lateral teeth, and the same number of lateral teeth has been indicated by Loven. In my former examination (of two individuals) I saw sixteen to twenty-two rows on the rhachis and twenty-five to twenty-seven in the sheath, or a total number of forty-one to forty-nine rows, with ten to thirteen lateral teeth. In my present examination of five specimens of *D. arborescens* (like the former, all from the Greenland coast at Jacobshavn, etc.) I find the number of rows on the rhachis varying in small individuals from thirteen to eighteen, and those in the sheath from sixteen to twenty-three, the total number thus varying between twenty-nine and forty-one; in three large individuals, having a length of 35.0 mm., the number was 13 + 20 (33), 16 + 20 (36), and 22 + 26 (48); the number of lateral teeth being eleven in the former and thirteen in the latter. In all specimens two or three median teeth were found loose at the under side of the root of the tongue.

The salivary glands were very long, accompanying the œsophagus (cf. Pl. III. fig. 12*a*) and extending further backwards; the duct was also rather long (fig. 12*b*).

The œsophagus, stomach, and intestine were as in the typical species. The liver, perhaps in consequence of occasional contraction of the animal, much thinner anteriorly, much thicker posteriorly, and of a more grayish color.

The heart was as usual. The renal syrinx nearly equalled the ventricle of the heart in size. The renal organ, as far as could be determined, was as in the *Aeolidiidæ*. The hermaphroditic gland almost as in the typical species[1] covering the back of the liver from the anterior end of this organ (or nearly reaching the anterior genital mass) to a point between the last pair of branches for the dorsal papillæ. The gland forms a rather thick layer, which is a little narrower than the liver, and fills the longitudinal median groove in the upper side of it. It is of a slate gray color, owing to the peculiar pigment of the single glands; is composed of a mass of rather large, rounded, isolated, but (from reciprocal pressure) often subangulated glands (cf. Pl. II. fig. 15).

Neither developed zoösperms nor large oogene cells were found in the glands of the individual examined. The anterior genital mass was whitish and yellowish: and, as far as could be determined, quite as in the *Dendr. arborescens;* a very large part of the whole mass was formed by the long penis, which still seemed somewhat shorter than it usually is[2] in the typical species (cf. Pl. IV. fig. 4).

This form might, perhaps, prove to be identical with the form of *Dendronotus* "with the tips of the branchial tufts white," fished by Couthouy (U. S. Explor. Exped. Moll., 1852, p. 311), in Puget Sound; or even to agree with the *D. iris* of Cooper (l. c.). Under the circumstances, the form described above must very likely be regarded as a new species, not even identical with the nearly red *Tritonia pulchella* of A. and H. (Ann. Mag. Nat. Hist. iv. 1842, p. 33), which, like all the forms of *D. arborescens* is still dotted with yellow (cf. A. and H., Monogr., Part I., 1845, fam. 3,

[1] The representation by Alder and Hancock (l. c., Pl. II. fig. 1*j*) is incorrect.

[2] The penis seems to vary a good deal in the *Dendron. arborescens*, or a least to be very contractile.

pl. 3). Besides the color the form clearly differs in the *very weak serrulation of the median teeth.*

Dendronotus Dalli, Bergh, n. sp. Plate I. f. 21; Pl. II. f. 9–12; Pl. III. fig. 2–6.

Animal?

Dentes mediani margine lævigato.

Hab. Fretum Beringianum.

In dredging on rocky bottom at a depth of thirty-five fathoms in the Arctic Ocean, Bering Strait, August, 1855, Dr. Wm. Stimpson obtained the *bulbus pharyngeus* of a mollusk, which proves to be a *Dendronotus.*

The size of the bulbus was uncommonly large, the length being about 10.5, the breadth 7.0, and the height about 6.0 mm. Its form and that of the mandibles (fig. 2–4) resembled that of the same parts in *D. arborescens* and *D. purpureus*, but of somewhat darker color, the edge of the cutting blade (fig. 2*c*, 3*c*, 4) differing a little from that of the other species, and the serrulation of the denticles being more distinct than in them. The tongue (Pl. II. fig. 9, 10) as in the other species. There were on the rhachis twenty-four rows of teeth, in the sheath twenty-five developed and two not quite developed rows, the total number of rows amounting to fifty-one. The median teeth were of very dark, nearly black-brown color, reaching a breadth of 0.3 mm., without any trace of serrulation of the margin (fig. 11, 12*b*). The lateral teeth (fig. 5) number fourteen, rarely fifteen, quite as in the other species, the four to five outermost also without denticulations (fig. 21*a*, fig. 5*a*).

The bulbus clearly belonged to a *Dendronotus* different from the two former species. The *Dendron. arborescens* has the cutting edge of the median teeth very distinctly serrulated, and to the very point of the teeth; this serrulation is much weaker in the *D. purpureus* and shorter, but it *disappears entirely* in the *D. Dalli*, which, moreover, is distinguished by a somewhat peculiar form of the cutting edge of the mandibles. As the length of the *bulbus pharyngeus* in specimens of *D. arborescens*, preserved in spirits, commonly is about one-tenth of the length of the whole body (cf. my former paper) the *D. Dalli* is likely to reach the very notable length of about 100.0 mm.

TRITONIIDÆ.

The genus *Tritonia* was established by Cuvier as early as 1798, but may have been at first[1] hardly separable from the forms subsequently named *Dendronotus*, A. and H.

Cuvier gave no type of the genus. Lamarck soon afterward (1801) adopted the name of Cuvier,[2] but used as example the *Doris clavigera* of Müller, which has since become the type of the genus *Triopa*. Thus the genus must really take date from the later anatomical publication of Cuvier in 1802.[3] The genus is not properly characterized here, and contains the *D. clavigera* (=*Triopa*), the *D. cervina* (=*Dendronotus*), the *D. coronata* (=*Doto*), the *D. arborescens* (=*Dendronotus*), and the *D. frondosa* (=*Tritonia Hombergi*), besides a form which Cuvier regarded as probably new, the *Tritonia Hombergi*, which he seems to establish as the type of the genus, especially in the first edition of the Régne Animale,[4] and this has since been regarded as the typical form by all later authors.

Except that some new species of the genus were described, nearly nothing since Cuvier was known of these animals until the anatomical examination of the *Trit. tethydea*, by Delle Chiaje, 1824,[5] and especially until the excellent publications of Alder and Hancock in 1855.[6]

The genus has by different authors been classed with other genera in different ways; as a family *Tritoniacea* (Menke, Philippi, Forbes, and Lovén); *Tritoniæ* (Fér., Rang); *Tritoniadæ* (Johnston); *Tritonidæ* (d'Orb.); but all the arrangements have been quite unnatural. Alder and Hancock first (1855) formed a natural group of *Tritoniadiæ*,[7] only including the genus *Tritonia*, and this family was soon after (1857) adopted by Gray.[8]

[1] Tabl. Elém. an vi. (1798), p. 387. "Le nombre des tentacules qui entourent la bouche varie de deux à huit." Cuvier, l. c.

[2] Lamarck, Syst. des animaux sans vert. an ix. (1801), p. 65.

[3] Cuvier, Mém. sur le genre *Tritonia*, Ann. du Museum, 1, 1802, pp. 480–496, Pl. XXXI.–XXXII.

[4] Cuvier, Régne Animale, ii. p. 391, 1817.

[5] Delle Chiaje, Mem. sulle storia degli an. s vert. iv. 1829. Tav. lxii. ed. 2, V. p. 74.

[6] Alder and Hanc., Monogr. of the Brit. Nudibr. Moll., Part VII. 1855. fam. 2, Pl. I.–II.

[7] Alder and Hanc., l. c. Part VII. 1855, app. p. xx.

[8] Gray's Guide, i. 1857, p. 218.

The characters of the family seem at present to be formulable in the following way:—

Corpus subquadrilaterale, subelongatum. *Velum frontale* sat magnum, integrum vel sub-bilobum, margine laciniis tentacularibus fimbriatum. *Rhinophoria* vagina tubulosa, erecta, margine revoluto retractilia; petiolo cylindrico; clavo culmine obtuso obliquo margine pennis bipinnatis instructo. *Branchiæ* numerosæ, subpedicellatæ, arbusculi-formes, inæquales, margine palliali prominulo serie simplici dispositæ. Anus lateralis.

Bulbus pharyngeus magnus. *Mandibulæ* fortes, plus minusve elongatæ, sat applanatæ. *Radula* lata, multiseriata. Series dentium multidentatae, dens medianus latus, depressus vel nonnihil elongatus, subpyramidalis; utrinque dens lateralis mediano subsimilis, sed magis elongatus; dentes exteriores hamiformes, margine lævi vel denticulato.

Hepar non ramificatum. Spermatotheca unica. Penis elongatus, inermis.

The body of the *Tritoniidæ* is rather stout and strong, somewhat elongated, subquadrilateral. A large frontal veil covers the head; it is simple or more or less bilobed, the margin with more or less numerous, rather short, digitations. The sheaths of the *rhinophoria* erect, tubulous, with revoluted margin; their stalks cylindrical, the club oblique above, with bipinnate plumes on the margin. The gills are rather numerous, unequal, subpetiolate arborescent, inserted one behind the other upon the somewhat prominent pallial margin. The anus is before the middle of the right side, the *bulbus pharyngeus* very large and strong. The mandibles are very strong, elongated, the anterior extremity (articulation) arched upwards. The interior cutting edge coarsely serrated. The radula broad, with many series of plates, the series with many plates. The rhachidian tooth broad or more elongate subpyramidal; with a somewhat similar, but more elongated, lateral on each side. The remaining laterals (uncini) hook-shaped, the hook with smooth or denticulated margin. The liver is as in the *Dorididæ*, quite without ramifications. As in the former groups a single *spermatotheca* (the spermato-cysts[1] wanting). The penis elongate, somewhat flagelliform, unarmed.

The *Tritoniidæ* form a connecting link between the large group

[1] I have used this name for the secondary spermatotheca of the *Dorididæ*.

of *Nudibranchiata* with a ramified liver, and those with a simple liver embracing the *Dorididæ* and the *Porostomata*[1] (*Doriopsidæ*, *Phyllidiidæ*).

As in the *Dorididæ* there is only one *spermatotheca;* but in the general form of the body, and in the nature of the pharyngeal bulbus they show more affinity to the *Porostomata*.

The family seems to include but one genus, the proper *Tritoniæ;* two other established genera, the *Candiella* of Gray (Fig. Moll. An. iv. 1850, p. 106), with *Tr. plebeia* as type, and the *Nemocephala* of A. Costa (Atti della R. Acad. delle Sci. di Napoli, iii. No. 19, 1869) with the new (?) species (*N. marmorata*, C.) as type—very likely merge in the typical genus, at least the characters given by these authors do not raise these forms to new generic rank.

The animals belonging to this group are all slow, sluggish, and voracious. The *spawn* of the northern European species has been made known by Dalzell, Alder, and Hancock; of the developmental history nothing is hitherto known.

This group seems not to belong to the tropical seas. A small series of species has been published from the eastern part of the Atlantic (while only one is yet known (?) from the western), from the Mediterranean, the Red Sea, and the northern part of the Pacific.

1. *Tritonia Hombergi*, Cuv. N. Atlant.
2. *Tr. rubra*, Leuck. Rupp. Atlas, 1828, p. 15, t. 4, fig. 1.
3. *Tr. elegans*, Sav. Égypte, xxii. Pl. II. fig. 1, 1827.
   Tr. glaucæ, Leuck. Rupp. Atl., p. 16, t. 4, fig. 2, 1828. Mare Rubrum.
4. *Tr. cyanobranchiata*, Leuck, Rupp., l. c., p. 16, t. 4, fig. 3 *a*, *b*, Mare Rubrum.
5. *Tr. decaphylla*, Cantr. Bull. de l'Ac. des Sci. de Brux. 11, p. 384, 1835.
   Tr. quadrilatera Schultz, Phil. En. Moll. Soc., i. p. 103, t. xix. fig. 2; ii. p. 76.
   ? *Tr. Blainvillea*, Risso, Eur. Mérid. iv. p. 35, 1826. Verany, Journ. de Conchyl. iv. p. 386, 1853[2] (unpublished).
   ? (Juven.) *Tr. gibbosa*, Risso, l. c. p. 35. Mare Mediteran.

---

[1] I have used this name for a group including the *Doriopsidæ* and *Phyllidiidæ;* cf. my Mal. Unters. x. 1876.

[2] The species is named, but not described. The cited book of Verany has never been published. Last year a young friend, M. Vayssière, of Marseilles got some specimens from the family and kindly sent me one. Cf. my Mal. Unters., xiii. 1878, p. 530.

6. *Tr. tethydea*, Delle Chiaje, Mem. iv. 1829, t. 2, fig. 20, Ed. 2, v. p. 74. Mare Mediterran.
7. *Tr. Costæ*, Verany, Catal. p. 23, t. ii. fig. 7, 8, 1846. Mare Mediterran.
8. *Tr. Meyeri*, Verany, Zool. des Alpes Marit. p. 871, 1862. Mare Mediterran.
9. *Tr. acuminata*, O. G. Costa, Statistica fis. ed econ. dell'isola di Capri, ii. 1, 1840, p. 1840, p. 69, Tav. V. fig. 1 *a*, *b*.[1] Mare Mediterran.
10. *Tr. tetraquetra* (Pallas). Mare Pacificum.
11. *Tr. Palmeri*, Cooper, Proc. Cal. Acad. Sci., ii. 1863, p. 207. Mare Pacificum (Cal.).
12. *Tr. Hawaiensis*, Pease, Proc. Zoöl. Soc., xviii. 1860, p. 33. Mare Pacificum.
13. *Tr. pallida*, Stimpson, Proc. Phil. Acad. Nat. Sci., vii. p. 388, 1856. Mare Capense.
14. *Tr. cucculata*, Gould, Expl. Exp. Shells, 1852, p. 308. Mare Atlant. occid. (Brasilia).
15. *Tr. plebeia*, Johnst. Mare Atlant.
16. *Tr. lineata*, Alder and Hancock. Mare Atlant.
17. *Tr. (Duvancelia) gracilis*, Risso, l. c. p. 38. Mare Mediterran.
18. *Tr. manicata*, Desh., Tr. de Conchyl. 1839–1853, expl. des pl. p. 59, pl. 93, fig. 2.

? *Nemocephala marmorata*, A. Costa, Illustr. di due generi di Moll. Nudibr., Atti. della R. Ac. Sci. di Napoli, iii. No. 19, 1869, Tav. —. fig. 6–8. Mare Mediterran.

I. Tritonia tetraquetra (Pallas), Pl. III. f. 13–16; Pl. IV. fig. 5–12; Pl. V. fig. 1–2.

Limax tetraquetra, Pallas, Nova Acta Petrop. ii. p. 237, 239, Tab. V. f. 22, 1788.

Doris tetraquetra, Gmelin; S. N. ed. xiii. t. 6, p. 3106, 1789.

Color animalis cinerascens.

Hab. M. Pacific. septentr. (Insulæ Kurilæ, Aleutianæ).

This species was detected by Pallas, and described (l. c.) among his "marina varia nova et rariora;" and immediately afterwards was inserted by Gmelin in his undigested genus *Doris:* it seems not to have been mentioned since that time, nor recognized by any of the different explorers of the Pacific.[2]

Pallas got the animal from the Kuril Islands, "where the inhabitants eat it, raw or cooked, and where it is known by the name of Tochni." He says nothing about the colors of the animal, only

[1] On account of the rarity of the work cited (kindly given to me by Prof. A. Costa, of Naples, the son of the author) this species has only been mentioned by Gray, Guide, i. p. 218.

[2] Cuvier (l. c. p. 4) mentions the possibility of this species of Pallas being a Tritonia.

remarking that they are found larger than the figure he gives, which has a length of seven to eight centimetres.

Of this curious form only one specimen was found by Dall at Unalashka, on a reef at low water (in April, 1872). The color of the *living animal* is noted as having been "ashy gray."

The color of the animal, *preserved in spirits*, was uniformly light gray-yellowish; on the pinnæ of the plumes of the rhinophoria, but especially on the envelope of the papillæ of the club of these, were remains of a silverish-white, which is also seen on the lobes of the anus and the renal orifice. The length of the body was about 75.0 by a breadth of 37.5, and a height of 26.0 mm. In general the form of the animal was somewhat as in the typical *Tritonia*, rather stout; the anterior part of the body hardly narrower than the median, the posterior somewhat constricted. The back was a little convex, sloping backwards, rather smooth or very minutely granulated, feeling a little rough to the touch; on the edge finely tuberculated.[1] The edge projecting about 6 mm.; thinner towards the border, which is finely and irregularly toothed, but showed (Pl. III. fig. 14) few traces of gills;[2] on the left side the margin is continued to the (left) rhinophorium, on the right it did not reach quite to the region of the genital openings; backwards it grew narrower and thinner, over the tail it was nearly 2 mm. broad. The *rhinophoria* are rather distant from each other, almost entirely as in the *Tr. Hombergi;* the apertures of the prominent sheaths oval, with a diameter of about 6 mm., with the border undulated, and involuted. The stalk of the club low; the club itself cylindrical, about 3.75–4.0 mm. high; the central part of the club much lower, oblique; in the periphery the club is divided in several (about ten) larger, commonly bi- or tripinnate plumes, which sometimes are again divided into a medial with a lateral one on each side; between these stand sometimes one or two smaller and single plumes; the foremost is the lowest; the hindmost of all the plumes is the largest, and the stem of this is produced in a thick papilla projecting over all the plumes; from

[1] Pallas mentions the back as more unequal ("grandinoso-inæqualæ").

[2] Very likely the gills were rubbed off; on the other hand, Pallas, too, does neither mention nor in his figure represent gills, he only says that the back side has "anguli carunculato hiulci." (The animal when fresh showed no traces of any gills to the casual observer, and had not been subjected to rough handling.—Dall.)

the base of this papilla three to five low septula diverge, divide and go to the base of the plumes and their broad rhachides.[1] The *veil* entire (not bilobed); with the upper border (about 8 mm.) and the corners (about 10 mm.) freely projecting (fig. 13); it is (36 mm.) broad and (16 mm.) high; on the front side regularly furrowed by fine reticulated lines, which produce the appearance of a serpent's skin (Pl. IV. fig. 5); the upper edge of the veil is smooth or showing only traces of dentition;[2] there is no trace of the grooved fold on each side at the base of the veil found in the *Tr. Hombergi;* the end of the muzzle beneath the middle of the veil is contracted. The sides of the body somewhat high and convex, a little lower in the anterior part; decreasing in height from the region of the anus backward. The upper genital opening was entirely filled by the flagelliform penis (Pl. III. f. 13*d*) which was about 20.0 mm. long, with a diameter at the base of 3.0, and at the tip of 0.5 mm. The larger mucous gland (fig. 13) was below this opening. Behind the middle of the body is the crateriform anal papilla projecting about 3 mm., in the orifice of which are strongly projecting folds (Pl. III. fig. 15*a*) before which is the renal opening also provided with internal folds (fig. 15*b*). The foot is as long as the back, rounded in front, with a marginal groove which extends beyond the region of the genital orifices; the foot projects laterally some 3–4.0 mm. from the body. The tail is short, hardly 3.0 mm. long.

The peritoneum is colorless, the viscera not in the best preservation in the specimen examined.

The central nervous system closely resembles that of the *Tritonia Hombergi*,[3] the limits of the two compartments of the cerebro-visceral ganglia are more pronounced than in the *Tr. Hombergi;*

[1] The representation of the rhinophoria of *Trit. Hombergi*, by Alder and Hanc. (l. c. part vii. 1855, fam. 2, pl. 2, fig. 2) is too simple.

[2] Pallas mentions and represents the veil as "lacero-dentatum."

[3] The representation given by Alder and Hancock, as well as that of Ihering (Vergl. Anat. der Nervens. und Phylog. d. Moll., p. 174, Taf. II. f. 6) are nearly correct, at least in the essential characters; the short commissure between the cerebro-visceral and the pedal ganglia is of course double, as seen by Ihering, and perhaps also represented by Alder and Hancock, on the left side; in the hinder part of the left visceral and pedal ganglion is a small ganglion communicating with the visceral one; the gastro-œsophageal ganglia are shorter-stalked than represented by A. and H.

the buccal ganglia (Pl. IV. fig. 6) are rather large, of oval outline; the gastro-œsophageal rather short-stalked, ovoid, with three large cells (fig. 6*a*).

The eyes are as usual.[1] The otocysts about 0.2 mm. in diameter contain about sixty round or oval *otoconia*, reaching from 0.025 mm. rarely to 0.04 mm. in diameter, many of them marked with a few fine concentric lines.[2] The skin is almost free from spiculæ, they are almost entirely absent from the interstitial connective tissue.

The oral tube is rather short, about 6.0 mm. long, wide, with the usual longitudinal folds. The *bulbus pharyngeus* is strong, about 16.0 mm. long by 14.0 mm. broad and high. The form is in general shorter and stouter than in the typical *Tritonia.* The "muscle-plate" on the front side as in *Tr. Hombergi.*[3]

The jaws (Pl. IV. fig. 7) shorter, broader, and higher than in the *Tr. Hombergi;* the length of the united jaws was 12, the

[1] The eyes in *Tr. Hombergi* show black pigment and a yellow lens, they are about 0.28 mm. in diameter.. The *nervus opticus* is about four times as long as the cerebro-visceral ganglion, and issues from a small ganglion situated near the pedal ganglion, giving out a nerve before reaching the eye, and continued in a third nerve beyond the eye. Cf. Ihering, l. c. p. 174.

[2] Alder and Hancock did not discover the otocysts in *Tr. Hombergi*, nor did I, but they were seen by Ihering.

[3] The *bulbus pharyngeus* of the Tritoniæ is, as also the tongue, very like that of the *Pleurophyllidiæ,* but somewhat more flattened (cf. my Bidrag til en Monographi af *Pleurophylliidierne,* Naturh. Tidsskr. 3 R. iv. 1866, pp. 224–356). The lip disk at the bottom of the oral tube is as in those; also the thick muscular plate at the front of the jaws (cf. l. c. p. 229), and with the usual transverse groove. In two individuals of the *Tr. Hombergi* of the length of 7.5 and 5.5 cm., the *bulb. phar.* had the length of 20 to 23 mm., a breadth of 12 to 15 mm., and a height of 11.5 to 15.0 mm., or the length of the bulbus amounted to about one-third that of the body; on the surface of the bulbus were marked partitions nearly as in the *Pleurophyllidiidæ;* the sheath of the radula on the hinder and upper end of the bulbus was distinct, but not prominent. The united jaws 23 to 24 mm. long, with a breadth of 12 to 16, and a height of 6 to 7 mm.; the breadth of the jaw alone behind the articulation about 2.5, on the broadest part 6.75 to 7.0 mm.; the free part of the *proc. masticator.* 1.5 to 2.0 mm. long; the articulation rather prominent in front; nearly the posterior half of the cutting edge is serrated, every denticle composed of several, more or less coalescent, conical points, elevated about 0.16 mm.; a deep furrow for muscular insertion nearly parallel with the cutting edge.

breadth 13 mm., and the height 5 mm.; the jaw alone had behind the articulation (fig. 7*a*) a breadth of 5.5 to 7.0 mm. in the hinder part;[1] the length of the (free part of the) *proc. masticatorius* (fig. 7*b*) 1.5 mm.; the articulation rather prominent in front; the cutting edge in the posterior part slightly undulated, but plain, under the microscope covered with many irregular series of irregular prismatic bodies (fig. 16) about 0 02 mm. high. The tongue is large, broad, and high; the radula narrower than in *Tr. Hombergi*, brownish-yellow, with nineteen series of teeth.[2] On the under side of the tongue, moreover, the marks of eight series of teeth remain, the teeth themselves having been dropped. There were under the *tectum radulæ* and in the sheath twenty-five fully developed series, and six which were yet only partly colored. The number of series in all fifty. The number of teeth was, in one of the foremost series of the radula, about two hundred and twenty-five (on each side), and the number seemed not to increase notably farther backwards. The *median* tooth is like a compressed pyramid, somewhat narrower in the hinder part (Pl. IV. fig. 8*aa*; Pl. V. figs. 1*aa*, 2*a*), with the upper part bent backwards (fig. 8); the posterior margin more or less rounded, the anterior margin (fig. 1*aa*) with a slight cleft, the continuation of which (fig. 2*a*) forms a groove on the anterior side of the pyramid. The first lateral tooth shaped nearly as the medial is, but (fig. 8*bbcc*, 1*bb*, 2) narrower and longer, the (fig. 8) upper part less prominent, less crooked, and commonly more rounded at the top (fig. 8). The *second* lateral tooth either nearly like the first (fig. 8*d*), or with a distinct beginning of the form (fig. 1*e*, 2), that reigns through the long series of external teeth (fig. 12); *all* these lateral teeth are high (fig. 9), compressed, crooked; the point rather blunt; the basal part of the teeth is continued in an uncolored

[1] The form of the mandibulæ is rather similar to the figure of Pallas (l. c. fig. 22A).

[2] In a very large individual of the *Tr. Hombergi* the (always large) radula contained forty-three series of teeth, behind which were forty-seven additional series, the total number of rows being ninety. In the forty-second row or series, on each side, were about two hundred and eleven teeth, in the fifty-second row two hundred and twenty-nine lateral teeth. According to Alder and Hancock (l. c. part vii. pl. 46, suppl.) the number of rows is eighty-four, and the number of lateral teeth two hundred and twenty-one.

(not thickened), flexible process (fig. 9). The one to two *outermost* teeth small and in form very variable (fig. 10*aa*, 11*aa*). The teeth (in their thickened parts) of yellowish color, somewhat darker and less clear than in the typical species. The length of the rachidian teeth in the hinder part of the tongue 0.2 mm.; the greatest height of the lateral teeth (in about the same region) 0.4 mm. Double plates (fig. 12) were present.

The *glandulæ salivales* were clay-yellowish, about 25.0 mm. long, rather flattened; about 10.0 mm. broad on the under side, separated by the œsophagus; on the upper side confluent in a large convex plate about 25.0 mm. broad. The efferent ducts were short.

The œsophagus was about 38.0 mm. long, with a diameter of 11.0 mm., and rose from the foremost part of the *bulbus pharyngeus;* in the posterior half were rather strong longitudinal folds passing without distinct limits into the stomach. The latter formed a moderately sized sac at the anterior part of the liver; the under side was free, the upper decked by a flat lobe of the liver. The stomach was somewhat compressed; in antero-posterior direction about 9.0 mm. high; the *cardia* were wide with two biliary orifices in the posterior part; above, a rather narrow pylorus with very strong folds; the walls of the stomach are rather smooth. The intestine issues from the uppermost part of stomach, appearing on the surface of the liver at the left side of the heart, following the left margin of the liver forwards, lodged in a groove on the surface, but backward at the front and end of the liver, following the right side of that organ, somewhat descending, then ascending again and terminating at the anus. The anteriorly proceeding part of the intestine was about 25.0 mm. long, the rest was about 50.0 mm. long, of which 15.0 mm. belonged to the part which ascends to the anus. The diameter of the terminal portions of the intestine was about 3.0 mm., of the middle portion nearly 7.0 mm. Through nearly the whole length of the intestine, and nearly reaching to the knee of the last ascending part, was a strong and thick fold of about 3 mm. in height; the last part of the same for a length of full 4 mm., free and projecting wing-like. Fine longitudinal folds, often shining through the walls of the intestine, were moreover seen through the whole length of it, in the first part especially strong on the under side; in the last part finer, partly ending in the folds of the anal opening (Pl. III. fig. 65*a*). The contents of the intestine, stomach, and œsophagus were indistinct animal matter.

The liver of a clay-yellowish color, large; the length about 4.7 mm., with a breadth of 30, and a height of about 26.0 mm.; the hinder end rounded; the foremost half of the lower lobe wanting, its place occupied by the stomach; the front, therefore, very oblique, sloping backwards and somewhat towards the right side (with an impression for the large anterior genital mass). On the surface of the liver rather superficial furrows in different directions, especially transverse; through the middle part of the upper side of the liver, beginning at the right side, a somewhat deeper longitudinal furrow diverges towards the left side, containing the renal chamber; at the junction of the first and the second third of the upper side a very deep transverse groove for the pyloric part of the intestine (which turns to the left); but the part of the liver before the groove is a continuation of the whole liver, and not only of the left part of it (as in the *Tr. Hombergi*). The structure of the liver is as in the typical form.

The atrium and ventricle of the heart are as usual, the ventricle 9.0 mm. long, and the renal syrinx about 3.0 mm. long, of the usual structure; the renal chamber, as far as it could be determined, as in the *Tr. Hombergi.*[1]

The *gland. hermaphrodisiaca* not distinguishable in color from the liver, covering the surface of that organ nearly as in the *Tr. Hombergi*, and of similar structure. The follicles contained zoösperms and large oögene cells.

The anterior genital mass very large, 30.0 mm. long, 18.0 mm. in greatest breadth, and 23.0 mm. in greatest height. The *ductus hermaphrodisiacus* issues from the upper part of the front of the liver about in the middle line under the first reflection of the intestine. It is yellowish, not long, and about 1.0 mm. in diameter.

It swells rather abruptly into the ampulla, which is very long and strong, and forms a bunch of thick coils on the back of the anterior genital mass. When straightened the ampulla was about 120.0 mm. long; diameter variable, but reaching 6.0 mm. It was crammed with zoösperms. The spermato-duct (*vas deferens*) was strong, not long; furnished before entering the penis (in the specimen examined), with an ampulliform dilatation; then penetrating

[1]. Cf. A. Hancock on the structure and homologies of the renal organ in the Nudibr. Moll. Trans. Linn. Soc., xxiv. p. 515, Pl. LIV. fig. 5-8, 1864.

the whole length of the everted penis, with several irregular dilatations and constrictions through the posterior part, and ending on the blunted point of that organ with a small round orifice. The spermato-duct is attached to the walls of the penis by abundant connective tissue; its wall is very thick; the inside in the posterior part with some strong longitudinal folds, clothed with a fine epithelium, which towards the end of the penis is about 0.07 mm. in thickness. The (Pl. III. fig. 13*d*) penis, as above stated, flagelliform, about 20.0 mm. long, under the loop furnished with a whitish covering, partly confluent, partly scattered; in the skin through the whole length of the organ an infinity of bottle-shaped, glistening glands about 0.035 to 0.04 mm. in length. The *spermatotheca* pyriform, about 9 mm. long, passing without precise limit into a short ductus, that is a little dilated in the inferior part (vagina). The large mucous gland convex in front; on the back rather flat toward the anterior part, in the posterior excavated (for the reception of the ampulla of the hermaphroditic duct); the duct short; the cavity of the organ narrow, empty.[1]

DORIDIDÆ.

This large group is easily distinguished through the (retractile or not retractile) branchial rosette on the middle of the back. This character is only found in a single other group of gasteropoda, the *Doriopsidæ*, which, in their exterior characters, closely simulate the *Dorididæ*, and had been confounded with them, at least so far that they were regarded as both belonging to a single large group, until my examination of them[2] showed their affinity to the *Phyllidiidæ*,[3] with which they were combined by me in a larger group, the *Porostomata*, particularly characterized through their poriform "outer mouth," and the conversion of the *bulbus pharyngeus* into a quite unarmed sucking apparatus. On the contrary the *Dorididæ* all show a very well-developed *bulbus*, with a more or less strong tongue; and often also a particular armature of the lip-disk on the anterior end of the *bulbus*, and

[1] Pallas (l. c. p. 238, fig. 22*B) seems to have seen different parts of the anterior genital mass.

[2] R. Bergh, neue Nacktschnecken der Sudsee. Journ. der Mus. Godeffroy. Heft viii. 1875, pp. 82–94, Taf. x. xi.

[3] R. Bergh, Beitr. til Kundsk. om Phyllidierne (Schiödte) Natur. Tidsskr., 3 R. v. 1869, pp. 357–543, tab. xiv.–xxiv.

lip-plates of rather different kind and nature. With the *Doriopsidæ* (*Porostomata*) the *Dorididæ* agree in the presence of *two spermatothecæ*, and of a vascular gland connected with the central nervous system.

There have been detected but a small number of the generic forms and species belonging to this large family during Dall's expeditions.

ARCHIDORIS, Bergh.

Doris auct.

Archidoris, Bergh, Malac. Unters. (Semper, Philipp. ii. Heft xiv. p. 616, 1878).

Corpus sat molle subdepressum. Tentacula humilia, plicæ-formia intus altiora. Dorsum tuberculosum et granulosum. Branchia (retractilis) e foliis tripinnatis formata. Podarium sat latum, margine anteriore superficialiter sulcatum.

Armatura labialis nulla. Radula rhachide nuda, pleuris multidentates; dentes hamati. Ventriculus liber. Penis inermis.

When Linné, in the tenth edition of his *Systema Naturæ* (1758), founded the genus *Doris*, he referred but one species to it (cf. my Mal. Unters. [in Semper, Reise Philipp. II. ii.], Heft x. 1876, p. 388), his *D. verrucosa*. This, which was founded only on the figures of Seba and Rumphius, is probably indeterminable, and the *Doris* of the tenth edition of the Syst. Nat. should, therefore, not have been retained.

In the twelfth edition (1767) the genus embraces, beside *D. verrucosa*, which still figures as first species, three other forms, the *D. bilamellata*, *D. lævis*, and *D. argo*.

One of these should become the type of the restricted genus *Doris*, but which? It would be much better to quite do away with the name *Doris* as a generic designation (especially as it was also used in another sense by Linné, for the animal of various shell-bearing mollusks), and under this view the genus *Archidoris* has been formed.

This generic group, which is congeneric with the first of the sections established by Alder and Hancock (Monogr. part vii. 1855, p. xvi.) in their systematic prospectus, is rather distinctly marked. The animals are of a rather hard consistency, of a robust, and not much depressed form. The tentacles are formed in folds higher inwards. The openings of the *rhinophoria* are simple. The back more or less granulous and tuberculous. The (retractile) gill composed of (a not large number of) tripinnate leaves. The lip-disk clothed with a simple thick cuticula. The radula with naked rhachis, the pleuræ with numerous hook-shaped uncini. The ventricle is large, free. The penis unarmed.

The group, so far as yet known, contains but few species.

1. *A. tuberculata* (Cuv.).
2. *A. flammea* (A. et H.).
3. *A. montereyensis* (Cooper).

Archidoris Montereyensis (Cooper), Plate XVI. figs. 6, 7.

Doris Montereyensis, Cooper, on new or rare Moll. inh. the coast of Cal.; Proc. Cal. Acad. Sci., ii. p. 204, 1863; iii. 1868, p. 58.[1]

Archidoris Montereyensis. Bergh, l. c. p. 624, Taf. LXVIII. fig. 24.

Color luteus vel ochraceus, supra maculis nigris sparsis et seriatis notatus.

Hab. Mare Pacificum. (Monterey, Cala. to Sitka, Alaska.)

Four specimens of this form were collected by Bischoff at low water in Sitka Harbor. Two were small and two much larger, but otherwise similar in every respect. No notes have been received in regard to the living animal. The specimens were sent me in a dried condition. They were of a yellowish or ochraceous yellow color with a larger or smaller number of roundish black spots on the back, here and there confluent in irregular large patches on the middle of the back, which were nevertheless indistinctly arranged in two series. The specimens measured 18.0–40.0 mm. in length, 11–24.0 mm. in breadth, and 5–13.0 mm. high. The width of the rhinophorial orifices in the largest specimen 4.0, and of the branchial aperture 10.0 mm. The back was covered, quite as in the typical species, with large and small rounded tubercles, reaching 1.5 mm. in diameter in the largest individual. The foot was large, exactly as in the typical species; the tentacles, as far as could be determined, of the usual kind.

In two of the individuals the gill was expanded, and the number of the branchial leaves 80.

Through the kindness of Mr. Dall I have had the opportunity

[1] "Pale yellowish, with scattered black spots (or entirely brown?); mantle rough, tuberculate, or nearly smooth; dorsal tentacles knob-shaped; branchial rays bipinnate, short, in eight divisions, forming a crown-shaped expansion on the posterior third of the dorsum. Foot expanded into a broad, thin margin as wide as the mantle. Length 3″, breadth 1″, height $\frac{3}{4}$″; form elongated oval." Cooper, l. c.

of examining a colored drawing of the animal made by Cooper. The color of the back was here ochre-yellow, with scattered small and some larger black spots; on the middle of the back especially several larger elongate irregular patches; the rhinophoria of somewhat more reddish color. In the gill eight leaves.

Through cautious emollition of one of the larger and one of the smaller individuals the nature of the *lip-disk* and of the armature of the tongue could be determined. The former was quite as in the typical species. The *tongue* showed thirteen to fifteen rows of plates; the number of rows further backward could not be determined with certainty, there seemed to be about fourteen to fifteen developed rows, and the total number of plates thus seemed scarcely to exceed thirty-three to thirty-six. The series seemed to contain about sixty to seventy plates. These plates (figs. 6, 7) were very like those of the typical species, perhaps the hook was a little slenderer; the height of the outermost plates (fig. 7) was commonly about 0.1–0.15, and the height increased through the series of plates to about 0.28 mm.

Perhaps this form might prove to be merely a variety of the *D. tuberculata.*

CHROMODORIS, Alder and Hancock.

Chromodoris, A. and H. Mon. Brit. Nudibr. Moll., vii. p xviii. 1855. R. Bergh, Neue Nacktschn. der Sudsee ii. in Journ. der Mus. Godeffroy, Heft viii. pp 72–82, 1875, and iv. l. c. Heft xiv. pp. 1–21, 1878.

Goniobranchus, Pease, Am. Journ. Conch. ii. 1866, p. 204.

Doriprismatica, A. d'Orbigny (pp.), Moll. des Isles Canaries, 1834, p. 40, note.

The *Chromodoridæ* of Alder and Hancock, the *Goniobranchi* of Pease were some years ago (1875) revised by me after careful examination of fourteen species, three of which were then published, the rest more recently (1878).

Meanwhile I had shown[1] that the genera *Glossodoris*, *Actinodoris*, and *Pterodoris*, established by Ehrenberg in 1831, should be dropped, being founded on non-essential and inconstant characters of the branchial leaflets of different *Chromodorides*. Moreover a part of the genus *Doriprismatica*, established by D'Orbigny (1834) belongs to this group. The name given by Alder and Hancock must be conserved for this genus.

[1] R. Bergh, Krit. Unt. der Ehrenberg'schen Doriden, Jahrb. d. D. Malak. Ges. iv. 1877, pp. 52–58.

In the latest of my cited papers was moreover given a supplement to the former list of described or denominated *Dorides*, that could be referred with more or less probability to this group. The number of species amounted to about ninety.

In external form the *Chromodorides* somewhat agree with the *Goniodorides*, but have much more gay and handsome colors, mostly forming longitudinal stripes. The tentacles are small, conical; the (retractile) rhinophoria with densely perfoliated club. The margin of the mantle on the anterior and posterior ends developed in a frontal and a caudal veil, which sometimes shows peculiar knots.[1] The (retractile) gill is formed of simply pinnate plumes, sometimes divided at the top. The foot rather narrow. The *lip-disk*, with an annular hard lamina, composed of densely set small hooks, mostly bifurcated at the top. In the radula no median plates, but often on the rhachis peculiar thickenings (pseudo-plates). The lateral plates, of ordinary form, nearly always serrulated or denticulated on the margin of the hook. The penis unarmed.

In the southern part of the Pacific the *Chromodorides* are represented by a whole series of species; from the northern part (China) only a few representatives are known; among the specimens sent by Dall only two species were detected, the hitherto known most northern representatives of this group, of which no form has yet been found in the northern part of the Atlantic.

Chromodoris Dalli, Bergh, n. sp., Plate XIII. f. 1–7; Plate XIV. f. 1–4.

Hab. Oc. Pacific. sept. (Puget Sound, Washington Territory.)

An individual of this species was obtained, during the progress of the U. S. Boundary Commission, by Dr. Kennerly, the lamented naturalist of the U. S. party, in Puget Sound. No notes have come to hand in regard to the living animal.

The animal preserved in spirits was 11.5 mm. long, 5.5 broad, and 4.2 mm. high. The height of the rhinophoria was 1.25 mm., of the tentacula 0.75 mm., of the branchial leaves 2.0 mm.; the breadth of the mantle margin 1.2 mm., of the foot 2.5 mm., and the length of the tail was 2.5 mm. The ground-color of the back and sides isabelline-gray, everywhere covered with small, and still smaller, coal-black, rounded points about 0.25 mm. in dia-

[1] Such knots have been found (by me) in the *Chr. runcinata*, *picturata*, *camœna*, *elegans*, *glauca*, *gonatophora*, and *Californiensis*.

meter, which were also visible on the under side of the mantle edge and on the upper side of the foot. The sides were also abundantly furnished with bright yellow points, appearing in smaller number also on the back where they are, for the most part, represented by yellow ocelli with darker yellow pupils. The mantle-edge had a yellow margin on the upper side; there was also a fine yellow line along the upper side of the edge of the foot. The stalk of the rhinophoria was gray, the club (grayish) reddish. The branchiæ and tentacula grayish-white with a yellow colored rhachis on the outer and posterior edge.

The branchial leaves with a few scattered black points, the margin of the orifice for the rhinophoria and of the gill cavity embellished with a yellow line.

The form as usual; the mantle edge rather prominent, the frontal and caudal veil not particularly developed (without traces of larger nodules on the under side). The club of the *rhinophoria* strong, with about thirty broad leaves; the tentacles conical (as it seemed), retractile in a little cavity. The *gill* consisting of fifteen (Pl. XIII. fig. 1) simple plumes; increasing four times in height from the posterior involute end gradually forward. The angles of the anterior margins of the foot not very prominent.

The intestines not shining through the walls of the body; the peritoneum colorless.

The central nervous system yellow. The *cerebro-visceral ganglia* reniform, the two divisions of nearly equal size; the rounded *pedal ganglia* a little larger than each of them; the great commissure not short. The proximal *olfactory ganglia* of about the same size as the distal (at the root of the club of the rhinophorium), larger than the optic ganglion. The *buccal ganglia* (Pl. XIV. fig. 1*a*) larger than the *olfactory*, of oval form, connected by a rather short commissure; the *gastro-œsophageal* (Pl. XIV. fig. 1*b*) rather short stalked, developed on one side of the nerve, small—about one-eighth the size of the former, with one large and some smaller cells. The *nervi optici* rather short. The eye with black pigment and a yellow lens. The otocysts of about the same size as the eyes, the number of otoconia not very large. The leaflets of the rhinophoria and the tentacula without spiculæ, the skin of the back and the interstitial tissue nearly so.

The oral tube very large, about 2.0 mm. long by 2.2 mm. in diameter, with strong, internal, longitudinal folds.

The *bulbus pharyngeus* 2.5 mm. long by 2.0 mm. broad and high. The radula reddish-gray, freely projecting about 2.5 mm. The armature of the lip-disk broad, rather thick, fine horny-yellow, consisting (Pl. XIII. fig. 2) of rather long (0.06 mm.) hooks, somewhat curved at their upper ends and slightly bifurcated at the point (fig. 3).

The tongue as usual, with about forty rows of teeth, behind which were sixty-six rows of developed, and six rows of immature teeth, the total number being one hundred and twelve. The teeth of yellowish color, except the rhachidian and external uncini, which were nearly colorless. The height of the second lateral (Pl. XIV. fig. 2) about 0.035 mm., of the most elevated teeth about 0.05 mm., of the outermost uncini 0.025 to 0.03 mm. On the narrow rhachis was a median pseudo-plate (rhachidian boss) about 0.035 mm. long, pointed anteriorly (Pl. XIII. fig. 4; Pl. XIV. fig. 1*a*) broader and rounded behind (Pl. XIII. fig. 5) consisting of a high anterior portion which falls abruptly toward the plain part, slopes gradually towards the fore-end, and is divided by a longitudinal groove into two halves (figs. 4, 5). On each side of the median plate twenty-seven to twenty-nine laterals. The lateral teeth of usual form, somewhat low; the (Pl. XIV. fig. 2) first with four to five denticulations on each side of the low hook; the rest (figs. 6, 7, 8) with such only on the outer side, mostly with six to seven, more rarely (especially on the innost plates) with four to five, or at the utmost with eight to nine denticles; the six outermost of the usual aberrant form, without denticulations (Pl. XIV. fig. 3).

The *salivary glands* long, ribband-shaped, whitish. The *œsophagus* as usual; the intestine filled with large pieces of a *Ceratospongia*, mixed with some fragments of the lip-plates and some teeth from the radula. The *liver* about 6.0 mm. long by 3.0 mm. broad and high, truncate at the fore-end, rounded behind; the substance yellow.

The *renal layer* rather thick. The *sanguineous gland* whitish.

In the cavities of the *hermaphroditic gland* were zoösperms. The *anterior genital mass* about 3.5 mm. long by a height of 3.0 and a breadth of 2.0 mm. The *ampulla* of the hermaphroditic duct rather (about 2.5 mm.) long, yellow. The *spermatoduct* very long; the first, darker, part forming a large flattened coil, the second passing into the short *penis*. The spherical *spermatotheca*

(Pl. XIV fig. 4*a*) of a diameter of about 1 mm ; the longer *spermatocysta* forming a long *cul-de-sac* (fig. 4*b*). The *mucous gland* whitish, in the neighborhood of the anterior end was a yolk-yellow part.

2. **Chromodoris Californiensis**, Bergh, n. sp. Pl XII. fig. 5 to 15.

Color caerulescens, dorso et lateribus punctus majoribus aureis ornatus.

Hab. Oc. Pacific. septentr. (coast of California, Santa Barbara Islands).

Of this very handsome species Dall obtained an individual on algæ at low water in the harbor of Catalina Island, California, January, 1874. (Specimens have also been seen from Monterey and San Diego.—W. H. D.)

The color of the living animal, according to Dall, was "mazarin-blue with golden spots" (changing to greenish-blue in the alcohol, which it continues to color for a long time, and after several changes for fresh spirit.—W. H. D.).

The rather contracted animal in spirits was 12.0 mm. long, and 6.0 mm. broad and high. The height of the retracted rhinophoria was 1.3 mm., of the retracted branchial plumes 1.5 mm., the length of the tail about 2 5 mm., and the breadth of the foot 2.0 mm.

The color was uniformly greenish-blue (which it had also given out to the alcohol). On the back were several yellowish-white, round spots, a millimetre in diameter. On the anterior part they were chiefly in the median line, on the rest in two longitudinal series, outside of which on the back were scattered some similar spots and on each side of the body was a line of four or five more of the same kind. A brighter, fine line seemed to border the margin of the mantle-edge and that of the foot. The rhinophoria were green-blue, the gills dark green-blue; the internal connecting branchial "mesenterium" and the root of the branchial leaves partly silver-white.

The *form* as usual. The mantle-edge little prominent except over the head and tail, the breadth on this last part being about 1.65 mm.; on the under side of the caudal veil thus formed were six semi-globular nodules (fig. 5) one full mm. in diameter. The tentacles as usual; the club of the rhinophoria with about twenty leaves. The gills formed of nine leaves of nearly equal size; the anal papilla rather low; posteriorly completing the branchial ring. The peritoneum with a light-bluish hue. The pericardium bluish.

The central nervous system as usual, but less depressed, and of greenish color; the cerebro-visceral ganglia reniform, somewhat broader in front; the distinction between the *cerebral* and the *visceral* parts very pronounced, the latter a little smaller than the former; the pedal ganglia rounded, a little larger than the visceral. The buccal ganglia larger than the (proximal) olfactory, roundish, connected by a rather short commissure; the gastro-œsophageal roundish, having about one-tenth of the size of the former, rather short-stalked, developed on one side of the nerve, with one very large and a few smaller cells. The proximal olfactory ganglia rather depressed—bulbiform; the distal ones much smaller, of oval form.

The lens of the eye was greenish-blue, the pigment brownish-black; the retina bluish. The otocysts were as usual. There were no spiculæ in the skin, the leaves of the rhinophoria or the interstitial tissue, which was always of a greenish-blue color. The nodules of the caudal veil resembled those of other species possessing them.

The oral tube was about 2.5 mm. long, and 1.6 mm. in diameter at the posterior end; of greenish-blue color throughout. The *bulbus pharyngeus* of the same or a darker shade, about 3.0 mm. long, by a breadth of 2.5 mm., and a height of nearly 2.0 mm.

The large sheath of the radula prominent posteriorly is also about 1.0 mm. in diameter. The lip-plates are of a grayish olive-green color, separated at their upper (fig. 6) and more widely at their lower ends. The plates are scarcely narrower above, the nearly uniform breadth being 1.5 mm. The elements of the plates reach the length of 0.045 mm., with thick, recurved, hooked points (figs. 7–10), these last were seldom cleft (fig. 10). The elements adjacent to the spaces between the plates were much smaller and of irregular form (fig. 6). The tongue was of the usual form, the radula shining like silver and grayish-green in color. In the radula were thirty-five rows of plates, behind which were fifty-one well-formed and six immature rows; the total amounting to eighty-two rows. In the posterior rows of the tongue were ninety-eight teeth on each side of the narrow and naked rhachis. The teeth had a very pronounced greenish hue; rising to the height of about 0.1 mm., that of the outermost was about 0.04 to 0.06 mm. The form as usual; the hook bifurcated at the point, the outer and posterior branch shorter, denticulated (figs. 11–13), and the denticulations continued downwards along the exterior margin of the hook (fig. 13). The innermost teeth (fig. 11) lower and with fewer denticles; the largest number of teeth generally with about six to eight denticles; the outermost plates (fig. 14) of the usual modified form, sometimes rather irregular (fig. 13).

The (about 7 mm.) long, ribband-formed salivary glands through their white color contrasted with the green of the adjacent viscera; in their foremost part broader, having a breadth of about 0.6 mm., in the rest of their length thin.

The liver grayish-green, about 5.5 mm. long, by a breadth of 4 and a height of 3 mm.; the substance more yellow. The heart and especially the renal region, of greenish color. The sanguineous glands greenish, much flattened; the anterior linguiform about 1.75 mm. long, with a breadth of about 0.6 mm.; the posterior of about the same length, a little broader. The anterior genital mass small, about 2.5 mm. long, by a breadth and a height of 1 mm., of blue-green color, as were the different component organs of the mass. The spermatotheca as usual, spherical; the spermatocysta shorter than in the former species. The penis as in other species.

CADLINA, Bergh.

Corpus sat depressum; dorsum granulatum, vix asperum; branchia retractilis, e foliis tripinnatis paucis formata; caput parvum tentaculis brevibus, applanatis, triangularibus quasi; podarium sat latium, sulco marginali anteriore profundo.

Armatura labialis lamelliformis, fere annuliformis, e hamulis minutissimus formata.

Radula rhachide dente denticulato armata, pleuris multidentatis; dentes laterales hamati, externo margine serrulati.

Glans penis hamulis seriatis armata.

This genus has been established for a group of *Dorididæ* with the *D. repanda* (A. et H.) as type. The *Cadlinæ*[1] have a somewhat depressed body with rather broad mantle-edge; the back is rather finely granulated; the gills retractile, consisting of few tripinnate leaves; the opening orifices for the rhinophoria subcrenulate; the head small, fitting in a groove of the mantle; the tentacles short, lobe-formed; the foot rather broad, with a strong furrow in the anterior margin. The nearly annular lip-plate

[1] Laxdäla Saga; Hafniæ, 1826, p. 123.

formed of densely set (bifid) hooks The rhachis of the tongue with a depressed plate with a low denticulated hook; the pleuræ with a series of hook-shaped teeth, the inner denticulated on both edges; the outer only on the exterior margin. The glans penis armed with rows of small hooks. A spoon-shaped process at the upper wall of the vestibulum.

Alder and Hancock have given some notes on the nervous and genital systems and on the structure of the radula of the typical species, which has also been the subject of some observations by Meyer and Möbius.

Up to the present time only three species of the genus are known, two belonging to the northern part of the Atlantic, the third to that of the Pacific; nothing is known of their spawn or their biology.

1. *Cadlina repanda* (A. & H.). Oc. Atlant. sept.
2. *Cadlina glabra* (Friele & Hansen).
   Doris glabra, Fr. & Hans., l. c. p. 2. Oc. Atlant. sept.
3. *Cadlina Pacifica*, Bergh, n. sp. Oc. Pacific. sept.

1. **Cadlina repanda** (A. & H.). Pl. V. fig. 15; Pl VI. figs. 21, 22; Pl. VII. figs. 9–18; Pl. VIII. figs. 3–6.

Doris repanda, A. & H. Monogr., Part III., 1846, Fam. I. pl. 6; Part V., 1851, Fam. I. pl. 1, figs. 10, 11; pl. 2, fig. 14, Part VI., 1855, app. p. II. pl. 46, suppl. fig. 7.
Hancock and Embleton, Anat. of Doris, Phil. Trans., 1852, II. p. 212, 215, 219, 233; Pl. XI. fig. 3; Pl. XII. figs. 11–13; Pl. XIV. fig. 5; Pl. XV. fig. 5; Pl. XVI. fig. 10; Pl. XVII. fig. 9.
Meyer and Moebius, Fauna der Kieler Bucht, II. 1872, p. 68, Taf. fig. 1–7.

Doris lævis, Fleming. Brit. Anim., p. 282, 1828.

Doris obvelata, Lovén, Ind. Moll. Scand., p. 4, 1846. Sars, Reise til Lofoten og Finmarken, p. 76, 1851.

Color lacteus vel luteus, limbo palliali supra maculis luteis vel lacteis distinctus.

Branchiæ e foliolis quinque composita.

Hab. M. Atlant. sept.

It is useless to discuss the question, if the *D. lævis* Linné represents this species; if this in reality was the case, the name of Linnæus ought to be re-established, as it has been done by Mörch[1] (*Acanthochila lævis*, M.). It is scarcely worth while

[1] Cf. Mörch, Faunula Moll. Islandiæ, Naturh. Foren. vidensk. Meddel. 1868, p. 202.

to try to determine, if the *D. lævis* should happen to be the *D. obvelata* of O. Fr. Müller, as supposed by Lovén.[1] In many cases the authors of the present time are unable to determine the species described by authors of late date; it is in most cases still more impossible to determine the species described by elder authors. Better to leave those names of the past to oblivion. Science, after all, ought not to take notice of any Nudibranchiate, that was not anatomically examined; as without such examination it is in many cases not possible even to determine the genus, to which in reality the species belongs. The form described and figured by Alder and Hancock as *D. repanda* is on the contrary determinable, and this name ought to be preserved, although perhaps identical with the elder denominations of Linné and of Müller.

Of this species I have had five specimens for anatomical examination; two kindly sent me by Mr. Friele, of Bergen, and obtained in that vicinity; two from Samso, Kattegat, and from the Island of Zeeland (Denmark), and one from the neighborhood of Kiel, for which I am indebted to the friendship of Prof. Moebius; the individuals agreed in their internal and external structure.

The color of alcoholic specimens was uniformly white or yellowish-white. The Norwegian specimens were 11–19.0 mm. long, 6.5–8.0 mm. broad, and 3.5–6.0 mm. high. The breadth of the foot was 2.6–4.5 mm., of the mantle-edge 1.5–2.5 mm.; the height of the rhinophoria 1.2–2.0 mm., of the gill 1.5–2.5 mm ; the corresponding measurements of the Danish specimens were 20.0–23 0, 14.0–15.0, 8.–9.0, 4.–6.0, 3.5–3.75, and about 2.0 and 3.0 mm. The length of the individual from Kiel was about 8.0 mm.

The form was rather depressed, the outer part of the mantle-edge not thick. The back was covered all over with small and very small papillæ, obtuse or more pointed, low and rounded.[2]

The rhinophorial orifices were not prominent, but were slightly crenulated on the margin. The club showed fifteen to twenty

[1] Lovén, Ind, p. 4: "*D. obvelata*, M. (non C. Fabr. non Johnston, non Bouch. Chant.)—*D. repanda*, A. & H. Mörch, on the contrary (Faun. Moll. Isl., p. 202) regards the *D. obvelata*, Möller (Ind. Moll. Grönl.) non Müller, as identical with the *D. repanda* of Alder and Hancock.

[2] No trace of the characteristic yellow spots was to be seen on the mantle-edge.

leaflets.[1] The opening of the branchial cavity rather small (diameter 1.5–2 mm.) round, not prominent, with a reflexed and scarcely crenulated margin. The gill consisted of five tripinnate leaflets,[2] the anterior median hardly smaller than the others. The two anterior laterals were often cleft so as to simalate two plumes. The anal tube was short, truncate, situated between the two posterior branchial plumes, the renal orifice at the right side.

The head was small, consisting of the mouth and two small flattened tentacles, with a furrow along their outer margin. The flattened genital papilla furnished with a rather contracted orifice; in its upper part always a more or less (1.0 mm.) projecting triangular or spoon-shaped lobe (figs. 21, 22). The foot straight or a little rounded in the forepart, strongly grooved in the margin; the upper lip slightly cleft in the median line.[3] The peritoneum colorless. The five individuals were dissected.

The central nervous system showed the cerebral ganglia of rounded-triangular form, sometimes somewhat elongated, larger than the visceral ones, which are more rounded. In connection with the hind part of the under side of the right cerebral ganglion was a small rounded ganglion (of about 0.07 mm. diameter) prominent between the hinder part of the cerebral ganglia, and giving off a long nerve backwards. In connection with the anterior part of the upper side of the cerebral ganglion was an optic ganglion, a little smaller than the former; the *n. opticus* rather short. In connection with the posterior part of the under side of the visceral ganglion through a rather short nerve is an oblong *ganglion genitale*,[4] giving off a long nerve to the anterior genital mass (penis?); the ganglion containing cells of rather unequal size. The pedal ganglia are situated perpendicularly or oblique to the former, and a little compressed. The commissure rather broad and short, as long as the largest diameter of the pedal ganglion; the proximal olfactory ganglion bulbiform, very short stalked, a little smaller than the buccal ones. No true distal was observed. The visceral

[1] According to A. and H. the number of leaflets is twelve to thirteen, and to Meyer and Moebius fourteen.

[2] Both A. and H. and Meyer and Moebius mention five plumes.

[3] The markings on the under side of the mantle-brim (cf. Alder and Hancock, l. c. fig. 2) were not visible.

[4] This ganglion had already been seen by Hancock and Embleton (l. c. Pl. XVII. fig. 9).

ganglia were of oval form, connected by a very short commissure; the gastro-œsophageal oblong, about one-eighth the size of the last, short stalked, developed on the side of the nerve; with a single large and several small cells.

The eye showed a yellow lens and deep black pigment. The otocysts visible as chalk-white spots under the loop in the usual position, with about one hundred otoconia of the ordinary kind. There were sparingly scattered calcified spiculæ, 0.25–0.30 mm. long, in the broad and rather thick leaves of the rhinophoria, set perpendicularly or obliquely on the free margin of the leaves. The skin was profusely furnished with large and small rod-shaped spiculæ, mostly much calcified; in the axes of the granules of the back were bundles of perpendicular spiculæ as usual. In the interstitial connective tissue a very few large spicules.

The oral tube was wide (1.0–2.5 mm. long). The *bulbus pharyngeus* of the usual form, about 1.3–2.25 mm. long, 1.2–2.0 mm. broad, and 1.0–1.75 high. The radula also projected 0.3–0.75 mm. from the posterior part of the under side of the *bulbus*. The true mouth of triangular form, the point upwards. The lip-plate was deep horn-yellow, narrow at the upper end and broader downward at the lowest square part about 0.66 mm. broad; it is composed of densely set hooks, cleft at the point and rising to the height of about 0.033 mm. (figs. 9, 10). The tongue broad and flat; in the five individuals examined, furnished with twenty-six, twenty-seven, thirty-six, thirty, and fifteen rows of teeth; further backwards thirty-three, thirty-four, twenty-eight, thirty-six, and thirty-two rows developed, and four immature rows; the total number of rows sixty-three, sixty-five, sixty-eight, seventy, and fifty-one.[1] The basal plate of the teeth rather broad (fig. 16), the hook standing nearly perpendicular on it. The median tooth (figs. 11*a*, 12*a*, 13) broader on the posterior margin; the cutting edge of the recurved hook with three to four denticles on each side. The lateral plates[2] in two individuals number only twenty-two to twenty-three; in three others twenty-five to twenty-six on the hind part of the tongue, and further backwards twenty-eight to twenty-nine; the three to four foremost rows were always very

[1] According to Alder and Hancock the number of rows is sixty-eight. I found the lowest number in the small individual from Kiel.

[2] The number was according to Alder and Hancock twenty-two, and to Meyer and Moebius eighteen.

incomplete. The first plate with seven to nine denticles at the outer side of the hook, and with three to four on the inner side (figs. 11*bb*, 12*bb*). The second and third (fig. 14) with broad basal plate, as (figs, 14, 3) also all the succeeding plates without denticulation of the inner margin; on the outer edge (Pl. V., fig. 15) a certain number of denticles, increasing to twenty or twenty-five. In the outermost part of the rows the number of denticles decreased (fig. 15); the outermost plates were of very variable form (figs. 15*a*, 4*a*). The height of the outermost plate sometimes only 0.007, generally 0.04–0.05 mm., the height of the next plate about 0.06, of the next 0.075 mm.; the height rising to about 0.1 mm.; the height of the innermost lateral plate 0.04, of the fifth 0.06 mm. The color of the plates was pale yellow, the outermost colorless.

The salivary glands strong, whitish or yellowish, flattened, with a breadth of 1.5 mm., forming two to three short coils at the sides of the œsophagus; the duct very short. The *œsophagus*, as usual, also the stomach. The intestine emerging from the liver (fig. 17*a*) behind the middle of its upper side; the first part proceeding towards the fore end of the liver, in the largest individuals about 5.8 mm. long, somewhat wider in the pyloric part, the descending part of the intestine nearly 13–17 mm. long, with a nearly constant breadth of 0.75–1 mm. The liver (in the largest individuals) about 1.3–15.0 mm. long, by a breadth of 7–7.0, and a height of 6–7.5 mm.; about half of the light anterior part strongly flattened for the reception of the anterior genital mass, the posterior end rounded; the color of the surface yellowish-white, the substance (when cut) yellow. The biliary sac whitish, very distinct (fig. 17*b*) on the surface of the liver, about 2 mm. long, laying at the anterior end of the pyloric part of the intestine, on the right side.

The heart and renal chamber as usual; the last white, very large, reaching to the fore-end of the liver. The sanguineous gland whitish, very flattened, about 3.5–5.0 mm. in largest diameter, covering the central nervous system. The yolk-yellow hermaphroditic gland covering the upper and right side of the liver (fig. 17*cc*) occasionally with groups of lobes scattered on the under side, but never forming a nearly continuous layer over the liver. The structure was as usual, with large oögene cells and zoösperms in the lobules. The anterior genital mass large, in the largest specimens 8–8.5 mm. long, 3.5–4.0 mm. broad, and

6–7.0 mm. high, ovoid, plano-convex, flattened on the left side. The ampulla of the hermaphroditic duct usually crossed over the left side, whitish, sausage-shaped, 6–7 0 mm. long, by 1.1–2.0 mm. in diameter. The windings of the spermatoduct rested on the anterior margin of the genital mass, the first part thicker but not much longer than the rest, which was thinner and stronger (in the largest individual 7–10.0 mm. long). A stricture unites the two parts, the last passing without definite limits into the nearly cylindrical or elongate-conical (retracted) penis, which was about 1.5–2.5 mm. long, the somewhat elongated glans being straight or curved, 0.5–0.6 mm. in length, by 0.08–0.1 mm. in diameter (fig. 18). It was furnished with irregularly set (fig. 5) rows of pale-yellowish hooks, which rose to a height of about 0.016 mm. They were straight or curved, sometimes irregular or connate (figs. 5, 6), mostly solitary, yet sometimes arranged in small groups (fig. 6); the sperm duct continued (fig. 18*a*) through the whole length of the glans to the round orifice on the point of the glans; there was no continuation of the armature of the glans backwards over a longer portion of the sperm duct. The spermatotheca spherical, about 2–3-0 mm. diameter; its own duct a little longer than the leg, rather wide, then uniting with the thinner and somewhat longer (and wider at the union) duct of the *spermatocysta*, which was also round and of the diameter of 1–1.5 mm.; both organs resting upon the anterior margin of the mucus gland; the vagina about as long as, and a little wider than, the special duct of the spermatotheca.[1] The large mucous gland yellowish-white or yellow; the opaque part on the upper part of left side yellow or brownish; the cavity empty.

2. **Cadlina pacifica,** Bergh, n. sp. Plate VII. figs. 19, 20; Pl. VIII. figs. 7–18.

Color cærulescente albidus.

Branchia e foliolis novem composita.

Hab. Oc. Pacific. sept. (Captain's Bay, Unalashka, and Coal Harbor, Shumagin Ids.).

Dall obtained a living specimen of this species at Captain's Bay, Unalashka, in May, 1872, at low water and on rocky bottom. The color of the living animal he states to have been "bluish-white."

The alcoholic specimen was of a uniform yellowish color, with

[1] Hancock and Embleton, l. c. 1852, Pl. XV., fig. 5.

a slight tinge of olive. The rhinophoria and branchiæ of deeper yellow. It was about 28.0 mm. long, 13 0 mm. broad, and 7.0 mm. high; the foot 7.0 and the free mantle edge 3.0 mm. broad. The rhinophoria 2.5 mm. and the branchial leaflets 3.5 mm. high. It was of rather depressed elongate form; the mantle margin rather broad. The back covered all over with rather small compressed or rounded densely set tubercles, which often coalesced, forming short longitudinal folds. These nearly disappeared at the margin of the mantle. The rhinophorial orifices situated rather forward with several tubercles on their margins, the club of the rhinophoria with twelve to fifteen large and very oblique leaves. The opening of the branchial cavity (the branchial leaves retracted) was a longitudinal slit of about 4 mm. in length, and rather narrow; the margin of it with tubercles of the usual kind. The branchial leaves nine in number, four lateral pairs and one anterior unpaired, tripinnate. The anal tube low, with two (lateral) lips (fig. 19); the renal pore in front of and at its right side. The outer mouth a small longitudinal slit; the tentacles very small, with a furrow at the upper part of their outer margin. The under side of the mantle edge even; a small deep groove for the head. The sides of the body rather low; the genital opening round, with at least two openings in its depth. The foot rounded at the fore end with traces of a fine furrow, the posterior end somewhat pointed.

The intestines where visible through the skin. The peritoneum colorless, nearly without spicula.

The central nervous system showed the cerebral and the visceral ganglia very distinct; the cerebral short, reniform, a little broader in the anterior part, a little larger than the buccal, bulbiform, short-stalked; the optic ganglia scarcely equal to one-tenth of the size of the latter; the optic nerve short. The visceral ganglia short, pyriform; on the under side of the right hand are a short-stalked genital ganglion, intermediate in size between the optic and olfactory ganglia. The pedal ganglia nearly perpendicular on the under side of and a little smaller than the visceral. The commissures rather short, the visceral nearly free from the broad subcerebro-pedal.

The buccal ganglia rounded and connected by an extremely short commissure. The gastro-œsophageal short stalked, ovoid, about one-eighth the size of the former, developed on one side of its nerve with one very large and several smaller cells.

The eye provided with black pigment, and a yellow lens. The otocysts in their usual place, filled with ordinary otoconia. The broad leaves of the rhinophoria with a rather large quantity of spicula, generally set obliquely or perpendicularly on the free margin. The spicula mostly rod-shaped, long, and much calcified. These also occur abundantly in the skin of the back, often associated in small groups. The tubercles of the back were stiffened in the ordinary way, but there were very few spicules of the larger kind in the interstitial tissue.

The oral tube was about 2.5 mm. long, 1.8 mm. wide at the posterior end, internally as usual; the retractor muscles very strong. The *bulbus pharyngeus* strong, about 3.0 mm. long, 2.5 mm. broad, and 2.1 mm. high. The sheath of the radula projecting about 1 mm., bent upwards. The lip-disk rather broad; the lip-plate broad, broadest below, yellow; the lateral parts with several transverse folds; the elements (fig. 7, 8) scarcely different from those of the typical species, or perhaps a little less crooked, of a height of about 0.05 mm.; the mouth, of triangular form, quite as in the *C. repanda*. The tongue of usual form with about thirty-three rows of plates; further back forty-eight developed, and four immature rows; the total number of them eighty-five; the first ten rows of the tongue more or less incomplete.[1] The number of lateral plates in the hinder row of the tongue thirty-three, the number scarcely increasing in the sheath. The plates of yellowish color; the breadth of the oldest plate (in the hinder part) 0.045 mm., the breadth of these plates increasing to 0.06 mm.; the height of the outermost plates about 0.04, and the height of the lateral plates increasing to about 0.12 mm. The plates of nearly the same form as in the last species. The median plate a little emarginated in the posterior margin; the short recurved hook usually with 3–4 denticles on each side of the point (fig. 9, 10*a*), sometimes this point was replaced by two single or bifid larger denticles (fig. 9). The first lateral plate (fig. 10*bb*) with 5–6 denticles at the inside, and with 6–7 at the outside of the hook. Through the 4–6 following plates (fig. 10) the size of the plates

[1] The progression was as follows, 6—1—1, 4—1—3, 6—1—7, 10—1—12, 20—1—18, 22—1—19, etc.

and the number of denticles did not much increase, after which both gradually increased as usual (figs. 11–13). Still the number of denticles in the individual examined hardly exceeded 18–22, and was still smaller in the outer portion of the rows (fig. 15). The three or four outer plates were of rather variable form (figs. 14–15) generally without denticles or only traces of them (figs. 14*aa*, 15*a*).

The salivary glands were yellowish, flattened, riband-shaped, 10.0 mm. long, with a greatest breadth in the anterior part of 1.0 (fig. 20); the glands adhering to one another through more than the posterior half; the ducts short (fig. 20*a*). The œsophagus about 9.0 mm. long, rather thin, and somewhat broader in the middle. The stomach narrow. The intestine appeared at the surface of the liver behind the middle of that organ, was about 5.5 mm. long, reaching to the second fifth of that organ. The reflected part was about 14.0 mm. long, and the alimentary cavity was empty.

The liver 14.0 mm. long, reaching 6.0 mm. in breadth and 5.3 mm. in height. The posterior end rounded, somewhat pointed, more than half the right anterior portion flattened for the anterior genital mass. The surface was grayish-yellow, the substance deeper yellow. The *vesica fellea* smaller than in the typical species, appearing at the right side of the pyloric part of the intestine with a rounded upper end about 1.5 mm. in diameter.

The heart as usual. The sanguineous gland whitish, flattened; about 6 mm. long, with a breadth in the posterior half of 3.5 mm. in the anterior of scarcely 2.0 mm., its thickness about 0.5 mm., covering the largest part of the central nervous system. The urinary chamber large.

The hermaphroditic gland yolk-yellow, spread over the forepart of the liver, over the anterior part of its upper side and over the lateral parts of this organ; in its lobules were large oögene-cells. The anterior genital mass large, about 9.5 mm. long, nearly 6.5 mm. high, and 4.5 mm broad, oval plano-convex. The yellowish hermaphroditic duct issued from about the middle of the applanation on the forepart of the liver, rather strong, swelling into the yellow ampulla that runs in short windings over the left side of the anterior genital mass to its anterior end; the length of the unrolled ampulla was about 9.0 mm., its diameter only 0.1 mm. The spermato-duct with its windings resting on the anterior margin of the genital mass; its first part about 15.0 mm. long with a diameter of about 1.0 mm., yellowish, passing through a slight stricture into the second, which has only half the length and half the diameter and is of a paler color. The penis nearly 4.0 mm. long, and 1.5 mm. in diameter. The glans in the upper end of the cavity having a length of nearly 1.0 mm. (fig. 17); the cuticula clothing the inside of it seemed to present hooks similar to those in the typical species, but fewer and thinner (fig. 18). The *spermatotheca* spherical, about 3.0 mm. in diameter; its duct as usual. The spermato-cysts spherical, about 1.6 mm. in diameter. The ducts as usual, the cavity filled with sperma. The mucus gland large, whitish, and yellowish-white; on the anterior part of the left side was a yolk-yellow mass, the large cavity empty. The spoon-shaped lobe in the vestibulum had a length of nearly 2.0 mm.

Since the above observations were made two other individuals of the same species have come under my notice. They were obtained by Dall in September, 1872, at Coal Harbor, Shumagin Islands, Alaska, on a muddy beach at low water. The color of the living animal was "bluish."

The specimens in spirits were 8.0 and 14.0 mm. long, 6.0 and 10.0 mm. broad, 3.5 and 5.0 mm. high respectively, and of yellowish color. The form as above.

The opening of the retracted gill transversely oval, as above mentioned, the gill with 8–9 leaves. The anal papilla as above. Both specimens were dissected.

The central nervous system, the eyes, the oto-cysts, and the skin quite as above mentioned. The oral tube about 1.5 mm. long. The *bulbus pharyngeus* in the largest individual about 1.75 mm. long, and 1.5 mm. broad and high. The sheath of the radula rather prominent, bent upwards. The mouth-slit triangular; the lip-plates chocolate-brown in the larger, yellow in the smaller individual; the structure as usual. The hooks in general a little thicker at the point. The tongue with twenty-seven to thirty rows of plates; further backwards thirty-six to thirty-nine freshly developed and four immature rows; the total number of rows was sixty-seven to seventy-three rows. In the posterior rows of the tongue twenty-seven to thirty plates. The plates as previously mentioned; the median tooth (fig. 9) merely broader in the hind part of the basal plate

The salivary glands, the œsophagus, the stomach, and the intestine as above. The liver was in length 8.5, in breadth 4.25, and in height 4 mm.; the applanation on the right anterior part shorter than above. The *vesica fellea* as above. The sanguineous gland and the urinary chamber as above.

The hermaphroditic gland with its yellow lobes clothing the largest part of the fore-end and the upper side of the liver. The anterior genital mass about 4.5 mm. long, 3.0 in height, and 2.0 mm. broad. The ampulla of the hermaphroditic duct as above, also the spermato-duct and the penis, which was about 2.0 mm. long. The glans short, its opening and interior clothed with an armature; this last only extended over a total length of about 0.8 mm.; the hooks (fig. 18) pale yellowish, as above, rising to a height of about 0.016 mm. The spermatotheca and spermatocysta as above, and also the spoonshaped lobe in the vestibulum.

Note. Should the reader find any errors of proof-reading in the preceding paper, he will bear in mind that Dr. Bergh has not been able to correct the proofs in person and make due allowances, though it is hardly necessary to remark that the utmost pains have been taken to avoid any such errors.—W. H. D.

EXPLANATION OF PLATES.

An asterisk denotes that the drawing is by camera lucida, the fraction denotes the magnification.

Plate I.

Aeolidia papillosa (L.) var. *Pacifica.*

1. Mandible from the inside,* $\frac{55}{1}$; *a*, *crista connectiva*; *b*, *processus masticatorius.*
2. Part of the masticating edge,* $\frac{350}{1}$.
3. Two teeth from the radula,* $\frac{200}{1}$.
4. Another from the side,* $\frac{350}{1}$.
5. Penis; *a*, *ductus ejaculatorius.*
6. Cnidæ,* $\frac{350}{1}$.

Fiona marina (Förskal) var. *Pacifica.*

7. Two teeth from the radula from above,* $\frac{350}{1}$.
8. The hook of the same,* $\frac{350}{1}$.

Hermissenda opalescens (Cooper).

9. Mandible,* $\frac{55}{1}$; *a*, *crista connectiva ; b*, *process. mastic.*
10. Part of the masticating edge;* *a*, superior (anterior) part; *b*, posterior part, $\frac{350}{1}$.
11. Inferior margin of the hook of a tooth,* $\frac{350}{1}$.
12. Cnidæ,* $\frac{350}{1}$.

Coryphella sp.

13. Hind part of masticating edge from the inside;* *a*, posterior part, $\frac{350}{1}$.
14. Part of the radula;* *aa*, lateral teeth, $\frac{350}{1}$.

Flabellina iodinea (Cooper).

15. Anterior part of the posterior third of the masticating edge,* $\frac{350}{1}$.
16. A lateral tooth, from the side,* $\frac{350}{1}$.
17. A lateral tooth,* $\frac{750}{1}$.

Dendronotus purpureus, Bergh.

18. Elements of the prehensile collar,* $\frac{750}{1}$.
19. Part of the middle of the collar,* $\frac{750}{1}$.
20. Elements of the posterior part of the collar,* $\frac{750}{1}$.

Dendronotus Dalli, Bergh.

21. Exterior part of a row of teeth;* *a*, outer tooth, $\frac{350}{1}$.

Plate II.

Hermissenda opalescens (Cooper).

1. Three plates of the radula, from one side,* $\frac{350}{1}$.
2. Two ditto, a little oblique, from above,* $\frac{350}{1}$.
3. Two of the anterior teeth,* $\frac{750}{1}$.
4. The hook of the hindmost developed plate,* $\frac{750}{1}$.
5. A lobe of the hermaphroditic gland,* $\frac{100}{1}$; *a*, efferent duct.
6. Penis; *a*, spermatoduct; *bb*, *præputium ; e*, glans with its orifice.

Coryphella sp.

7. The right mandible from the outside,* $\frac{55}{1}$; *a*, the articulation; *b*, the cutting process.
8. The hinder part of the cutting edge from the outside,* $\frac{350}{1}$; *a*, posterior part.

Dendronotus Dalli, Bergh.

9. The tongue and its muscular mass (*c*) from the side; *b*, radula; *c*, *tectum radulæ*.
10. The same from above; *a*, superior end of the radula; *bb*, muscular masses of the tongue; *c*, end of the descending sheath of the radula.
11. Anterior rhachidian tooth, from above,* $\frac{100}{1}$.
12. The same, from below,* $\frac{100}{1}$.

Dendronotus arborescens (O. F. Müll.).

13. Hinder part of the cutting edge;* *a*, youngest part, $\frac{350}{1}$.
14. Hook of a rhachidian tooth,* $\frac{350}{1}$.
15. A group of (5) follicles of the hermaphroditic gland, *a*, efferent duct,* $\frac{100}{1}$.

Flabellina iodinea (Cooper).

16. Part of three rows of plates, from above;* *a*, rhachidian *b*, lateral plates, $\frac{350}{1}$.

Plate III.

Dendronotus arborescens (F.).

1. Four lateral teeth;* *aa*, doubled tooth, $\frac{350}{1}$.

Dendronotus Dalli, Bergh.

2. The left mandible from the inside;* *a*, *crista connectiva;* *b*, superior process; *c*, *processus masticatorius*, $\frac{55}{1}$.
3. The same with the same lettering,* $\frac{55}{1}$.
4. A part of the masticating edge,* $\frac{750}{1}$.
5. Thirteen outer plates of one of the posterior rows of the radula;* *a*, outermost plate, $\frac{350}{1}$.
6. A rhachidian tooth or plate from behind, $\frac{350}{1}$.

Dendronotus purpureus, Bergh.

7. The masticating process;* *a*, the point, $\frac{100}{1}$.
8. Median plate from the upper side,* $\frac{350}{1}$.
9 Two median plates from the under side,* $\frac{350}{1}$.
10. The serrations of the right side of the median plate,* $\frac{750}{1}$.
11. Three lateral plates,* $\frac{750}{1}$.
12. (*a*) Anterior part of the salivary gland;* *b*, duct, $\frac{100}{1}$

Tritonia tetraquetra (Pallas).

13. *aa*, the foot; *b*, the corner of the frontal veil; *c*, margin of the genital opening; *d*, penis with the opening of the mucus gland under its root.
14. A branchial leaf or plume.
15. *a*, the anal papilla; *b*, the renal pore.
16. Part of the cutting edge of the *processus masticatorius*, $\frac{350}{1}$.

Plate IV.

Dendronotus arborescens (O. F. Müller).

1. Masticating edge of the jaw, posterior end,* $\frac{350}{1}$.
2. Elements of the prehensile collar,* $\frac{350}{1}$.
3. Point of the penis; *a*, orifice,* $\frac{350}{1}$.
4. Penis;* *d*, vas deferens; *b*, point of the organ, $\frac{55}{1}$.

Tritonia tetraquetra (Pallas).

5. Part of the cuticle of the frontal veil.
6. The buccal ganglia, with *b* the right gastro-œsophageal ganglion,* $\frac{55}{1}$.
7. The mandibles from in front;* *a*, articulation; *b*, *processus masticatorius*.
8, 8. Teeth from the middle of the radula, parts of three rows, seen obliquely from above;* *aa*, median teeth; *bbb*, first laterals from the left side; *cc*, same of the right side; *dd*, second laterals of the left side, $\frac{350}{1}$.
9. Lateral teeth from the middle of a row,* $\frac{350}{1}$.
10. Outer teeth (6–9) of two rows;* *aa*, the outermost; *b*, fold of the cuticula, $\frac{350}{1}$.
11. Outer teeth (5–4) of two rows; *a* and *b* as above, $\frac{350}{1}$.
12, 12. Doubled (monstrous) teeth of two rows,* $\frac{350}{1}$.

Akiodoris lutescens, Bergh.

13, 13. Spicula of the skin.*

Plate V.

Tritonia tetraquetra (Pallas).

1. Rhachis or median part of the radula, with part of three rows of teeth;* *aa*, rhachidian teeth; *bb*, first lateral teeth; *cc*, second laterals, $\frac{350}{1}$.

2. Middle part of a row;* *a*, rhachidian with 12 laterals; *b*, twelfth lateral, $\frac{350}{1}$.

Diaulula Sandiegensis (Cooper).

3. Papillæ of the back.
4. Outer part of two rows of teeth with 6–8 teeth;* *aa*, outermost teeth, $\frac{350}{1}$.
5. Inner part of two rows;* *aa*, first teeth, $\frac{350}{1}$.

Diaulula Sandiegensis (C.) var.

6. Two innermost teeth,* $\frac{350}{1}$.
7, 7. Outer part of two rows with 5 and 2 teeth;* *aa*, outermost, $\frac{350}{1}$.
8. *a*, first part of the spermato-duct; *b*, prostate; *c*, spermato-duct; *d*, penis; *e*, *vestibulum genitale.*
9. Penis opened with the glans and spermato-duct.

Lamellidoris bilamellata (L.) var. *Pacifica.*

10. Dorsal papillæ,* $\frac{100}{1}$.

Akiodoris lutescens, Bergh.

11. Dorsal papilla,* $\frac{100}{1}$.
12. Spicula from the rhinophoria,* $\frac{350}{1}$.
13. Glans penis from the side.
14. Glans penis from the end.

Cadlina repanda (A. & H.).

15. Lateral tooth from behind,* $\frac{750}{1}$.

Plate VI.

Akiodoris lutescens, Bergh.

1. Median part of a row of teeth;* *a*, rhachidian; *bb*, first lateral; *cc*, second lateral; *d*, third lateral, $\frac{350}{1}$.
2. The rest of the same row;* *e*, the fourth tooth; *f*, the thirteenth, $\frac{350}{1}$.
3. The rhachidian tooth, obliquely,* $\frac{350}{1}$.
4. *a*, first, and *b*, second lateral teeth from one side,* $\frac{350}{1}$.
5. First tooth, anterior margin, from above,* $\frac{350}{1}$.
6. *a*, first, and *b*, second tooth from behind,* $\frac{350}{1}$.

7, 8. Third and fourth teeth from beneath,* $\frac{350}{1}$.

9, 10. Fourth and fifth teeth obliquely from the side,* $\frac{350}{1}$.

11. The fifth tooth from above,* $\frac{350}{1}$.

12, 13. The seventh and eighth teeth from below,* $\frac{350}{1}$.

Akiodoris lutescens, Bergh, var.

14. Rhachidian tooth from below,* $\frac{350}{1}$.
15. First lateral tooth of two rows,* $\frac{350}{1}$.
16. The sixth tooth from one side,* $\frac{350}{1}$.
17. *a*, the ventricle; *b*, the proceeding intestine; *c*, the biliary sac; *d*, the liver.
18. *a*, yellowish part of the spermato-duct; *b*, thinner continuation; *c*, penis; *d*, duct of the spermatotheca; *e*, vagina of vestibulum.
19. *a*, spermatotheca; *b*, spermatocysta; *c*. long duct of the mucus gland; *d*, duct of the vagina, directly continuous with *d* of fig. 18.
20. Longitudinal section of the wall of the glans penis;* the hooks partly broken off and their sockets naked, $\frac{100}{1}$.

Cadlina repanda (A. and H.).

21. Spoon-shaped process of the upper part of the vestibulum from below.
22. The same from above.

Plate VII.

Akiodoris lutescens, Bergh.

1. Upper part of the interior of the glans;* *a*, outer wall, $\frac{100}{1}$.
2. Part of the covering of the glans with its hooks,* $\frac{350}{1}$.
3. Covering, with hooks, from the anterior end of the inverted part of the glans;* *a*, posterior; *b*, more anterior portions, $\frac{350}{1}$.
4. Similar hooks from the anterior part,* $\frac{350}{1}$.
5. Anterior end of spermato-duct and posterior part of the inverted penis;* *aa*, walls of the spermato-duct; *b*, end of the same; *c*, most posterior part of the penis with its hooks, $\frac{100}{1}$.
6. Covering of the vagina with its rod-like palisades;* at *a* and other places they have been torn away, leaving only their stiff axes, $\frac{00}{1}$.

7. Similar covering with well preserved "palisades,"* $\frac{100}{1}$.
8. Elements of the same,* $\frac{350}{1}$.

Cadlina repanda (A. and H.).

9. Elements of the buccal plate from above,* $\frac{750}{1}$.
10. The same from the side,* $\frac{750}{1}$.
11. The median part of the radula;* *a*, median tooth; *bb*, first laterals, $\frac{750}{1}$.
12. The same with four median teeth,* *a* and *b*, as above, $\frac{750}{1}$.
13. A median tooth,* $\frac{750}{1}$.
14. Third lateral tooth from the side,* $\frac{750}{1}$.
15. Outer part of four rows, with one to three teeth;* *a*, outermost tooth, $\frac{750}{1}$.
16. Median part of the radula from below;* *a*, median teeth, $\frac{200}{1}$.
17. *a*, pyloric part of the intestine; *b*, the *vesica fellea; c*, lobes of the hermaphroditic gland.
18. Everted glans penis;* *a*, continuation of the armed cuticle of the anterior part; *b*, interior of the spermato-duct, $\frac{100}{1}$.

Cadlina Pacifica, Bergh.

19. The anal papilla.
20. Anterior part of the salivary gland; *a*, duct.

PLATE VIII.

Akiodoris lutescens, Bergh.

1. Part of the radula with three to six rows of teeth;* *a*, rhachidian tooth; *b*, first lateral; *c*, second; *d*, third; *e*, fourth, $\frac{350}{1}$.
2. The remainder of these three rows of teeth;* from *a*, the fifth, to the twelfth and outermost tooth, $\frac{350}{1}$.

Cadlina repanda (A. and H.).

3. The seventeenth to the twentieth teeth of two rows,* $\frac{750}{1}$.
4. The outermost teeth of seven rows,* $\frac{750}{1}$.
5. Part of the glans penis,* $\frac{750}{1}$.
6. Some of its isolated hooks,* $\frac{750}{1}$.

Cadlina Pacifica, Bergh.

7. Elements of the lip-plate or buccal plate.
8. The same in another part,* $\frac{750}{1}$.
9. Three rhachidian teeth,* $\frac{750}{1}$.
10. Median part of the radula;* *a*, median plates; *bb*, first laterals; *c*, fourth lateral, $\frac{750}{1}$.
11. Side view of a lateral tooth from the outer side,* $\frac{750}{1}$.
12. The same from the inner side,* $\frac{750}{1}$.
13. Largest lateral tooth,* $\frac{750}{1}$.
14. Outer plates (teeth) of four rows;* *aa*, the outermost, $\frac{750}{1}$.
15. Four outer plates of one row;* *a*, the outermost, $\frac{750}{1}$.
16. Part of the cuticle with its spicula,* $\frac{350}{1}$.
17. The glans penis,* $\frac{100}{1}$.
18. Part of the penis,* $\frac{750}{1}$.

Jorunna Johnstoni (A. and H.).

19. Lateral tooth,* $\frac{350}{1}$.

ON A NEW GENUS AND SPECIES OF SCOMBRIDÆ.

BY W. N. LOCKINGTON.

Since D. W. B. Ayres, between the years 1854 and 1863, described nearly seventy species of fishes from the West Coast of N. America, principally from the neighborhood of San Francisco, until my own scattered notes appeared in the Proc. Cal. Acad. Sci. 1876, very little has been done in ichthyology by naturalists resident on this coast. In 1863–1864, Dr. J. G. Cooper, at that time attached to the Geological Survey of Cal., described eight species; and about the same time Mr. A. Garret, during a visit to this coast, described a Murænoid fish in a paper principally devoted to the fishes of the Sandwich Islands. All these papers were published in vol. iii. of the Proc. Cal. Acad. Sci.

Meanwhile the ichthyology of this coast has received careful attention from Gill, Günther, and Steindachner, the last of whom visited us with the Hassler Expedition, resided here a short time, and took away with him numerous specimens.

It has for some time been my endeavor to collect together and identify such of the species described by the above authors, and by Girard in vol. x. of the Pac. Rail. Reports, as occur in or near the Bay of San Francisco, and to add to our knowledge of them whatever information I can collect respecting their distribution, life-colors, variations, etc.

In so doing I have meet with the following new form.

CHRIOMITRA, nov. gen.

Body elongate, fusiform, cleft of mouth wide. First dorsal separated from the second by an interspace, seven or more spurious fins behind dorsal and anal. No corselet or pectoral region, body naked or covered with small scales. Teeth of moderate strength in the jaws, none on the vomer or palatines. A longitudinal keel on each side of tail. Seven branchiostegals. Dorsal spines 15. Pectoral fins inserted at the level of the eye. This genus is distinguished from *Scomber* by the greater number of the finlets, and by the want of a uniform covering of scales; from *Orcynus* and *Sarda* by the absence of a corselet, and the presence of an interval between the two dorsals; from *Cybium* by the latter character; and from all these genera by the absence of teeth on either vomer or palatines. From *Auxis* it differs in the absence of a corslet, in the larger size of the teeth, and in the greater number of dorsal spines. Etymology, χρεια *want*, μιτρα *stomacher*, viz., corslet.

Chriomitra concolor, sp. nov.

D. 15 17, VII. A. 1 17, VIII.

Teeth in a single row, triangular, compressed, those of lower jaw largest, none near the symphysis. Seven or eight finlets behind the dorsal, eight behind the anal; pectoral one-eighth of the total length to the end of the central caudal rays, ventrals small, in length less than $\frac{2}{5}$th of the pectorals.

Description.—Dorsal outline a regular gentle curve from snout to tail, ventral outline similar to that of dorsal.

Cleft of mouth slightly oblique, maxillary reaching to a vertical from the hinder margin of the eye; its anterior part concealed behind the preorbital when the mouth is closed.

Jaws equal in front, teeth in a single row on the jaws, none on the vomer or palatines. Teeth in lower jaw larger than those in upper, compressed at base, gently curved inwards; those in upper jaw much smaller, compressed, triangular, straight.

Length of head slightly exceeding the greatest depth, and contained about five times in the total length.

Eye slightly oval, its longitudinal diameter contained seven times in the length of the head; snout a little more than one-third of the same length, tapering regularly to the tip; and convex above, as is also the whole upper surface of the head.

Hinder margin of preoperculum with a long shallow sinus, its lower angle extending a little farther back than its upper extremity; lower border almost straight, horizontal. Hinder margin of operculum and suboperculum a regular curve.

Distance from tip of snout to origin of first dorsal contained about $4\frac{1}{2}$ times in the length to end of central part of caudal; its length of base very slightly less than its distance from tip of snout. Second, third, and fourth dorsal spines highest, thence diminishing rapidly in height to the tenth, the remainder short and apparently isolated.

All the spines are exceedingly slender and fragile; the longest are about equal to one-third the length of the head.

Interspace between the two dorsals about one-fourth of the length of the base of the first dorsal.

Second dorsal commencing half way between the tip of the snout and the origin of the caudal, increasing rapidly in height to the fourth, which is equal to the sixth, and slightly shorter than the fifth, the fifth a little less than half the length of the head. The rays diminish rapidly in height to the eleventh, which is about half as long as the fifth; the remaining rays decrease slowly to the last, which simulates a finlet.

Anal similar in form to second dorsal, but its rays somewhat shorter than the corresponding dorsal ones.

Pectoral pointed, the rays diminishing very rapidly from the fourth to the eleventh from its upper margin; the 11th to 15th rays nearly equal, remaining rays very rapidly shortening. Centre of base of pectoral in a line with a line drawn from the tip of the snout through the centre of the pupil.

Ventrals very small, less than two-fifths as long as the pectorals.

Length of inner side of upper lobe of caudal a little less than $\frac{2}{9}$th of the length of the fish (to end of middle caudal rays); lower lobe slightly shorter. Lateral line diverging gradually from the dorsal outline as far as the origin of the second dorsal, where it lies slightly below the upper third of the height, thence curving downwards rapidly to a vertical from the front of the first dorsal finlet, thence in an undulating line along the centre of the depth to the caudal keel.

A low keel, convergent posteriorly, above and below the central keel of the caudal peduncle.

Long narrow scales on the region behind the eye, along each side of the dorsal outline, and on the peduncle of the tail; remainder of body naked.

Color of the upper portions dark steel blue, becoming silvery below; no streaks.

The specimen in the possession of the Cal. Acad. of Sciences was obtained in San Francisco Market, and was probably taken, as were previously examined specimens of this species, in Monterey Bay. It is said to occasionally straggle as far north as San Francisco, or even Tomales Bay.

	Inches.
Total length to end of middle rays of caudal	21
Length of head	$4\frac{1}{4}$
Greatest depth of body about	$4\frac{1}{8}$
Longitudinal diameter of eye	$\frac{19}{32}''$
Length of snout	$1\frac{7}{16}$
Width between orbits	$1\frac{1}{8}$
From tip of snout to origin of first dorsal	$4\frac{3}{4}$
Length of base of ditto	$4\frac{5}{8}$
From tip of snout to origin of second dorsal	$10\frac{1}{4}$
" " " anal	$11\frac{3}{8}$
Length of pectoral	$2\frac{5}{8}$
Length of upper lobe of caudal, along posterior margin .	$3\frac{3}{4}$
Length of ventrals	1''

1–6. Aeolidia papillosa (L.) var. pacifica.
7–8. Fiona marina (Forsk.)
9–12. Hermissenda opalescens (Cooper).
13–14. Coryphella sp.
15–17. Flabellina iodinea (Cooper).
18–20. Dendron. purpureus, Bgh.
21. D. Dalli, Bgh.

R. Bergh

1–6. *Hermissenda opalescens* Cooper. 9–12. *Dendronotus Dalli*, Bgh.
7–8. *Coryphella* sp. 13–15. *D. arborescens* (F.).
16. *Flab. iodinea* C.

R. Bergh. Jenny Hansen.

1. *Dendronotus arborescens* (F.). 7–12. *D. purpureus*, B.
2–6. *D. Dalli*, Bgh. 13–16. *Tritonia tetraquetra* (Pallas).

R. Bergh

1–4 Dendron arbor (F.) 5–12 Trit. tetraquetra (P.)
13. Akiod. lutescens, Bgh.

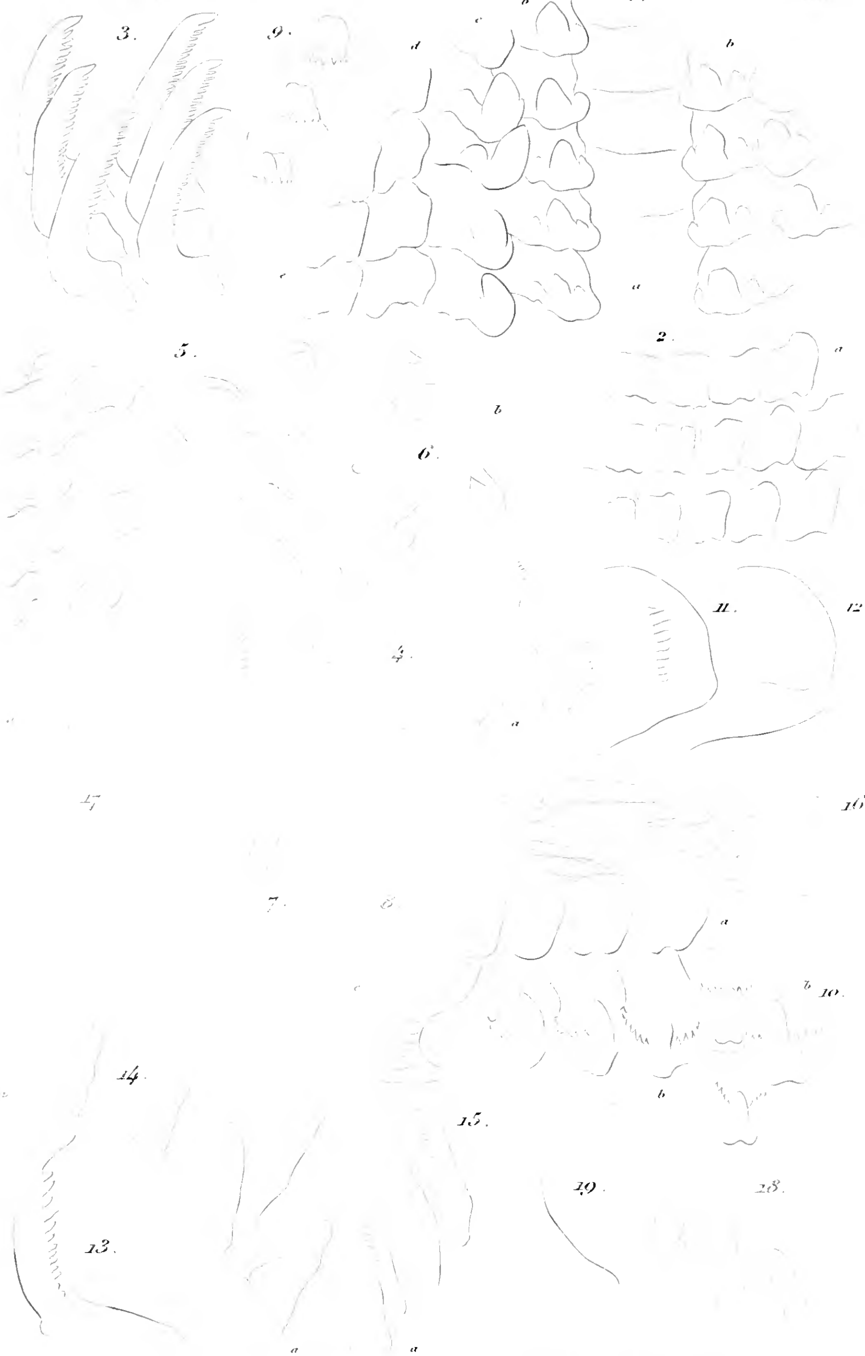
R. Bergh Jenny Hansen

1 - 2. Tr. tetraquetra (P.) 3 – 9. Diaulula Sandiegensis (Cooper.)
10. Lam. bilamell. (L.) 11 - 14. Aktod. lutescens. B.

1 – 20 Aktodoris lutescens, Bgh.   21 – 22 Cadlina repanda (A. et H.)

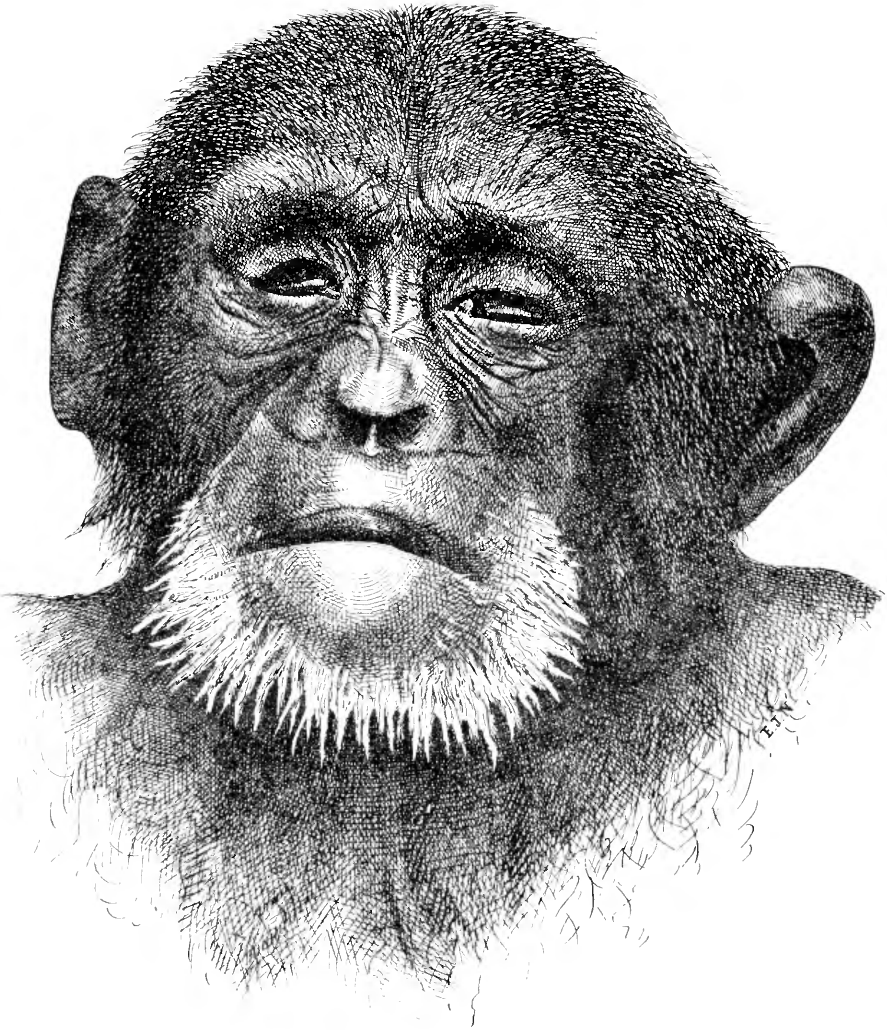
1–8. Akiod. lutesc. B. 9–18. Cadl. rep. (A. et H.) 19–20. C. pacifica. B.

R. Bergh ...ovendal

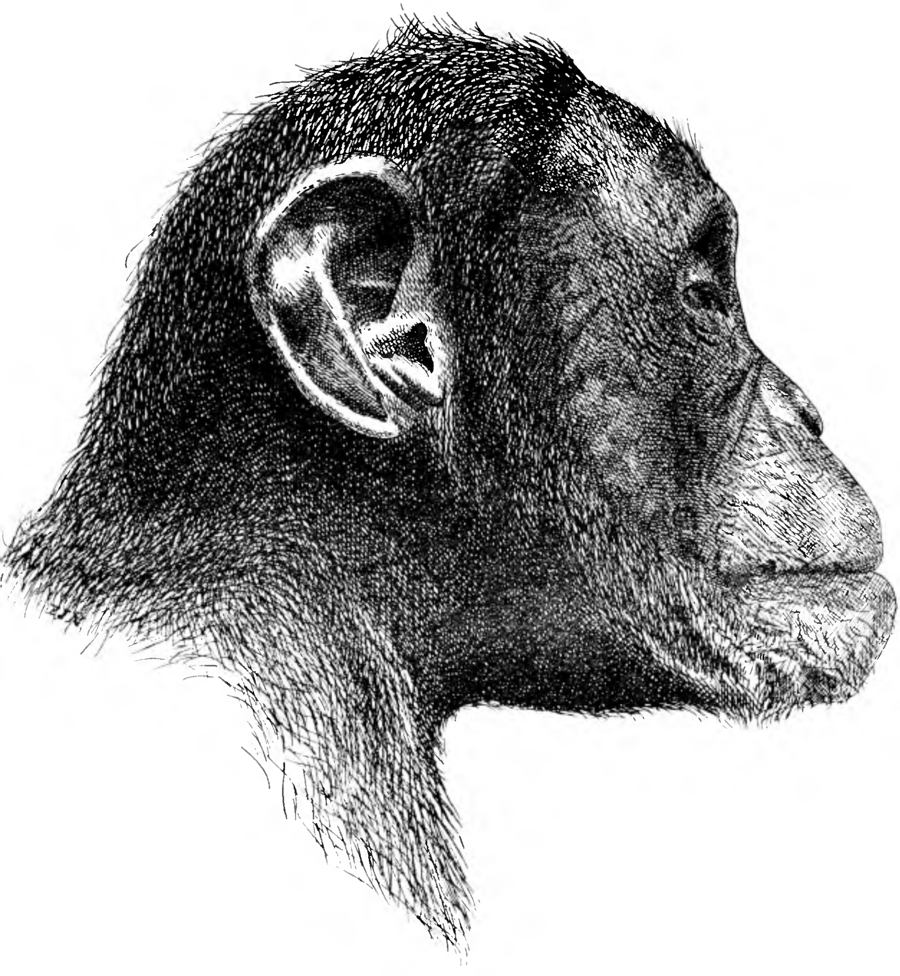


1–2. Ak. lutescens, B. 3–6. Cadl. rep. A. et H.
7–18. C. pacifica, B. 19. Jorunna Johnstoni A. et H.

R. Bergh

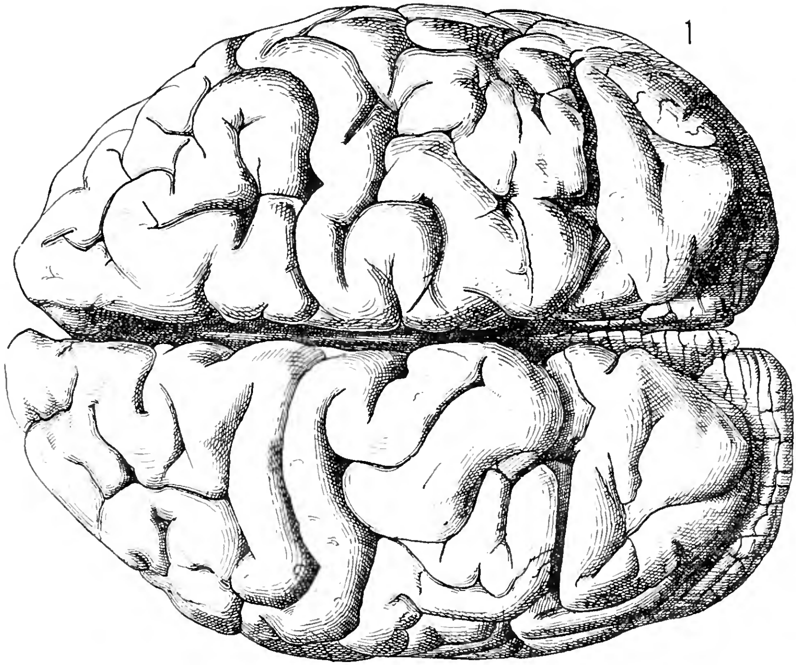


CHAPMAN ON THE CHIMPANZEE.

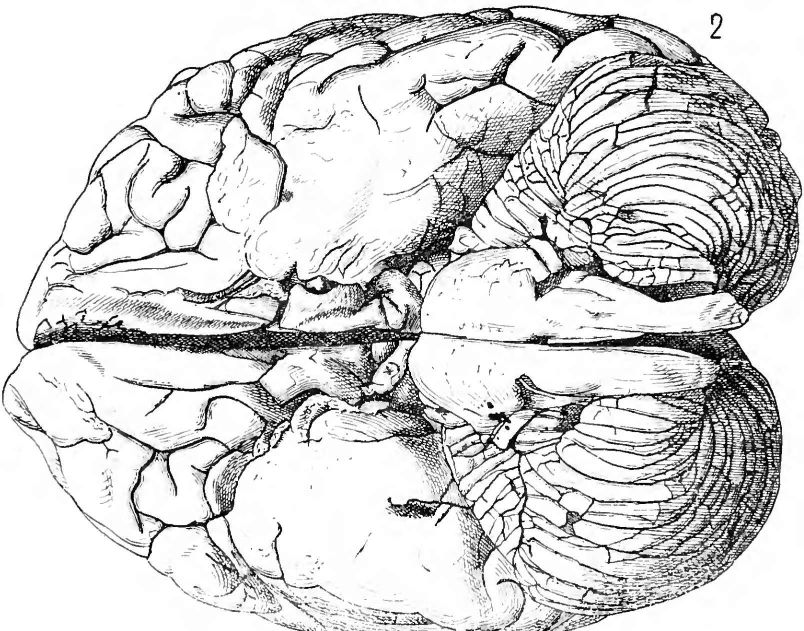


CHAPMAN ON THE CHIMPANZEE.

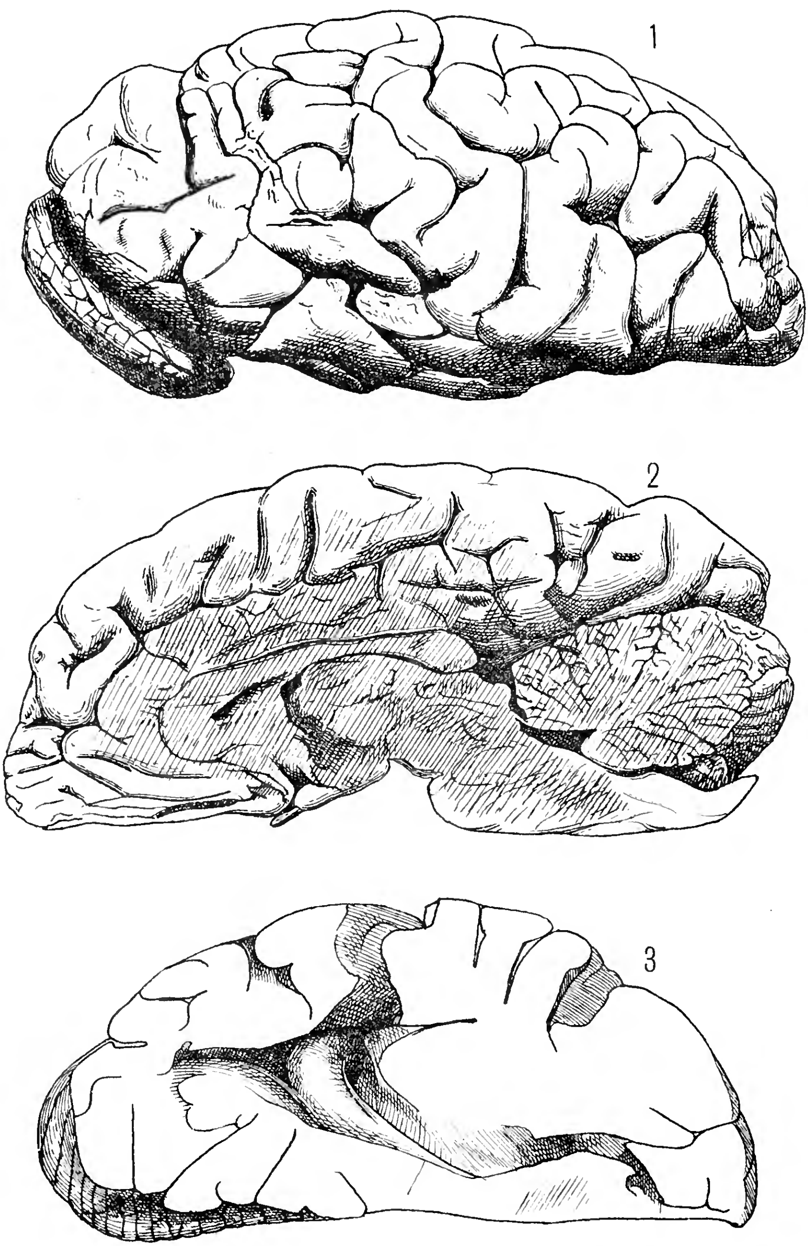
1



2



CHAPMAN ON THE CHIMPANZEE.



CHAPMAN ON THE CHIMPANZEE.

APRIL 1.

The President, Dr. RUSCHENBERGER, in the chair.

Forty-two persons present.

The death of Geo. B. Wood, M.D., a member, was announced.

On Hybrid Fuchsias.—Mr. THOMAS MEEHAN exhibited a seedling fuchsia which had been obtained from *F. syringæflora*, that had been pollenised by a garden hybrid named "Inimitable." Mr. M. detailed the precautions taken to avoid the use by the flower of its own pollen. This one exhibited was the only one that had foliage and habit exactly like its female parent, and the flowers were also alike in every particular. The five remaining had not yet flowered, but were more or less unlike the female parent, and unlike each other in appearance. The foliage of one yet to flower was very much like the male parent; and one plant which had been destroyed by an accident last summer was exactly like the male parent.

The chief point of interest was that the pollen from one single flower, operating in one single pistil, and resulting in one single berry, should produce such a dissimilar progeny.

Note on the Adoption of an Ant-Queen.—Mr. McCOOK reported the following case of the adoption of a fertile queen of *Crematogaster lineolata*, a small black ant, by a colony of the same species. The queen was taken in Fairmount Park April 16th, and on May 14th following was introduced to workers of a nest taken the same day. The queen was alone within an artificial glass formicary, and several workers were introduced. One of these soon found the queen, exhibited much excitement, but no hostility, and immediately ran to her sister workers, all of whom were presently clustered upon the queen. As other workers were gradually introduced they joined their comrades until the body of the queen (who is much larger than the workers) was nearly covered with them. They appeared to be holding on by their mandibles to the delicate hairs upon the female's body, and continually moved their antennæ caressingly. This sort of attention continued until the queen, escorted by workers, disappeared in one of the galleries. She was entirely adopted, and thereafter was often seen moving freely, or attended by guards, about the nest, at times engaged in attending the larvæ and nymphs which had been introduced with the workers of the strange colony. The workers were fresh from their own natural home, and the queen had been in an artificial home for a month. As among ants the workers of different nests are usually hostile to each other, this adoption of an alien queen is an example of the strong instinct which controls for preservation of the species.

APRIL 8.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-five persons present.

APRIL 15.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-three persons present.

The following papers were presented for publication:—

"Placenta of Macacus Cynomolgus." By H. C. Chapman, M.D.

"Description of a new species of Chirocephalus." By John A. Ryder.

The death of Isaac Hays, M.D., a member, was announced.

On Special Fecundity in Plants.—At the meeting of the Botanical Section, Mr. THOMAS MEEHAN exhibited specimens and remarked on the curious fact that special fecundity was not confined to individuals of any one species of plants, but the species themselves often exhibited peculiar fertility, as other species again were characterized by an indisposition to produce seed. Occasionally whole families or natural orders of plants exhibited these peculiarities. In our green-houses the *Begonia*, which has male and female flowers separately on the same plant, some species had an unusual preponderance of fertile female flowers; others, as, for instance, *Begonia glaucophylla*, had never borne a female flower within his observation. The race of Primroses were famous for an apparent abhorrence of their own pollen, rarely producing any seeds unless the plant had the chance to receive pollen from some other plant; but the Madeira Primrose—*Primula involucrata*—was a remarkable self-fertilizer, and every flower, apparently under the most varied circumstances, produced an immense quantity of seeds. As illustrations of the infertility of some natural families, Asclepiadiæ and Apocynaceæ were quoted. In these we have the common Hoya or "Wax plant," the Oleander, the common Silk-weeds, in which thousands of flowers are produced for every one that results in a seed vessel. In this part of the world at least the "Trailing Arbutus" rarely, if ever, produces perfect seed.

April 22.

The President, Dr. Ruschenberger, in the chair.

Twenty-seven persons present.

Notice of a New Pauropod.—Mr. J. A. Ryder described a new myriapod which he had recently discovered, and which turned out to be nearly allied to the form described by Sir John Lubbock under the name of *Pauropus*. The specimens which the speaker had obtained were five in number, and had but six segments, fewer than any other known member of the group, whilst the number of pairs of legs was nine, the same as in *Pauropus*, which is very strong evidence that the specimens are adults. The following characterization of the genus and species was proposed:—

Eurypauropus spinosus, gen. et sp. nov. Body segments six in number, sixth exceedingly rudimentary; antennæ five-jointed; legs in nine pairs, equidistant; tergal sclerites laterally expanded so as to conceal the legs almost entirely when the animal is viewed from above, and covered with fine tubercles which are joined to each other by raised lines; appressed curved spines are also scattered over their surface in less number, and also fringe their margins, being disposed at regular intervals; the spines and lines give the dorsal surface of the little creature a slightly silky lustre when viewed with reflected light. Color a delicate light brown. Mouth-organs the same as in the first-described genus. No evidence of eyes could be detected. Length $\frac{1}{25}$th of an inch; width about $\frac{1}{70}$th of an inch. Habitat in Fairmount Park, Philadelphia, east and west of Schuylkill, under decaying wood.

The tergal sclerites are much thicker than in *Pauropus*, having the characteristic brown color of chitin when viewed with transmitted light. The antennæ have the terminal globular hyaline body with a long pedicle as in *Pauropus pedunculatus*. The type is the most distinct form discovered since the detection of the first known representatives in England in 1866, and also extends the geographical range of the family, and does much towards fully establishing the *Pauropoda* as a distinct order of myriapods.

Do Snakes Swallow their Young?—Mr. Meehan remarked that European zoologists yet seemed incredulous that young snakes would enter their mothers' mouths for protection when frightened. He had witnessed such an occurrence, but it had been suggested that his eyes deceived him. Professor Brown Goode had collected evidence sufficient, he thought, for American zoologists to believe in. Similar facts came to us from Australia. He read a part of a letter to himself from Baron Ferdinand Von Mueller, of Melbourne, stating that two observers, whom Dr. M. believed perfectly credible, had, independently of each other, witnessed similar protection in that country.

Dr. Kenderdine said he had personally seen a case where a garter snake so protected its young.

Mode of Depositing Ant-eggs.—Mr. McCook stated that a queen of the black carpenter ant, *Camponotus Pennsylvanicus*, which had long been kept in an artificial nest, had once been seen in the act of depositing an egg. The queen was at the time clinging to the side of a hollow in the surface of the earth, almost in a vertical position. The usual body-guard of workers quite surrounded her, continually touching her with their antennæ. The egg was a white cylindrical object, about one-eighth of an inch in length. It was about two minutes in escaping from the body, and as soon as dropped was carried below within the galleries by a worker. The queen was never left by her body-guard, who sought to control her movements by pressing around her, blocking up the path which she wished to take. Frequently more vigorous persuasions were used, an antenna or leg being grasped by a worker, and the queen thus pulled backward. She made no attacks upon her guard, but often stubbornly held her own way; though commonly yielding more or less graciously to her attendants. This colony had been received from the Allegheny Mountains in December, within their formicary in an oak bough, in which they were hibernating, being quite stiff with cold. They immediately revived in the warmth, and were healthy and active during the following spring. The queen survived until September following, and would doubtless have lived longer had she not been neglected during a prolonged absence in summer. She outlived all her subjects, and was certainly more than a year old.

April 29.

The President, Dr. Ruschenberger, in the chair.

Thirty-eight persons present.

Note on the Marriage-flights of Lasius flavus and Myrmica lobricornis.—Rev. H. C. McCook remarked that the first named ant is one of the most familiar objects in nature. Its small dusky-yellow workers may be seen in every American lawn, walk, field, and yard, throwing up its fragile moundlets of sand-pellets, and swarming upon particles of fruit, crumbs, bones, dead insects, and all manner of sweets. It is quite cosmopolitan in its distribution, and is well known in Europe. The following observation of the annual marriage-flight of the sexes was made September 5, 1878, in the vicinity of Philadelphia. The nests observed were located directly in and on the grassy border of a trodden path in a farmyard. At 4 P.M the males and females were seen coming out and re-entering the gate, amid great excitement on the part of the workers. The females particularly were followed by workers who "teased" them occasionally by gently nipping them with their mandibles. The flight of the young queens was, with few exceptions, made from the top of stalks of grass, where they clung for several minutes, poising themselves, spreading their wings, and swaying up and down. Even to these elevations the workers followed them, hastening their flight by occasional "nips." When the queen rose in flight, there was no evidence of feebleness or inexperience, except, in some cases, a slight tendency to a zig-zag course for the first few yards. The flight was then, and in most cases from the very first also, strong and in a straight course. The insect first rose to a height of about 20 feet, which was soon increased to 40, 50, and even 60 feet (estimated), and this latter height was maintained until the form was lost to sight. He was able to follow the ants in several instances to a distance of more than 300 feet, before they disappeared, at which time they gave no sign of alighting. Some were seen to alight at the distance of 60 and 80 feet; others flew into a large buttonwood tree within 30 feet of the nest.

The flight was in every case solitary, and was in all directions, although generally in the direction of the breeze. The males were in the mean time continually taking flight, urged thereto by teasing workers, each separately, and wholly independent of other males and of the females, as to the time and direction of flight. This fact led Mr. McCook to infer that the pairing of the sexes must have occurred within the nest before departure therefrom. Except in the case of those individuals who lit upon the buttonwood tree, there appeared no opportunity for a meeting after flight. There was nothing in all the facts to suggest the idea of a future consort. The same feature of independent and solitary flight of the sexes had been observed in the swarming of the Shining Slave-maker *Polyergus lucidus*. This is in marked contrast with the habit of some other ants as illustrated in an observation subsequently given.

Before taking flight the *L. flavus* females spent some time in combing and cleansing themselves. A female was placed among the workers of another nest not more than a yard distant from her own, in order to test the treatment of an alien. She was immediately attacked fiercely, and would no doubt have been soon killed had she not been removed. In two formicaries from which the above marriage-flight occurred, it was observed that the doors were closed about 4½ P.M. by bits of dry grass and pellets of soil. They so remained during the night, or at least were found closed in the morning. Three days thereafter several males were found nestled under a chip by the roadside. As soon as the chip was turned up, two of these were seized by a couple of prowling ants of the species *Tetramorium cæspitum* and *Formica Schauffussi*, and carried off as prey, a suggestion of the common fate of emmet masculines.

His attention had been called to an article in a Hollidaysburg (Pennsylvania) journal, which reported a remarkable swarm of ants that had crossed that town on the 13th September, 1876. He immediately wrote to Rev. D. H. Barron, a citizen of the place, and a gentleman of intelligence and prudence, giving certain points which it was desirable to ascertain. The ants in the course of their flight had come in contact with the mechanics at work upon the tower of the new court-house, whom it was reported they had assaulted vigorously. Mr. Barron visited these men, and after a careful interview communicated the following facts: The flight actually occurred substantially as reported; the day was clear, warm, and calm; the ants came between 10 and 11 A.M., from the direction of the Chimney Rocks, a ridge of the mountain on the southeast of the town. As to numbers, the answers of the men were as follows: "so thick you could hardly see through them;" "swarms;" "about 30,000!" The ants struck the building at the height of about 120 or 125 feet, and certainly assaulted the men. Whether the attack was a bite or a sting they could not tell, but it was something very uncomfortable, and they would not like to have it repeated. The ants were of two sizes, some larger some smaller. One of the men had saved some specimens which were sent to Mr. McCook and proved to be the males and females of *Myrmica lobricornis*, Nylander. These ants can inflict a painful sting, but probably attacked the workmen simply in self-defence; that is, the men happened to obstruct their flight, and naturally vigorously brushed off the insects who lit upon them, who in turn becoming irate applied their stings. Such a vast horde as this swarm contained must have been composed of the winged inmates of many formicaries on the mountain side. This is quite in contrast with the solitary flight of *Lasius flavus* as described in a former note. The pairing of the sexes was probably in the air, or after alighting, as in the case of the agricultural ant.[1] Mr. McCook had taken ants of the same sub-family *Myrmicidæ*, while they were in the act of pairing in the air.

In connection with the above notes on the queen-life of ants, he presented an observation reported to him by Mr. Jos. Wilcox. This gentleman had seen a colony of some species of *Camponotus* occupying a large dead cyprus tree standing in the midst of a cyprus swamp in Florida, at least 600 feet from the shore. The tree was wholly isolated from the land and from all surrounding vegetation except another fallen cyprus tree which leaned up against it. Evidently a fertilized queen had at some time flown from the land to this tree, where she had established the colony.

[1] Agricultural Ant of Texas, p. 143.

The fact is interesting as indicating the origin of formicaries from single queens, as myrmecologists have supposed to be frequently if not commonly the case. Further, as showing the ability of a large number of ants (this nest was reported to consist of vast numbers) to maintain active life under quite circumscribed environment. The insects sheltered in such numbers by old trees may have furnished a large portion of the food supply. The specimens brought by Mr. Wilcox were taken from a colony on the land, which he supposed to be identical with the swamp-tree nest, and were examples of *Camponotus esuriens*, Smith.

Henry W. Stelwagon, M.D., Henry T. Coates, Wm. S. Magee, James F. Magee, J. J. Kirkbride, M.D., and Robert Meade Smith, M.D., were elected members.

The following were ordered to be printed:—

NOTES ON THE AMPHIUMA.

BY HENRY C. CHAPMAN, M.D.

On looking over general works, like those of Owen, Huxley, Milne Edwards, Gegenbaur, Stannius, etc., in reference to the anatomy of the Perrenibranchiate Batrachia, I find that the *Amphiuma* is only referred to in a general way, and, with the exception of Cuvier's memoir,[1] I do not know of any special paper having been published on the structure of that animal. Having dissected the *Amphiuma* that recently died at the Zoological Garden, I thought that it might not be uninteresting to notice the disposition of its internal organs. The specimen was a male, and measured twenty-nine inches. As regards the alimentary canal, the only difference that I noticed in my specimen, as compared with that described by Cuvier, was that the rectum did not exhibit the constrictions seen in the figure of his specimen. In other respects, such as the longitudinal folds of the stomach, the openings into the cloaca, etc., they were alike. The liver and spleen were large, and there was a distinct pancreas. The lungs were well developed, and attained a length of thirteen inches, which may serve to explain the fact of the animal being able to remain under water such a length of time. The heart differs from that of the siren in that the auricles are not fringed to the same extent. The ventricle is large and muscular, and is separated from the bulbus arteriosus by a short and narrow constriction. The bulbus bifurcates each branch at once, then subdivides into the pulmonary artery and a branchial vessel. The latter winds around the pharynx, and, meeting its fellow of the opposite side, the two form the aorta. From the branchial vessel are given off cephalic and hyoid branches. The blood is returned from the lung to the heart by a pulmonary vein. As compared with *Siredon*, *Menobranchus*, *Siren*, *Proteus*, and even with the closely allied *Menopoma*, *Amphiuma* exhibits a very simple and concentrated type of circulation. I did not notice anything peculiar about the branches given off by the aorta, which I examined through its length; the vessels supplying the Wolffian bodies were large. The bladder

[1] Cuvier Memoires du Musée. 2 op. cit., pl. 1, fig. 2, tome 14th.

was long and narrow, measuring nine inches: it opened into the cloaca. I can only account for the great length of the bladder in the *Amphiuma* and *Siren* on the supposition that it represents a sort of rudimentary allantois. This view is strengthened by the fact of the *Amphiuma* having very simple limbs, and in this respect also foreshadowing higher types of life. The uro-genital apparatus in its general arrangement resembles that of the newt (*Triton tæniatus*). The testicle, however, was undivided, and measured five and a half inches in length; it was situated in the posterior third of the body cavity. From the testicle six or seven efferent ducts pass transversely outward to the remains of the upper part of the Wolffian body, represented by a chain of dilatations. From this embryonic remnant pass about twelve tubes into a common uro-genital duct, which measures nine inches. This duct runs in a wavy course until it reaches the lower part of the Wolffian body, or the so-called kidney. Here the duct becomes straight, and lies on the outside of the Wolffian body, from which it collects, through small tubes, the urine. This common uro-genital duct opens into the cloaca posteriorly to the bladder. I was able by pressing upon the duct to squeeze a considerable amount of semen through its opening into the cloaca, which gave me the opportunity of examining the spermatozoa. These bodies did not exhibit a very well defined head, but one end was obtuse and the other tapered off tail-like. Just between the cloaca and abdominal wall I found coiled up a nematoid worm, which may be the *Ascaris unguiculata*. I found what seemed to be also the same worm in an encysted condition in the intestine and in the mesentery.

PLACENTA OF MACACUS CYNOMOLOGUS.

BY HENRY C. CHAPMAN, M.D.

Comparatively little is known concerning the fœtal condition of monkeys. In those of the New World (Platyrhina) the placenta is single. As regards the Anthropoids the placentation in the Gorilla and Ourang is unknown; in the Chimpanzee the organ is single; in the Hylobates it is double. In the remaining Old World monkeys (Catarhina) the placenta is usually described as being double. Thus Prof. Owen observes, "in the tailed Catarhina the placenta is double, the two being distinct and apart."[1] According to Prof. Milne Edwards, "chez les autres singes de l'ancien continent cet organe est divisé en deux lobes bien distincts."[2] Prof. Huxley states, "that the placenta is often bilobed."[3] In the genera *Nasalis*, *Semnopithecus*, *Cercopithecus*, according to Breschet,[4] and in the *Macacus nemestrinus*, according to Prof. Rolleston,[5] the placenta is double. In the case of the *Macacus nemestrinus* I have confirmed Prof. Rolleston's observation in two instances. Having recently made a post-mortem examination of a pregnant *Macacus cynomolgus*, which died at the Philadelphia Zoological Garden, of phthisis, I was surprised to find on opening the uterus that the placenta was single, contrary to what might have been expected. As the opportunity rarely presents itself of examining *in situ* the fœtus and membranes of a monkey, it appears to me proper to communicate the results of my dissection. In opening the uterus I found that it measured from side to side 7 inches, and was $\frac{1}{8}$th inch thick. The placenta, single and discoid in form, measured $3\frac{1}{2}$ inches in its longest diameter, and $2\frac{1}{2}$ inches in its shortest. The umbilical cord was 7 inches in length and consisted of the umbilical vein and the two hypogastric arteries. The umbilical vein passed into the liver of the fœtus, and the hypogastric arteries into the internal iliacs. The fœtus measured, from crown of head to tail, $6\frac{1}{2}$ inches, the tail itself measuring 7 inches. In

[1] Comparative Anatomy, vol. iii., p. 748.

[2] Anatomie Compareé, Tome neuvieme, p. 554.

[3] Anatomy of Vertebrates, p. 402.

[4] Etudes sur l'œuf.

[5] Trans. of Zool. Society, 1865.

reference to the membranes, the amnion and chorion adhered together and were in contact with the decidua. As the pregnancy was far advanced, I cannot state whether there was a decidua reflexa, at least it was undistinguishable from the decidua vera. In every respect the disposition of all the parts strikingly resembled those of the human being under similar conditions.

DESCRIPTION OF A NEW SPECIES OF CHIROCEPHALUS.

BY JOHN A. RYDER.

The genus *Chirocephalus* does not seem to have been noticed up to the present time in North America; I therefore take much pleasure in announcing the discovery of a hitherto undescribed species of the genus in the vicinity of Woodbury, New Jersey, where it was found in abundance in the ditches by Mr. W. P. Seal, a resident of the place, and an indefatigable collector of the minute life of his neighborhood.

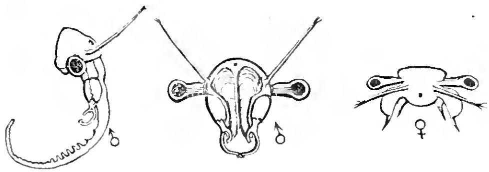
The genus, as characterized by Dr. Wm. Baird,[1] has been found in Switzerland, France, England, Russia, and Siberia. The species *C. lacunæ*, most nearly like the one I am about to describe, is figured and described by Guérin in his *Iconog. Regne Animale*, as being found at Fontainebleau, France. The differences between our species and Guérin's are, however, sufficiently striking and constant to characterize a well-marked specific type, and I accordingly propose the following specific characterization of the American form.

Chirocephalus holmanii, nov. sp.

Char. specif.—Claspers moderately robust; second joint forked, longest branch longer than first joint, and curved inwards, its tip crossing that of its fellow of the opposite side when in repose; shorter branch less curved, slightly swollen, and rough on the inner surface of its tip, about half as long as the longer branch. Two long fleshy proboscis-like prehensile organs arise from the bases of the claspers and are coiled up between the latter; muscular fibres pass throughout their length; near their origin and for the first third they are expanded inferiorly into a thin margin with about seven papilliform processes; they then gradually contract, becoming cylindrical at their second third, where about seven well-marked digitiform processes are found, the longest of which are about as long as twice the diameter of the proboscis at this point; the remaining third gradually contracts, and is thickly studded with half rings of small papillæ which seem to mark

[1] Monograph of the Family Branchipodidæ, Ann. and Mag. Nat. Hist., 2d ser., vol. xiv., 1854, p. 216–229.

indistinctly the segments of the organ. Total length of the proboscis, when extended, about three times that of the claspers. Total length 12–14 mm. Habitat, Woodbury, New Jersey.



Head of male with proboscidiform organs uncoiled, from the side. Same, viewed from before, with proboscidiform organs coiled up and retracted between the claspers. Head of female from above.

I name the above species in honor of Mr. D. S. Holman, Actuary of the Franklin Institute, in recognition of the services he has rendered in devising methods for studying living objects, both large and small, under the microscope, and to whom I am also indebted for the specimens from which the above description has been taken.

The detection of a member of the genus in this country is very interesting, but less so than the detection of *Pauropus huxleyi* Lubbock, in the vicinity of Philadelphia, without any difference, as far as Mr. Lubbock's excellent plates of English specimens would enable one to judge, that would make it even a variety, although removed by more than 3000 miles of ocean from its congeners. It has been suggested, however, that, inasmuch as Philadelphia is an old English settlement, *Pauropus* may have been introduced, but in the case of *Chirocephalus* such an explanation is less open to acceptance.

May 6.

The President, Dr. Ruschenberger, in the chair.

Thirty-one persons present.

Pairing of Spiders, Linyphia marginata.—Rev. H. C. McCook remarked that on the afternoon of June 14, 1878, he witnessed the pairing of a male and female of *Linyphia marginata* at Bellwood, Blair Co., Penna. The spiders were first observed at a quarter before 4 o'clock P. M. They were hanging inverted in the dome-shaped nest of the species, in line with each other, and about three-quarters inch apart. Each hung within a smaller dome, delicately but perceptibly defined, that rose within the summit. These were perhaps formed by the outspread feet drawing down the inner surface of the dome.

The position of these individuals seeming to indicate the act of copulation, he arranged himself before them as comfortably as possible for observation. The nest was hung from the lower surface of an end of a plank that jutted over from a pile of lumber, about two and a half feet from the ground, so that, seated before the nest, his face was on a level with the spiders. The male reached out one foot cautiously toward the female, pulling upon the threads. He turned a moment to adjust the block on which he sat, and, on again looking, the two were in embrace. The female was suspended in the same position as before, although turned at right angles to the line on which she hung when first seen. The head of the male was laid against the sternum of the female, the abdomen inclined a little upward, the forelegs interlocked with or rather interlaid upon those of the female. Both spiders were suspended by threads, in the normal way. This was at 9 minutes before 4 P. M. After a moment's embrace the pair separated; the female made a circuit of the lower part of the dome, moving in an excited, jerking manner, then returned to the summit. The male approached, the female stretching out her forelegs somewhat, as he laid his two forelegs within them, which position was maintained, as was the relative position of the two during the entire period of copulation. The female during the act remained perfectly motionless except an occasional twitching of the apex of the abdomen.

The two terminal bulbs upon the male palp were laid upon the epigynum of the female, and pressed downward. From one of these issued the sac, a bean-shaped organ, of a bright amber color, and translucent, which shone brilliantly in the sun that fell full upon it from the west. It remained thus projected, held between the finger-like tufted horn of the bulb, for a brief space, was then gradually contracted and withdrawn within the black corneous bulb, which was meanwhile pressed eagerly against the epigynum. A small elbow or projection upon the upper part of the bulb seemed to press within the spermatheca of the epigynum. The two bulbs were laid simultaneously upon the tubes of the spermathecæ, but the inflated sac appeared in but one bulb at a time; the latter action alternated in the bulb. There was a prolonged squeezing motion of the bulbs, as though pressing into the spermathecæ, and at times a corresponding motion in the abdomen of the female, especially at the apex. With this exception the female remained motionless during the whole period of copulation. After application as above the male bulb was slowly, for the most part, but sometimes rapidly, raised, bent upward, and apparently clasped upon the falces or lower margin of the face, which parts of course were upward. Three or four movements back and forth in this clinched position followed, when the series of motions above described was repeated.

In the meanwhile the other bulb remained upon the other tube until the first bulb began to descend, when it in turn was elevated, and the same motion made. As the bulb descended the sac began to inflate and issue. The above is the process as it was quite regularly repeated. Sometimes, however, both bulbs were clinched upon the falces at the same time; sometimes the movements of the bulb were more rapid than at others. The bulbs had the appearance of having been moistened by some secretion, presenting the peculiar gloss which a colorless liquid gives to a black surface, but he could see no secretion otherwise, although he was able at any time to use his pocket lens with the exercise of a little care.

At twenty minutes before 6 six o'clock he was compelled to leave, at which time the pair had been in embrace one hour and forty-nine minutes. At six o'clock twenty-eight minutes he returned, and found the pair in precisely the same positions. He remained five minutes, and then left an intelligent young man at the post, with full instructions as to points of observation. He reported that at thirteen and a half minutes to seven P. M. the pair parted very suddenly. The male ran downward to a portion in the lower margin of the dome pursued by the female, who stopped suddenly just above and turned back to the central point in the summit of the dome. Shortly after receiving this report Mr. McCook visited the nest and found the female suspended motionless in this position and the male at the point to which he had fled, feeding upon a small fly. The next morning at seven o'clock the female was in the same position, and the male had disappeared. He attempted to capture the female, but she ran among the boards and escaped. The pair had thus been in union two hours and fifty-five and a half minutes.

During this period they were separated a number of times.

Nineteen of these interruptions were noted; one was caused by a small fly striking the snare, which the male darted at in a fierce manner, but failed to seize, as the fly broke loose before he reached it. Others were caused by the observer touching the foundation threads or other parts of the nest. Toward the close of his observations he accidently broke the suspending lines nearest to him and so caused one side of the dome to fall in. This made only a momentary interruption. Many of these separations were, however, apparently without any extraneous cause. Twice the male ran to one side of the dome, made a web attachment to a bit of leaf hanging in the snare, drew out a thread about two and a half inches long, which he overlaid a couple of times, and then made the following motion: First, the body was placed erect, *i. e.*, back upward, and was moved back and forth along the line, rubbing the points or "nippers" of the palps at the same time; then the spider swung over until the body made an angle of about 45° with the line, and while holding on thus the palps were rubbed back and forth alternately along the line as before. The process was repeated during another of the intermissions, as described above. It was conjectured that the purpose of this movement might be the distribution of the seminal fluid into the palpal bulbs. This is taken up by the sacs, by the inflation and contraction of whose membranous coats it is forced into the spermathecæ of the female.

May 13.

Wm. S. Vaux, Vice-President, in the chair.

Thirty-three persons present.

The Lateral Sensory Apparatus of Fishes.—Dr. Francis Dercum called the attention of the Academy to the so-called mucous canals, or system of the lateral line in fishes. Up to the year 1850 these structures had been regarded as glandular, that is, as secreting mucus for the purpose of lubricating the general surface of the body. However, the following facts at once strike us as being directly contradictory to this view. In the first place, their size would render them wholly insufficient; secondly, these canals are in most fishes practically closed; and in some fishes actually closed along their entire course. Again, in mollusks in which the surface is equally well lubricated with those of fishes we find no such structures.

After referring to the discoveries of Franz Leydig in 1850, and afterwards to the observations of F. E. Schulze on young teliost fishes, Dr. Dercum offered the following evidence in confirmation of the view that these structures are sensory. Like Leydig he described as occurring at regular intervals in the canals of the head and lateral line certain discoidal bodies, termed by Leydig nerve-buttons, and in which terminates a nerve fibre. He corroborated Leydig's statements regarding the existence of a little mass of viscid mucous or jelly-like matter resting on each disk, and also regarding the positions of the disks, *i. e.*, as generally occurring under small bridges of bone in the canals of the head, and as occurring in every scale of the lateral line. However, the specimens exhibited by him showed a result entirely different from that of Leydig as regards the distribution of the nerves. Leydig pictures the disk as composed of two distinct areas, a dark or less translucent central portion, and a lighter peripheral portion. This appearance is, indeed, simulated in the fresh preparation, as the disk is somewhat transparent, and allows the insertion of the nerve fibre to be seen directly through it. No such appearance, however, is presented in specimens treated by osmic acid. A dense, arborescent plexus of nerve-fibres comes into view, and the distinction into two areas entirely disappears.

The size of the entering nerve as compared with the size of the disk is relatively very great, so that when the dense plexus of nerves makes its appearance it strikes one as though the bulk of the disk were nerve matter. Indeed, besides a large number of capillaries it contains only a small amount of connective tissue.

Owing to the want of the proper material, Dr. Dercum had not been able to confirm the observations of F. E. Schulze on young fishes. However, transverse sections of the disks macerated in osmic acid and teased, yielded essentially the same results as regards the structure of the epithelium. This appears to consist of two kinds of cells, one long and cylindroid, the other small and globose or pyriform, and having long outrunners penetrating the subjacent connective tissue. These outrunners are probably continuous with nerve-fibres, which they resemble. The drawings representing the connections of the nerves with the cells, given by F. E. Schulze for the "nerve-hills" of young fishes, are, therefore, very probably correct, but the material at hand did not permit an absolute decision of the point. The hairs of these perceptive cells were readily distinguished, but were generally broken and mutilated, owing doubtless to the reagents and teasing.

As is well known, the canals of the head are generally provided with bony supports, which form grooves, and which are at intervals generally bridged over by bone. Thus certain membranous interspaces of greater or less size are produced. In some fishes, as *Centropomus undecimalis*, the bony bridges are more or less wanting, so that a comparatively large expanse of membrane is formed stretched between the two walls of the canal. These membranes are, of course, composed of two elements. They consist, first, of the delicate connective tissue and flattened epithelium belonging to the canal, and, secondly, of the dense layer of connective tissue and epithelium belonging to the skin. The two layers can be readily separated by a careful dissection. Each membrane, were it stretched tightly, would form functionally a drum-head. It is, however, quite loose, and will fluctuate readily on pressure.

The function attributed to this apparatus by F. E. Schulze, that these structures appreciate mass movements of the water, and also waves having longer periods than those appreciated by the ear, is no doubt the correct one. However, the canals cannot act in the manner suggested by Schulze, *i. e.*, by allowing the water to flow freely through them, as such a free communication with the surrounding medium as is implied, is not present. As already stated, in some fishes the canals are completely closed along their entire course, and when openings are present, they are probably for the purpose of maintaining an equilibrium of pressure within and without the apparatus.

The true detailed action of these organs is probably as follows: Let us suppose any disturbing cause to set up a wave of long period in the water. It impinges, first, on the membranous interspaces or drum-heads before spoken of, and with the greatest intensity, of course, on those which are most nearly placed at right angles to its direction. The wave is thus communicated to the liquid in the canals, which transmits it to the adjacent masses of jelly-like mucus covering the disks. The quivering of these little masses probably excites and intensifies vibrations of the hairs of the perceptive cells. The fish probably judges of the direction of the disturbing cause by the portion of the apparatus most intensely excited. The membranous spaces or drum-heads, when the apparatus is well developed, are so arranged as to favor the perception of vibrations from almost all directions.

Dr. Dercum suggested that it would be well, in view of the confusion existing in the present names of the dermal structures of fishes, to call these organs definitely the *lateral sensory apparatus* of fishes. This would, of course, not include the sensory ampullæ of the sharks and rays, nor the Savian vesicles, which have already distinctive names. In view of the structural resemblance of the sensory disks to the maculæ acusticæ, he proposed to call them the *maculæ laterales*, giving a specific signification to the word macula.

MAY 20.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty persons present.

Note on Mound-making Ants.—Mr. McCOOK said that he had had an opportunity to spend a day (June 12) on the Allegheny Mountains, above Birmingham, Huntingdon Co., Pa., observing the habits of *Formica exsectöides*, our mountain mound-builder. While standing near a yellow pine tree whose roots ran into a large double mound, his attention was attracted by a continuous and peculiar rasping sound. This was produced by ants who were scattered over the surface of the trunk engaged in scooping out with their mandibles the bark thereof. The gray outer bark had been removed in many places, and the reddish-brown bark beneath cut away so as to give the tree a marked spotted appearance. The excavated portions covered a surface at times of two or three square inches, and were from one-sixteenth to one-eighth of an inch in depth. The pellets were sometimes allowed to accumulate in the mandibles, but were generally rejected as soon as cut off, and dropped to the earth. In only two cases was there any application of the tongue to the bark. No other tree was observed to be thus marked. The purpose of this curious behavior could not be conjectured.

The directness with which the foragers take the home path was thus illustrated. One worker was seen by his companion, Mr. Kay, to seize a small green insect, with which she immediately turned homeward. She was followed patiently with her burden to the nest, a distance of 126 feet, and her path upon measurement was found to be a direct line. She was twice attacked upon the route, once by several workers of the same species; she hid from these assailants beneath a leaf and waited until they dispersed. The second time she was assaulted by two workers from whom she escaped by running. Once she rested for one half a minute. A number of times she met foragers apparently of her own nest, for after antennal salutations she passed peacefully on. The direct line was in no case interrupted.

In turning up a number of stones in the neighborhood of various mounds, hosts of white ants, *Termes flavipes*, were uncovered, who were instantly attacked by the roving exsectöides, and carried off in their jaws. These termites evidently are preyed upon by the mound builders. Nests of small true ants, exposed in a similar way, were similarly dealt with.

A great number of abandoned and moss-grown mounds were seen here. In some cases, one part of the hill was occupied and the other abandoned. In the unoccupied parts when washed out by the rains, the exposed walls of the galleries presented a pretty columnar appearance, which was made more striking by the overcovering moss.

As the evening advanced attention was directed to the gates to note if any attempt would be made to close them. Previous studies, made later in the summer, had failed to detect any such effort. Five doors not far removed from each other upon the side of a large mound, were put under close observation. These were watched until the night was too far advanced to allow further notice, at which time, three doors were quite closed and two nearly so. There appeared to be a conflict of behavior on the part of the workers, some carrying the pellets of earth quite out of the galleries as usual, while others dropped them near the mouth or door. The evening was quite cool and Mr. McCook's impression was that the ants who dropped the pellets within or just outside of the doors were probably caused to do so by the sense of cold with which they were met. Feeling the cold air as they approached the gate, instead of pushing out, they stopped, dropped the pellet, and turned back. Thus the grains accumulated, giving the appearance of an intentional closing. Through the doors which were nearly closed an ant head and antennæ could occasionally be seen peeping forth.

May 27.

The President, Dr. Ruschenberger, in the chair.

Thirty-four persons present.

Charles H. Pennypacker and Robert S. Davis were elected members.

June 3.

The President, Dr. Ruschenberger, in the chair.

Twenty-one members present.

June 10.

The President, Dr. Ruschenberger, in the chair.

Fifteen persons present.

The deaths of Wm. W. Longstreth and F. F. Maury, M.D., members, were announced.

Combats and Nidification of the Pavement Ant, Tetramorium Cæspitum.—Mr. McCook exhibited a large glass jar containing a nest of this ant made by captives taken from a city garden. During the month of May immense numbers of this species have been seen along our sidewalks, in yards and gardens, engaged in combat. From one of these masses of struggling insects, three large groups were taken and placed in separate jars. The transfer had no visible effect in separating the combatants. Into one jar (No. 1) a pellet saturated in cologne was introduced. Instantly, as in the case of experiments previously reported,[1] the combatants separated, and buried themselves pell-mell in the earth. Not an

[1] Mode of Recognition among Ants, Proceed. Acad. Nat. Sci., p. 15, 1878.

ant remained above the surface. The pellet was removed, and the jar thoroughly aired; whereupon the ants speedily began to reappear. They seemed to be confused somewhat by the fumes of the cologne, but soon began to dig galleries. Only two pairs resumed the fight, and these shortly unclasped mandibles. There was no resumption of hostilities thereafter, and the two parties appeared to interblend and fraternize completely.

In the second jar (No. 2), the one exhibited, the ants were left undisturbed. The battle continued for two days. It was waged over the entire surface of the earth within the jar. Every clod and other elevation was the seat of one or more duels, for, as a general rule, the fight was waged by twos, but also frequently by threes. The duelists seized each other by the head, frequently interclasping mandibles, and pulling backward or swaying back and forth. Again, one would have her antagonist grasped by the face above the mandibles, which placed the latter at a great disadvantage. In such cases, and in others also, both ants would be reared upon the hind and middle legs, with abdomens turned under, and stinging organs thrust out. When three ants were battling in one group, the third commonly held her opponent by a leg, or had seized her by the abdomen or thorax. Occasionally the exertions of the combatants caused them to roll upon the ground.

At the close of the first day, numbers had retired from the conflict and perched upon the sides of the jar. On the third day the battle had ceased, and the ants were engaged in excavating galleries. Whether the survivors were all of one party could not be determined, except inferentially by the following experiment.

The jar which had been fumed with cologne (No. 1) was introduced into jar No. 2, which was large enough to admit it. The ants in No. 1, who had been hostile, were then working together harmoniously. They, in turn, soon interblended with those in No. 2, all thus composing one apparently united formicary. It thus appears, whatever may have been the cause of the combat, that, first, the influence of the cologne fumes completely pacified and united the contending parties; and, second, that the previous hostility was no barrier to their forming one harmonious nest. Subsequently the jar was placed uncovered in the open air and was abandoned by all but a few of the ants within two days.

There were many dead bodies, which were gathered in one large heap, that each day was increased by the death of the (probably) injured. This "graveyard" was subsequently changed to another spot, but the dead were kept together as they now are.

In at least one case noted the cause of the ant battle seemed quite clear. The warring insects were spread thickly over a surface of nearly a square foot of the sidewalk, quite near the curbstone. The centre of this struggling mass was a quantity of fatty matter which had been thrown on and around the seams of the bricks through which a large formicary had made its gates. From the battle field a column of ants, three or four lines deep, stretched along a depression caused by a shallow surface drain to a second nest just under a gate that led through a wall into the house-yard. Evidently the ants from the curb formicary had fallen upon the unctuous treasures which had dropped by their doors, but had been disturbed in their "feast of fat things" by stragglers from the gate nest. The stragglers were attacked; others came, and in time were attacked; messengers ran to the gate nest for reinforcements; fresh squadrons issued from the curb colony, and thus the battle grew. When it was first seen a single line of ants was stretched from battle ground to gate, and a double line from gate to battle field. The ants in these columns were in the utmost agitation. As they hurried along, fairly a-quiver with excitement, they suggested strongly the outward mien and behavior of human beings running to and from a fire, a riot, or a fight. Mr. McCook was not able to watch the issue of this ant battle, but had no doubt that the above is the true theory of its origin. It is probable that many similar conflicts originate in like rivalries for the possession of food

The system of galleries excavated by these insects is precisely like that of most other mason ants. It is a network of galleries for the most part from one-sixteenth to one-eighth inch wide, but with frequent greatly widened portions. The "meshes" or solid interspaces vary much in size. The galleries were made against the inner surface of the jar, and thus are entirely visible. The ants seemed to have no objection to working in the light. The principal galleries have a tendency more or less regular to the vertical and horizontal, but the impression was made by the mode of operations that the workers were rather influenced by some accidental feature or quality of the soil, than directed by any intelligent plan, in laying out and driving the galleries. The behavior of the ants gave to a human observer the impression of unconscious action, not of forethought. On the contrary, a glance at the series of galleries, as thus far completed, shows an arrangement admirably suited for the purposes of a nest. The cross-galleries are all inclined at various degrees of inclination, leading into each other and out of the surface-gates by grades which afford easy passage. There is thus a mechanical advantage in the very irregularity of the arrangement. It is not improbable, to say the least, that the muscular system of the ant is so constructed that she unconsciously takes the line of least action in her work, as do human beings and lower animals when climbing the side of a hill, or moving across irregular surfaces. The thorough interlacing of the galleries affords easy intercommunication throughout the nest. There is also an evident convergence of the cross galleries at several points upon vertical galleries which are much widened as though to provide for the convenient movements of increased numbers.

The structure of a nest in natural site is obviously more difficult to study. For the sake of comparison, one was taken which was located on the edge of a brick walk. The walk was separated from the grass-plat by a line of bricks set on edge. Several of these and the adjoining flat bricks were removed, thus quite exposing the fomicary to the depth in parts of four inches. The side of the grass-plat against which the bricks had pressed was pierced by many openings, one-quarter of an inch or more in diameter, leading for the most part directly into ovoid chambers whose longest diameters were from three-fourths of an inch to one inch in length. One of the largest of these was close to the surface just beneath the grass roots, and was filled with naked larvæ of worker ants, most of which were white, a few yellow. These chambers had interior openings extending into the earth. They were united together by galleries, where their boundaries did not interblend. There was an opening directly upward into the grass, but the main avenue for the carriage of excavated earth led downward to the lower edge of the brick, then diagonally upward through the earthen seam of that and the next brick, debouching at the surface and upon the pavement. Openings downward communicated with this avenue, as did also a broad (three-eighths inch) winding track, which followed the under surface of the brick its entire length, and beyond. These avenues presented the characteristics of those in the artificial nest, but were larger and not so numerous. The large larvæ of several queens were found in the lower avenues.

The behavior of the ants placed in jar No. 3 was like that of those in No. 2, *i. e*, the fighting soon ceased, and the work of gallery digging began. Here, also, it could not be determined whether the survivors were of one party or of both, but the latter was inferred in view of the experiment which showed the interblending of the harmonized hostiles of No. 1 with the survivors of No. 2. The galleries here were not made against the surface of the glass as in No. 2, but were confined apparently to the interior of the earth, which they must have quite honey-combed, as shown by the quantity of pellets brought up, and by the numerous openings upon the surface.

In this connection Mr. McCook referred to the economy in nature of ants by contributing to the fertilization of the earth. A comparison between the formicaries of various species shows that all the mason ants substantially agree in (at least) subterraneous nidification. The example presented of the underground work of *Tetramorium* will give some idea of the manner in which the earth may be excavated by a single colony. In a portion of the exposed surface, which presented less rather than more of the average amount of excavation, the gallery surface was measured. In a space of three square inches there were (approximately) one and nine-sixteenths square inches of gallery surface, or about one-half of the measured space. The galleries were in depth fully one-eighth of an inch. This will give a rude notion of the extent to which the underground space occupied by a single colony is excavated.

Another estimate was made of the quantity of earth thrown out of a nest in the two days succeeding a heavy rain. The excavations brought up from the seam of a brick that faced a grass plat, and which were spread along a distance of eight inches, were collected and measured. The result showed a solid contents of six cubic inches. This was only a part of the work of a formicary in the time specified, during only a part of which the ants were engaged in transporting pellets.

The other factor in the calculation is the number of ants of various species spread over any given surface of the earth. Accuracy of count would be quite impossible; but if one will take pains to observe the number of nests which may be seen in nearly every open tract of country, he will be surprised at its vastness. In some such rough observations, made in the open field, Mr. McCook had concluded that it would be scarcely possible to dig within any square foot of surface without uncovering the formicary of some, often of several, species of ants. There is of course a difference in this respect between soils and sections; but the fact is constant that innumerable myriads of ants are everywhere located and operating as above described. As results of such labor, *first*, the ground is pulverized and brought in great quantities to the surface, thus making good top soil for the growth of vegetation. The nest by which these remarks were illustrated shows that, insignificant in size as these insects are, the labors of countless hosts through many years are by no means insignificant in this shifting of the soil. *Second*, the aëration of the soil, so needful for its productiveness, is thus largely promoted. *Third*, the system of "pores," established by the galleries which everywhere perforate the ground, affords, on the one hand, free entrace for the rains into the earth, and, on the other hand, a series of tubes through which, by capillary attraction, the moisture may ascend to the roots of plants. In this geographical province (Philadelphia) perhaps the most numerous species, and therefore the most effective toward the above results, are *T. cæspitum* and *Lasius flavus*, both small species, the largest workers being little more than one-eighth of an inch in length.

The fate of the ants during the late heavy June rains had somewhat occupied Mr. McCook's attention. Where do the little creatures find refuge? or do they find any sheltered spot within their nest? It would seem that the health and safety of the larvæ at least must require some protection from the water. But he could not satisfy himself that *Tetramorium* has any such shelters. The pellets of soil brought up after the rains were all damp, and had evidently been reached by the water. The opened formicary above referred to showed that it had been penetrated, as far as examined, by the water, as the soil was thoroughly soaked through. The numerous galleries must give more ready access to the rains within formicary bounds than elsewhere. The points are of much interest, and are still under examination, but the following suggestions were made: First, the peculiar arrangement of the galleries and chambers indicates that the least exposed portion of the nest is that near the surface, in the parts which do not communicate directly with the same. The main entrance and exit being removed from this, and penetrating downward and beneath it, would cause a drainage which, carrying off the first flood, would leave the upper chambers comparatively safe until the water should fill up the lower spaces and back up to the surface rooms. Second, it is probable that the galleries which penetrate downwards may serve the purpose of drainage downward. In heavy rains, however, neither of the above arrangements would seem to afford ample protection. Third, it is therefore probable, and observation and some experiments[1] appear to point in this direction, that the ants themselves (if not the larvæ) can endure a submersion more or less prolonged with comparative safety.

Honey Glands on Catalpa Leaves.—Mr. J. A. RYDER stated at the meeting of the Botanical Section that he had recently observed the presence of a number of large nectar-secreting glands on the under side of the leaves of the common *Catalpa bignonioides.* These glands are situated in the axils of the veins of the leaf, *i. e.*, where the lateral veins join the midrib. Those nearest the insertion of the petiole are largest, whilst toward the apex of the leaf they are smaller. The glandular areas, extending over a considerable axillary space as well as to some extent over the sides of the veins, are without hairs, the place of the latter being taken by large biscuit-shaped, sub-circular glandular bodies attached to the surface of the leaf much like a button to a piece of cloth, and projecting above the circumjacent epidermis, though at the point where the gland is attached the epidermis is depressed. The appearance is not much unlike that of the circumvallate papillæ of the base of the human tongue. The glands seemed to be modified hairs, and in thin vertical sections are seen to be composed of columnar cells arranged around a cavity. The nectar observed in a few instances was perceptibly sweet to the taste, and thrown out in sufficient quantity to be seen as small clear drops in the axils of the veins. Ants of both red and black species were seen feeding upon this sweet liquid with great avidity.

[1] See a brief paper on the Vital Power of Insects, Proc. Acad. Nat. Sci. of Phila., 1877, p. 134.

June 17.

The President, Dr. Ruschenberger, in the chair.

Twenty-eight persons present.

The death of Wm. Adamson, a member, was announced.

On Rhizopods occurring in Sphagnum.—As an instance of the abundance of Rhizopods frequently found together in Sphagnum, Prof. Leidy stated that he had recently collected some from a cedar swamp near Malaga, Gloucester County, N. J., and in the water and sediment expressed from a small bunch, he had observed the following forms:—

1. *Difflugia pyriformis.* Var. *a.* with shell of coarse sand; var. *b.* with shell of chitinoid membrane with incorporated diatomes and sand. Occasional.
2. *D. acuminata.* Var. with shell of chitinoid membrane incorporated with variable proportions of diatomes and sand. Occasional.
3. *D. constricta.* Syn. *D. cassis.* Several varieties. Frequent.
4. *D. arcula.* Shell hemispherical, of yellowish chitinoid membrane, with incorporated sand; mouth trilobate. Occasional.
5. *D. globulosa.* Small forms. Frequent.
6. *D. spiralis.* Rare.
7. *Nebela collaris.* Syn. *N. numata.* Of many varieties, of different sizes and proportions. Some in the structure of the shell related with *Difflugia.* Abundant.
8. *N. flabellulum.* Few.
9. *N. barbata.* Occasional.
10. *N. ansata.* Occasional.
11. *N. carinata.* Rare.
12. *N. caudata.* Rare.
13. N. retorta, n. s. A single active living specimen. Shell retort form, nearly like that of *Cyphoderia ampulla*, but laterally compressed, and having the structure as in *N. collaris.* Length 0.144 mm., greater breadth 0.072; lesser breadth 0.036; breadth of mouth 0.027 mm.
14 *Arcella vulgaris.* Few.
15. *A. discoides.* Frequent.
16. *A. mitrata.* Rare.
17. *Heleopera picta.* Occasional.
18. *H. petricola.* Less frequent than the former, but more so than previously observed. Shell incorporated with variable proportions of sand.
19. *Quadrula symmetrica.* Occasional.

20. *Centropyxis aculeata.* Occasional.
21. *C. ecornis.* Frequent.
22. *Hyalosphenia papilio.* Not so abundant as usual.
23. *H. elegans.* Not so abundant as usual.
24. *Euglypha ciliata.* Frequent. Small ones and some of the larger ones hairless.
25. *E. cristata.* Frequent.
26. *E. brachiata.* Occasional.
27. *E. mucronata.* Occasional. Several without the mucro.
28. *Assulina seminulum.* Syn. *Euglypha brunnea; E. tincta.* Frequent.
29. *Sphenoderia lenta.* Syn. *Euglypha globosa.* Frequent.
30. S. MACROLEPIS, n. s. First observed. Small, compressed pyriform, with broad neck. Body on the broader surfaces with a single pair of wide hexagonal plates. Length 0.036 mm.; breadth 0.024 mm. Frequent.
31. *Cyphoderia ampulla.* Syn. *C. margaritacea.* Rare.
32. *Trinema enchelys.* Numerous and of much variety. Several of a brown color, as in *Arcella.*
33. *Placocista spinosa.* Syn. *Euglypha spinosa.* Rare.
34. *Pseudodifflugia gracilis.* Syn. *Pleurophrys sphaerica.* Oval form. Occasional.
35. *Clathrulina elegans.* Detached and dead, or in an encysted condition. Few.
36. *Hyalolampe fenestrata.* Few
37. *Acanthocystis* ———? Colorless, and with simple, delicate unforked spines. Few.
38. *Amphizonella violacea?* A single individual.
39. *Amoeba radiosa.* Rare.
40. *Amoeba* ———? Young of *A. proteus.* Rare.

With the foregoing there were associated many desmids, diatoms, rotifers, anguillulas, etc.

JUNE 24.

The President, Dr. RUSCHENBERGER, in the chair.

Seventeen members present.

Note on Lonas inodora.—Mr. THOMAS MEEHAN exhibited specimens of this Mediterranean plant, an escape from a garden, found growing wild in a swamp in association with *Iris versicolor*, *Onoclea sensibilis*, and other moisture-loving plants. They had made a growth of near two feet long, and the heads of flowers in all cases had ray florets, with the ligulate portions an inch in length. In garden culture the heads were nearly discoid, the ray petals being almost obsolete, and in De Candolle's description the discoid heads are given as a generic character.

Mr. Meehan also referred to the well known relationship between *Compositæ* and *Umbelliferæ*, and noted the presence of vittæ in the akenes of this plant as a point of agreement between the two orders, uncommon in those of the Composite family.

The Larva of Eurypauropus spinosus.—Mr. J. A. Ryder announced that, in a vial in which he had kept four living specimens of this animal for two months past, he had found a single specimen of its very minute hexagonal larva about one-hundredth of an inch long. It had three segments, and a very rudimentary fourth one, and was of a pale reddish or lilac color; exceedingly compressed, more so relatively than the adults, and with the antennæ bifurcate as in the latter. The specimen in life was almost as wide as long. Remains of the shells of ova were also found in a crevice in the same piece of decayed wood upon which the larva was found, and the adults were seen to get into the same crevice and remain for a day at a time, so that it is fair to infer that they are probably the parents of the larva in question. The finding of this larva places the validity of the species beyond question, and also renders it quite certain that six segments is the normal number in the adult. The ease with which these animals bear confinement for a protracted period gives promise that still other specimens of larvæ may be looked for in the same vial in the course of the season.

Wm. P. Foulke was elected a member.

July 1.

The President, Dr. Ruschenberger, in the chair.

Twenty members present.

A paper entitled "On the Genera of Felidæ and Canidæ," by Edw. D. Cope, was presented for publication.

The death of Thomas S. Root, a member, was announced.

July 8.

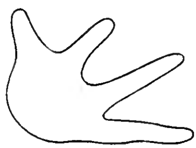
The President, Dr. Ruschenberger, in the chair.

Twenty-five members present.

Fossil Foot Tracks of the Anthracite Coal Measures.—Prof. Leidy read a letter from Mr. W. Lorenz, Chief Engineer of the Philadelphia and Reading Railroad Co., referring to the fossil specimen presented this evening by Mr. Wm. D. H. Mason, of

Williamstown, Pa. The specimen is a mass of coal shale, with foot prints, and was discovered by the donor at the Ellangowan Colliery, in strata between the Primrose and Mammoth veins, in the Mahanoy coal field. Mr. Lorenz remarks that it is of especial interest, as the first specimen of the kind found in the Anthracite coal field. The *Sauropus primævus* of Lea, of which the original specimen is preserved in our museum, was discovered in the umbral red shale, near Pottsville, belonging to the subcarboniferous series.

The specimen before us is an irregular slab, upwards of a foot long and less than half the breadth. The upper surface is obscurely ripple marked longitudinally, and is crossed in a slant by seven tracks, which are in pairs, except one in advance on the right. Three only are complete, the others being imperfect. The four tracks on the right occupy a line of six inches, and are about an inch and a half apart from those on the left. The tracks appear to be single, that is to say, not produced by fore and hind feet together, and no distinction can be detected between impressions of these. The more perfect impressions exhibit four widely divergent toes, successively increasing in length from within outwardly, excepting that the fourth toe is slightly shorter than the third. A feeble rounded impression of a sole is visible behind the toes. The expanse of the tracks is about an inch. The accompanying outline will give an idea of their form, though the sole comparatively with the toes is not so distinctly defined. The intervals of the toes appear not to be webbed, or at most are only feebly so.



The impressions are probably those of an amphibian, and perhaps pertained to some salamandroid animal.

As it is customary to refer to fossil foot tracks, as representing the animals by which they were made, under distinct names, it would be proper to designate the present specimen in the same way. In accordance with its discovery in the Anthracite coal field, and from the colliery in which the specimen was found, Mr. Lorenz suggests that it should be called the ANTHRACOPUS ELLANGOWENSIS.

On Sex in Castanea Americana.—Mr. THOMAS MEEHAN referred to the flowers of the common chestnut, *Castanea Americana*, and pointed out that the flowers were the products of axillary buds, which, in young trees, would have borne branches. These spikes of male flowers fell off by an articulation in the axils of the leaves soon after the flowers were mature, and it was remarkable that in young trees that had not arrived at bearing condition, the buds also fell by an articulation before developing the axillary branchlet. Sometimes the leaves would be considerably advanced before the disarticulation occurred. Chestnut branches several years old would be found full of these scars where the buds had been; but never would be found a perfect dormant bud, except at the termination of a branch, after the branch was one year old. There seemed to be whole classes of trees with distinct peculiarities in this respect. Leguminosæ would preserve dormant buds for an indefinite number of years. In *Gymnocladus*, the Kentucky coffee tree, the axillary bud of the one year branch could be found twenty years afterwards just beneath the bark, in the position it first occupied, having in all that time grown just enough as the tree grew to keep just beneath the surface. The same is true of magnolias. In some, young branchlets came from the axillary buds the spring following their formation, and continued an existence as weak branchlets for a few years until starved out by the stronger ones, but when they reached a flowering condition the whole axillary bud died out with the effort of producing flowers. This was well illustrated by some maples. There was a third class which produced flowers and also an axillary bud, and these continued always through life twiggy branching trees, depending also on ultimate starvation of the branchlets to keep the supply of main branches within bounds. Birches are good examples of this class. The chestnut seems to be the only tree which takes the matter in hand in time, and keeps down a superabundance of branchlets by a disarticulation of the buds themselves, though in arbor vitæs, deciduous cypress, and some others, there is a disarticulation of superabundant branches after they are a year or so old, in this way keeping finally but a few main branches to preserve the form and permit of the functions of the head of the tree.

In the growing branch of the flowering chestnut tree the first four or five axillary buds, instead of a branch or futile buds for next spring, produce at once spikes of male flowers. Often the two upper axillary buds remain till next spring, to run the chance of being thrown off as a bud, or perchance to make a weak branchlet. After these buds have been formed, a subsidiary second growth is formed, and from this renewed growth another crop of male flowers, at the base of which, if at all, two or three clusters of female flowers appear. The first crop of wholly male flowers disappears without apparently being of any service whatever in reproduction. It is an enormous waste of energy if the fertilization of flowers be the sole end of production. In each spike there were about fifty clusters, and at least five flowers in each cluster, and there were about five of these precocious spikes to each branch that might in the end bear two or three female flowers, or, in round numbers, over one thousand male flowers to one female, and when we remember that half the branches produce only the precocious male flowers, there would be two thousand males to one female, even under the best circumstances; but, as already noted, the whole mass of flowers which give so much charm to a chestnut tree fall off without any influence whatever on the fruit production of any trees in the vicinity, as the female flowers are not in bloom till these showy early ones have fallen, and depend on the second crop of male flowers for fertilization.

For what purpose is this immense mass of bloom with its resultant pollen created? Mr. Meehan believed that modern teleology based on the selfish idea that acts of each individual are solely for its own good, or the good of its immediate descendants, was wrong. The animal world, in the shape of insects perhaps, or in any other way, could be no more said to be created for the vegetable, as fertilizers of flowers, than were plants for them. It is a popular saying, that mouths were not created before something was prepared to put into them; and scientifically this might be reduced to the proposition, that plants may be made to behave and to produce, for ends having no relation whatever to their own individual wants, but that all things might be made to work together in harmony for some universal good.

Mr. Redfield asked whether it might not be that chestnut woods in more southern latitudes, and with female flowers more advanced, could receive the pollen from the precocious flowers of these northern trees; and, in view of the accidents liable to such a distant transmission by the winds, nature provided this immense superabundance to make the cross-fertilization more certain?

Mr. Meehan replied that he could not say; but if an answer to his questions were to be met by any of the prevailing theories on the necessities or utilities of cross-fertilization, he would like to ask what was the use of odor in the event of Mr. Redfield's question being answered affirmatively? The male flowers of the sweet chestnut were remarkably odoriferous. A fair sized bunch in a room would give fragrance to a whole house. Where would be the use of adding this powerful odor to flowers in mere arrangements for cross-fertilization by the aid of winds?

The following paper was ordered to be printed:—

ON THE GENERA OF FELIDÆ AND CANIDÆ.

BY E. D. COPE.

FELIDÆ.

The discovery of extinct species from time to time, renders it necessary to re-examine the definitions of the families and genera into which living forms naturally fall. We thus learn the characters of their primitive types, and the successive steps through which they passed in attaining their present characteristics. The *Felidæ* are known as that family of *Carnivora* in which the feet and teeth are most specialized for the functions of seizing and lacerating living prey. The number of living species enumerated by Dr. Gray is sixty-four, which he throws into a number of genera. The extinct species yet known are less numerous, but they present a greater variety of structure than the former. Two types or series may be recognized among the genera, namely those represented by the genera *Felis* and *Machærodus* respectively. All of the latter are extinct.

The greater number of the genera allied to *Macahrodus* are distinguished by the great development of the superior canine teeth, whose crowns are generally compressed and trenchant. The corresponding part of the mandible is expanded downwards so as to furnish a protection to the slender crown from fracture by lateral blows when not in use, but in some of the genera, *e. g. Nimravus*, this flange is not developed The only definition which can be used to distinguish these sections of the family, is found in the angular separation of the anterior and lateral planes of the ramus of the mandible, and this character cannot be expected to remain unaffected by future discovery. Forms will doubtless be found in which the angle is obsolete, and in which the lateral and anterior faces pass gradually into each other. Other characters which distinguish the extinct genera are found in the numbers of molar teeth, and, what has been heretofore neglected, the number of lobes of the molars themselves.

As regards the existing genera, Dr. Gray[1] has brought out their

[1] Catalogue of Carnivorous, Pachydermatous, and Edentate Mammalia in the British Museum. By John Edward Gray, F.R.S., V.P.Z.S., F.L.S., etc. London, 1869.

characters more fully than any other author. He points out the fact that in some of the species the orbits are closed behind, and in others open. He first examined into the manner of the contraction and closing of the pupil in the presence of light, and pointed out the fact that in the large cats it is always round and approximates a point in closing, while in the smaller forms the pupil closes as a vertical slit. He shows that the cats of the former group have the smaller orbits of the cranium, and the latter the larger. Dr. Gray, however, uses other characteristics in the discrimination of the genera, which are, in my estimation, quite inadmissible; as the relative length of the muzzle and of the premaxillary bones; also of the hair on different parts of the body and tail. Such features of proportion are essential as characters of species, but not of genera. In accordance with these views, I have united several of Dr. Gray's divisions into groups, which I call genera, and which repose on some definite structural characters. Thus I combine his *Uncia*, *Tigris*, *Leo* and *Leopardus* into a genus for which I employ his name *Uncia*, as the least objectionable,[1] after having confirmed by autopsy the circular character of the pupil. This I was enabled to do through the courtesy of my friend Arthur E. Brown, Superintendent of the Philadelphia Zoological Garden, who aided me in examining the eyes of these animals both by sunlight and the light of a bull's-eye lantern.[2] The detailed characters of the genera will now be given:—

I. The anterior and lateral faces of the mandible separated by an angle.

a. Inferior sectorial with a heel; no anterior lobe of superior sectorial; no posterior lobes of the premolars.

* An inferior tubercular molar.

Premolars $\frac{2}{3}$. *Dinictis*.

Premolars $\frac{2}{2}$. *Nimravus*.

[1] I assume that this name is derived from *uncus*, a hook, which is appropriate to the weapons of these animals.

[2] I add the following notes on some other *Carnivora*, which do not come within the scope of this paper:—

Hyæna crocuta. Pupils a vertical slit.

Viverridæ. Three species of *Ichneumon* and *viverricula*, a horizontal oval.

Nasua. A horizontal oval.

** No inferior tubercular molar.

Premolars $\frac{2}{2}$; incisors $\frac{3}{3}$. *Hoplophoneus.*

Premolars $\frac{}{1}$; incisors $\frac{}{2}$. *Eusmilus.*

aa. Inferior sectorial without heel; an anterior lobe of the superior sectorial, and posterior lobes of the premolars.

Premolars $\frac{2}{2}$, first inferior two rooted. *Machærodus.*

Premolars $\frac{2}{2 \text{ or } 1}$; first inferior one rooted. *Smilodon.*

II. The anterior and lateral faces of the mandible continuous, convex. (No inferior tubercular molar.)

a. Inferior sectorial tooth with a heel.

Premolars $\frac{2}{4}$, no posterior lobes; second superior with internal heel (plantigrade). *Cryptoprocta.*

Premolars $\frac{2}{4}$ with posterior lobes; no heel of second superior. *Pseudælurus.*

aa. Inferior sectorial without heel; premolars with posterior lobes; superior sectorial with anterior lobe.

β. Superior sectorial with internal heel.

γ. Pupil round.

Premolars $\frac{2}{2}$. *Uncia.*

Premolars $\frac{1}{2}$. *Neofelis.*

γγ. Pupil vertical.

Orbit closed behind; premolars $\frac{2}{2}$. *Catolynx.*

Orbit open; premolars $\frac{2}{2}$. *Felis.*

Orbit open; premolars $\frac{1}{2}$. *Lyncus.*

ββ. Superior sectorial without internal heel.

Pupil round, premolars $\frac{2}{2}$; orbit open posteriorly. *Cynælurus.*

The following catalogue includes the species of the *Felidæ*, the names of the recent ones being derived from Gray's Catalogue, and printed in Roman letters. These are probably too numerous in the genera *Felis* and *Lyncus*, but I do not possess the means of properly disposing of them.

Dinictis, Leidy. *Aelurogale*, Filhol. ?*Daptophilus*, Cope.

D. intermedia, Filhol. Phosphorites, France.

D. squalidens, Cope. White River, Colorado.

D. felina, Leidy. White River, Nebraska.

D. cyclops, Cope. White River, Oregon.

Nimravus, Cope.

N. brachyops, Cope. White River, Oregon.

Hoplophoneus, Cope.

H. primævus, Leidy. White River, Nebraska.
H. occidentalis, Leidy. White River, Nebraska.

Eusmilus, Gervais.

E. bidentatus, Filhol. Phosphorites, France.

Machærodus, Kaup. *Agnotherium*, Kaup. *Drepanodon*, Nesti.

M. palmidens, Blv. Falunian Sansan.
M. ogygius, Kaup. Oeningian, Epplesheim.
M. antiquus, Nesti. Pliocene, Italy, France.
M. falconeri, Pomel. Upper Miocene, India.
M. cultridens, Cuv. Pliocene, Europe.
M. latidens, Ourn. Pliocene, England.
M. aphanista, Kaup. Oeningian, Epplesheim.
M. maritimus, Gerv. Pliocene, Montpellier.

Smilodon, Lund.

S. neogæus, Lund. Pliocene, Brazil.
S. necator, Gervais, Buenos Ayres.

Cryptoprocta, Bennett.

C. ferox, Bennett. Madagascar.

Pseudælurus, Gervais.

P. hyænoides, Lartet. Falunian Sansan.
P. intrepidus, Leidy. Loup River, Nebraska.
P. edwardsi, Filhol. Phosphorites, France.
P. ? intermedius, Filhol. Phosphorites, France.
P. sivalensis, Lydekker.

Catolynx, Gray. *Viverriceps*, Gray.

C. marmoratus, Martin. India, Borneo.
C. charltoni, Gray. Nepal, Darjeeling (Charlton).
C. viverrina, Bennett. East Indies.
C. planiceps, Vig. and Horsf. Malacca, Sumatra, Borneo.
C. ellioti, Gray. Madras.
C. rubiginosa, I. Geoff. India, Madras.

Felis, Linn. *Pardalina*, *Felis*, and *Chaus*, Gray.

F. pardalis, L. America, tropical or subtropical.
F. grisea, Gray. Gautemala.
F. melanura, Ball. America.
F. picta, Gray. Central America.
F. pardoides, Gray. Tropical America.

F. macroura, Pr. Max. de Wied. Brazil.
F. mitis, F. Cuv. Mexico.? Paraguay.?
F. tigrina, Schreb. South America.
F. geoffroyi, D'Orb. South America.
F. colocolla, Molina, South America, Chili (Molina), Surinam (H. Smith).
F. jaguarondi, Lacép. South America.
F. eyra, Desm. Tropical America.
F. serval, Schreb. South and West Africa.
F. rutila, Waterhouse, Sierra Leone.
F. neglecta, Gray. Gambia.
F. servalina, Ogilby. Sierra Leone.
F. celidogaster, Temm. Guinea.
F. senegalensis, Lesson. Senegal.
F minuta (pars.), Temm. Sumatra.
F. javanensis, Horsf. Java.
F. nepalensis, Vig. and Horsf. India (perhaps a hybrid or domesticated).
F. chinensis, Gray. China.
F. pardinoides, Gray. India (Capt. Junes.)
F. pardochroa, Hodgson. Nepal (Hodgson). Tenasserim (Packman).
F. tenasserimensis, Gray. India, Tenasserim (Packman).
F. jerdoni, Blyth. Indian Peninsula, Madras.
F. herscheli, Gray. India, "Zanzibar."?
F. wagati, Elliot. India.
F. caligata, Temm. Africa, North, South, Central, and East.
F. inconspicua, Gray. India (domesticated or perhaps a variety).
F. domestica, Brisson. Syria.? Domesticated in most countries.
F. manul, Pallas. Thibet.
F. catus, L. Europe.
F. megalotis, Müller. Timar.
F. himalayanus, Gray. Himalaya (Cross, Warwick).
F. jacquemonti, J. Geoffr. Africa and Asia.
F. ornata, Gray. India (Capt. Boys).
F. catolynx, Pallas. Nepal (Hodgson).

Lyncus, Raf. *Pajeros*, *Lynx* et *Caracal*, Gray.

L. pajeros, Desm. South America. The Pampas.
L. borealis, Gray. Northern Europe, Sweden.
L. canadensis, Geoffr. North America.
L. pardinus, Temm. Southern Europe, Turkey.
L. isabellinus, Blyth. Thibet.
L. rufus, Güldenst. North America.
L. maculatus, Vig. and Horsf. North America, Mexico, and California.
L. caracal, Schreb. Southern Asia and Africa, Persia and Arabia.

Neofelis, Gray.

N. macrocelis, Temm. Himalaya (Hodgson), Malacca.
N. brachyurus (Temm), Siam. Swinhoe, Formosa (Swinhoe).

Uncia, Gray, Cope emend. *Leo*, *Tigris* et *Leopardus*, Gray.

U. concolor, L. North and South America.
U. auratus, Temm. Himalaya, Sumatra, Borneo.
U. onca, L. South America, Mexico, Texas.
U. chinensis, Gray. Pekin, mountain forests of the west.
U. japonensis, Gray. Japan.
U. pardus, L. Southern Asia, North, South, and West Africa.
U. tigris, L. Asia.
U. leo, L. Africa, India.
U. irbis. Thibet.

Cynælurus, Wagler. *Guepardа*, Gray.

C. jubatus, L. Africa, Asia, Persia, Cape of Good Hope.
? *C. ferox*, Leidy (*Aelurodon*). Loup River, Nebraska.

The successive order of the modifications of structure which define the above genera is not difficult to perceive, and it is interesting to discover that, as in other cases, it coincides with the succession in geologic time. The typical genera *Uncia*, *Felis*, etc., are characterized by great specialization, and it is they which now exist. The oldest found *Dinictis*, *Nimravus*, etc., are the least specialized in most respects, and they disappeared before the close of Miocene time.

Since one of the special characters of the *Felidæ* is the reduction in the number of the molar teeth by subtraction from both ends of the series, an increased number of these constitutes resemblance to other families. The genus *Dinictis*, above defined, has been shown by Leidy to possess two more inferior molars than *Felis*, or three more than *Neofelis* and *Lynx*, as in the *Mustelidæ*. The extinct *Pseudælurus* and the living *Cryptoprocta* have but one less molar than *Dinictis*, lacking the posterior tubercular. *Nimravus* has the same number of molars as *Pseudælurus*, but lacks the first premolar instead of the last true molar. In *Hoplophoneus* we first find the number of molars as in the existing genera, viz., Pm. $\frac{3}{2}$ m. $\frac{1}{1}$. Other characters of this genus are, however, of a generalized kind.

I here recall the statement that the genera of *Felidæ* fall into two series, which are distinguished by the forms of the anterior part of the mandibular rami, and generally by the large size of the canine teeth to which the former are adapted. This distinction appeared early in Miocene, or Oligocene time, in fact in the oldest of the cats of which we have any knowledge. The genera with large canines or Machærodontine line were then represented by *Dinictis*, and the Feline line by *Pseudælurus*. It is interesting to observe that these genera differed from their latest prototypes in the same way, viz.: (1) in the presence of more numerous inferior molars; (2) in the presence of a heel of the inferior sectorial; (3) in the absence of an anterior cusp of the superior sectorial. In the case of *Dinictis* one other character of primitive carnivora may be noticed, viz.: the absence of the cutting lobes on the posterior edges of the superior and inferior premolars, so distinct in the existing cats. The same feature characterizes the superior premolars of *Pseudælurus*, but the inferior premolars have the lobes. In the existing *Cryptoprocta*, which Gervais has shown to be nearly allied in dentition to *Pseudælurus*, the lobes are wanting from both jaws, but this genus adds to this primitive character another of modern significance, viz., the presence of the anterior cusp of the superior sectorial. Moreover *Cryptoprocta* has another peculiarity which recalls the genera of the Eocene *Creodonta*, in the well-developed interior tubercle of the third premolar, a character unknown in Miocene or existing *Carnivora*. That genus is evidently, like the *Lemuridæ*, also of Madagascar, a remnant of the Eocene Fauna, which once covered most of the earth, and may be regarded as, on the whole, the most primitive of the *Felidæ*, recent and extinct.

Following the two lines of *Felidæ* already indicated, we attain the same conclusion in both, by the same stages. The primitive form of the Machærodont line represented by *Hoplophoneus* has its extreme in *Eusmilus*, where the second inferior premolar and an incisor tooth are wanting, giving a formula of I. 2, C. 1; Pm. 1; M. 1. In *Machærodus* we have the modern characters of the molars seen in *Felis*, viz., no heel of the inferior sectorial; the superior sectorial with an anterior lobe, and posterior lobes of the premolars. The extreme of this line is reached in *Smilodon*, where the second inferior premolar is one rooted or wanting. This genus then stands related to *Machærodus*, as *Eusmilus* to *Hoplophoneus*. In the Feline line proper, on reaching the existing genera, we have lost the heel of the inferior sectorial and gained the posterior lobes of the premolars and anterior lobe of the superior sectorial at once. A further modification of the dentition of the superior series of the recent forms, is seen in the loss of the first superior premolar in *Lynx* and *Neofelis*. Still another, which is one step beyond what is known in the Machærodont line, is the loss of the interior tubercle of the superior sectorial, which characterizes the genus *Cynælurus*. A superior sectorial tooth having the character of that of this genus was discovered by Dr. Hayden in the Loup River formation of Nebraska, and was referred to a species by Dr. Leidy under the name of *Aelurodon ferox*. It was much larger than the *C. jubatus*.

As already remarked, the genera of the Machærodont line are extinct, and this in spite of the fact that they presented the most perfect weapons of destruction in their canine teeth, from the earliest times. Their other modifications of structure advanced *pari passu* with those of the Feline series, and, among others, the feet presented in the latter forms at least (*e. g.*, *Smilodon necator*, Gew.), the most perfect prehensile power of the lions and tigers of to-day. As nothing but the characters of the canine teeth distinguished these from the typical felines, it is to these that we must look for the cause of their failure to continue. Prof. Flower's suggestion appears to be a good one, viz.: that the length of these teeth became an inconvenience and a hindrance to their possessors. I think there can be no doubt that the huge canines in the Smilodons must have prevented the biting off of flesh from large pieces, so as to greatly interfere with feeding, and to keep the animals in poor condition. The size of the canines is such as to prevent their use as cutting instruments, excepting with the mouth closed, for the latter could not have been opened sufficiently to allow any object to enter it from the front. Even were it opened so far as to allow the mandible to pass behind the apices of the canines, there would appear to be some risk of the latter's becoming caught on the point of one or the other canine, and forced to remain open, causing early starvation. Such may have been the fate of the fine individual of the *S. neogaeus*, Lund, whose skull was found in Brazil by Lund, and which is familiar to us through the figures of Dr. Blainville, etc.

Description of New Species.

Dinictis cyclops.

The species of *Dinictis* differ in the proportions of their anterior molar and canine teeth as follows:—

First inferior molar one rooted; first superior molar two rooted; superior canine short, robust; large. *D. intermedia.*[1]

First inferior molar one rooted; superior canine compressed; two inferior incisors. *D. squalidens.*

First inferior molar two rooted; first superior molar one rooted; canine long, compressed. *D. cyclops.*

First molar of both jaws two rooted; canine long, compressed. *D. felina.*

In the *D. cyclops* the first superior molar is rudimental, and will probably be found to be wanting in some specimens. The second premolar has a distinct anterior tubercle on the inner side, a character not seen in *D. felina;* the anterior angle of the superior sectorial is more produced than in that species. The crown of the superior tubercular looks partly inwards, is rather long, and has three roots. The superior canine is quite long, and has a regularly lenticular section, without facets. Its anterior and posterior edges are denticulate. The external incisors are much larger than the internal, and have subconic crowns. The crowns of the others are subcuneiform. The inferior canines are considerably larger than the incisors. The latter are regular, and do not overlap each other. The second and third inferior premolars have well-developed basal lobes anteriorly and posteriorly. The

[1] *Aelurogale intermedia*, Filhol.

heel of the sectorial is well developed. The tubercular is very small.

The form of the skull is short and wide; the zygomata are much expanded, and the profile is very convex. The muzzle is short, and the orbits are rather large. The interorbital region is wide and convex, and the postorbital processes are robust, acuminate, and directed downwards. The infra-orbital foramen is very large. The apices of the premaxillary bones are elongate, but do not reach the frontals. The nasals are rounded posteriorly. The sagittal crest is prominent, and the inion elevated. The posttympanic process is short, and the paroccipital is short and is directed backwards. The cranium is constricted behind the orbits. The mandibular ramus is low posteriorly, and the anterior inferior flange is well-developed, but not large.

Measurements.	M.
Length of skull on base	.140
Width of skull, measured below	.111
Length of palate	.060
Width of palate between posterior angles of sectorials	.062
Width of palate between canines	.026
Length of skull to front of orbits (axial)	.050
Vertical diameter of orbit	.031
Interorbital width (least)	.045
Elevation of inion from foramen	.032
Length of inferior molar series	.050
Length of inferior sectorial	.018
Length of base of inferior first premolar	.055
Depth of ramus at sectorial	.016
Depth of ramus at first premolar	.021
Depth of ramus at flange	.026

From the Truckee beds of John Day River, Oregon.

CANIDÆ.

The range of variation presented by the species of *Canidæ* includes several generic divisions, recent and extinct. These genera are, however, as closely intergraded as are those of the cats, and their definite characters are subject to occasional failure from abnormal variations. These are, however, not so frequent as to invalidate the classification to which they form the exceptions.

The *Canidæ* appeared in the Upper Eocene period, and the genus *Canis* was well represented by species in the lowest Miocene in Europe and the United States. The other genera are represented by fewer species, and many of them are extinct. The foxes (*Vulpes*) are the most numerous of them, and but few extinct species of them are known. America presents us with the greatest variety of genera, as *Enhydrocyon*, *Temnocyon*, and *Palæocyon* extinct, and *Icticyon*, extinct and recent. *Speothus*, extinct in America, still exists in Asia.

The most complete catalogue of the species *Canidæ* is that of Dr. Gray. In his work the author brings together observations of various naturalists, and adds a number of his own. He admits a large number of generic divisions, but many of these, like those of his *Felidæ*, are simply founded on specific characters. A few good genera, however, exist, and a synopsis of their characters is given below. The genus *Megalotis* is here excluded from the *Canidæ* on account of the unspecialized character of the superior sectorial tooth, as is done by Dr. Gray:—

I. True molars $\frac{3}{3}$.
Premolars $\frac{4}{4}$; inferior sectorial with internal tubercle. *Amphicyon.*

II. True molars $\frac{2}{4}$.
Premolars $\frac{4}{4}$; inferior sectorial with internal tubercle. *Thous.*

III. True molars $\frac{2}{3}$.
α. Premolars $\frac{4}{4}$.
β. Inferior sectorial without internal tubercle.
Heel of sectorial cutting. *Palæocyon.*
ββ. Inferior sectorial with internal tubercle.
γ. Four toes in the manus;
A sagittal crest. *Lycaon.*
γγ. Five toes in the manus.
δ. Heel of sectorial simply cutting.
A median sagittal crest (? toes). *Temnocyon.*
δδ. Heel of sectorial concave, with raised borders.
Pupil round; temporal fossa with simple superior border. *Canis.*

Pupil erect; temporal fossa with simple superior border. *Vulpes.*

Pupil erect; temporal fossa bounded above by a rib-like crest. *Urocyon.*

aa. Premolars $\frac{3}{3}$.

Inferior sectorial with internal tubercle and cutting heel. *Enhydrocyon.*

Inferior sectorial with internal tubercle, and wide tubercular heel. *Tomarctus.*

IV. True molars $\frac{2}{2}$.

a. Premolars $\frac{4}{4}$.

Inferior sectorial with internal tubercle. *Speothus.*

Inferior sectorial without internal tubercle (superior molar sometimes one). *Synagodus.*

aa. Premolars $\frac{3}{3}$.

Inferior sectorial without internal tubercle (incisors caducous). *Dysodus.*

V. True molars $\frac{1}{2}$.

Premolars $\frac{4}{4}$; inferior sectorial with internal tubercle. *Icticyon.*

It is discoverable that the series represented by the above genera is a part of the greater line of the digitigrade *Carnivora*, embracing the greater part of it which is less specialized than, or inferior to, the part covered by the *Hyænidæ* and *Felidæ*. Without entering into the relations of the *Canidæ* with the civets and *Mustelidæ*, it may be remarked that the genera display a successive reduction in the number of premolars and molars from the more ancient to modern geologic times. It is interesting to note that the genera presenting the greatest reduction in all respects, *Synagodus* and *Dysodus*, are now only known in a domesticated condition. Another reduction is seen in the number of tubercles of the inferior sectorial.

Amphicyon, Lartet.

This genus is better represented in Europe than in North America, but two species being certainly known from the latter. No recent species.

Thous, Gray, *Dusicyon*, Smith (nomen nudum).

Existing species of South America only.

Palæocyon, Lund.

Extinct species of South America only.

Lycaon, Brooks.

Existing species of Africa, only known as yet.

Temnocyon, Cope, Proceedings Amer. Philosophical Society, 1878, p. 68.

In this genus the heel of the inferior sectorial tooth rises into a single more or less median crest; in *Canis* the corresponding front is basin-shaped, with tubercles on each side. The superior molars of the typical species, *T. altigenis*, are unknown, but those of a new species, described below, do not differ from those of the genus *Canis*. The *Cynodictis crassirostris* of Filhol, from the French Phosphorites, approaches this genus.

Temnocyon coryphæus, sp. nov.

This is the most abundant dog of the Truckee beds of the John Day country. I have identified it heretofore as my *Canis hartshornianus*, but I find on examination of the inferior sectorial tooth that it is a species of *Temnocyon*. This genus was characterized by me on evidence furnished by a mandible of a species which I named *T. altigenis*,[1] which is of considerably larger size than the present one, but which agrees with it in the presence of a cutting edge instead of a basin on the heel of the inferior sectorial. The *C. hartshornianus*, known as yet from few fragments, is intermediate in dimensions between these two.

Several crania, and more or less of the skeleton of the *T. coryphæus*, are present in my collection. A nearly perfect skull displays the following characters: The orbits are entirely anterior to the vertical line dividing the skull into halves, and the muzzle is proportionately shortened. It is also narrowed anteriorly, and its median line above is shallowly grooved. The interorbital region is greatly convex to the supra-orbital region, and is grooved medially. The postorbital processes are mere angles, and are flattened from below. The cranium is much constricted behind the orbits, where its diameter is not greater than the width of the premaxillary incisive border. The sagittal crest is much elevated, and forms a perfectly straight and gradually rising outline to its junction with the incisor. The borders of the latter are very prominent, extending backwards considerably beyond

[1] Proceedings Amer. Philosoph. Soc., 1878, viii. p. 68.

the brain case. The zygoma is rather slender, is elongate, and but little expanded. The otic bullæ are very large; the paroccipital processes are directed backwards, at an angle of 45°, and are rather elongate and acute; they cap the bullæ posteriorly. The lateral occipital crests bound a fossa of the occipital region near the condyles. The occipital surface is directed horizontally backwards above the foramen magnum. This part of it, and its superior portion, are divided by a median keel.

The basioccipital is keeled on the middle line below. The sphenoid is not keeled, and is concave, its borders descending on the inner side of the bullæ. The pterygoid fossa is rather narrow, and the hamular process is short. The posterior border of the palate does not extend anterior to the posterior edges of the last tubercular molar, and its middle portion projects backwards in a triangular process. The palatine fossa for the inferior sectorial is shallow. The superior surface of the postorbital region is roughened.

The *foramen infraorbitale exterius* is rather large, and issues above the anterior border of the sectorial tooth. The *f. incisiva* are short, not extending posterior to the middle of the canines. The *f. palatina* are opposite the posterior border of the sectorial. The *f. lachrymale* is altogether within the orbital border. The *f. opticum* is rather large. This species is peculiar in having the *f. f. spheno-orbitale*, *rotundum*, and *alisphenoidale anterius* united into one large external orifice. The alisphenoid canal is larger in *Canis latrans*, and its posterior foramen small. The *f. ovale* is further removed from the *f. alisphenoidale* than in the coyote, and is exterior to and a little behind the *f. carotideum.*

The nasal bones extend to above the middles of the orbits, and contract gradually to their apex. Their combined anterior border is a regular concave, and the lateral angles at this point are produced outwards and forwards. The posterior apex of the premaxillary bone is separated from the anterior apex of the frontal by a short space. The maxillo-malar suture is deeply notched in front below, and it extends upwards to above the infra-orbital foramen. A very narrow surface of the lachrymal is exposed on the external surface. The pterygoid bone is distinct, and is nearly equally bounded by the sphenoid and palatine on the outer side. The inferior suture of the orbito-sphenoid runs in a groove, which is deepest anteriorly.

The crowns of all the incisor teeth are narrow or compressed, and, though slightly worn, present no indication of notch. As usual, the external ones are much the largest in antero-posterior diameter. The canines have robust fangs and rapidly tapering crowns, which are but little compressed. The first superior premolar is one-rooted, and the crown is simple. The crown of the second is without posterior heel and tubercle, while the third possesses both. The sectorial is relatively short, less so than in *C. latrans*. The blades are low and obtuse as compared with recent species, and the notch separating them is quite open. The anterior external heel is small, and there is no anterior external tubercle. The first tubercular molar is large, and the crown is narrower than that of *C. latrans*. It has an obtuse external cingulum, two external conical cusps, a V-shaped median ridge, and a wide internal cingulum. This crown differs from the corresponding one of *C. latrans* in having conical instead of compressed external cusps, and a simple V-shaped crest within instead of two adjacent cusps. The second tubercular is smaller than in *C. latrans*, and its tubercles are less distinct. There are two outer tubercles, a V-shaped ridge, and an inner cingulum, all very obscure. The enamel of all these teeth is smooth.

Measurements of Cranium.	M.
Length along base of skull, including incisive border and occipital condyle	.160
Length of skull to palatal notch	.075
Length of skull to posterior border of pterygoid bone	.102
Length to front of orbit axially	.046
Width between zygomas (greatest)	.094
Width between orbits (least)	.036
Width at postorbital constriction	.021
Width between bases of canines	.017
Width between bases of second tuberculars	.027
Width between otic bullæ	.009
Width between apices of paroccipitals	.042
Width of foramen magnum	.017
Width of occiput above	.032

Six well-preserved crania of this species are embraced in the collection, and the mandible remains attached to some of them.

One of these exhibits the following characters: there is a well-developed marginal lobe of the posterior cutting edge of the third and fourth premolars as well as a low posterior heel, and a rudiment of an anterior one. The heel of the sectorial is shorter than the remaining part of the tooth, and rises to a cutting edge a little external to the middle line; there is a small tubercle at its interior base. The anterior blade-cusp of the sectorial is much lower than the median, which is conical; the two diverge, diminishing the shear-like character and action of the tooth. The internal cusp is well developed. The first tubercular is of moderate size, and is a longitudinal oval in outline. The crown supports two low tubercles anterior to the middle, of which the external is the larger. The last molar has a single compressed root, and the crown is a longitudinal oval in outline. Its position is on the ascending base of the coronoid ramus, so that the crown is slightly oblique. The masseteric fossa is profound and well defined; its anterior termination is below the middle of the second tubercular tooth. The horizontal ramus is not robust, but is compressed, and rather deep.

Measurements of Mandible.	M.
Length along bases of posterior five molars	.049
Length of base of fourth premolar	.011
Elevation of crown	.008
Length of base of sectorial	.018
Elevation of crown of "	.012
Length of base of first tubercular	.0075
Width " " "	.0050
Length of base of second tubercular	.0050

While the characters of this dog do not separate it widely from the genus *Canis*, many of them are quite different from those presented by the recent species of the genus with which I am acquainted. Thus the union of the foramina spheno-orbitale and rotunda, the anterior position of the orbits, and the postorbital constriction are not seen in the wolf, domestic dog, coyote, jackal, or the North American and European foxes. The size of the brain was evidently less than in those species, and the sectorial teeth quite inferior in the efficiency of their blades. These characters may be considered in connection with the low geological position of the beds in which the species occurs.

From the Truckee beds of the White River formation in Oregon.

Canis, Linn.

The names proposed by Smith, Gray, and others, and which must be regarded as synonyms of *Canis*, are *Lupus*, *Dieba*, *Simenia*, *Chrysocyon*, and *Lycalopex*. Many of the species, referred to by European paleontologists under the name of *Cynodictis*, Pomel, appear to me to be undistinguishable from *Canis*. Through the great kindness of M. Filhol, I possess specimens of the jaws of several of these species. A mandible with nearly complete dentition of the *Cynodon velaunum* of Aymard, agrees very nearly with the jaws of some of the smaller species from the American White River beds, which I have referred to *Canis*. *Helocyon*, Aym. may be distinct, but may not belong to the *Canidæ*.

The dentition of many of the recent species of *Canis* differs in very slight characters. The following may be detected in an examination of the superior molars of the three larger species most accessible in the United States.

Last superior tubercular short, wide; inner cingulum and crest nearly confounded.

Inner crest of tub. m. I. composed of two low tubercles. *C. familiaris*.

Vars. *molossus*, *terrarius*, *graius*.

Last superior tubercular narrower, transverse; inner cingulum very distinct.

Inner crest of tub. M. I., a ridge higher anteriorly. *C. lupus*.

Inner crest of tub. M. I. with two sharp cusps. *C. latrans*.

It is worthy of note that the wide oval form of the second superior molar of the *Canis familiaris*, exists equally in the extreme races or species, the grayhound and bulldog, as I observe by examination of several crania of each. This has also been shown by De Blainville. It is also seen in the terrier, and in various other races. But in some Saint Bernard crania in the Museum of the Academy of Natural Sciences, this tooth is more elongate; and in some of the specimens of *Canis lupus* from Europe its form is quite the same. So this character, as might have been anticipated, is not of universal application. Another character is seen in the crania of three specimens, which are supposed to belong to *Canis terrarius*. The superior border of the foramen magnum is interrupted by a deep vertical excavation. This is not seen in the St.

Bernard, the bulldog, greyhound, and other races, nor in any of the feral or extinct species of the genus examined. It appears to be associated with an increased size of the brain, and to be an adaptation to the vermis of the cerebellum. The expansion of the brain is also indicated by the protuberance of the frontal region, and the wide separation of the temporal fossæ by a smooth space on each side of the sagittal suture. This space does not exist in the greyhound, but a narrow one is found in the bulldog. These characters are important on various grounds, but are here mentioned in reference to the species of *Synagodus* and *Dysodus*, where they reappear. The absence of the second inferior tubercular molar is also not uncommon in the "black and tan" terrier.

I do not see the propriety of retaining the generic name *Nyctereutes*, Temm. for the *Canis procyoninus* of Japan. The peculiarity it presents in the form of the first superior tubercular molar, the only one[1] on which the genus reposes, I would regard as specific only.

Vulpes.

I would, with Gill, refer to this genus the species mentioned by Gray and others under the generic names *Pseudalopex*, *Fennecus*, and *Leucocyon*. The form of the post frontal process certainly does not furnish generic characters.

Urocyon, Baird.

The peculiar cranial ridges, in which this genus resembles one of the extinct genera of *Mustelidæ*, appears to me to be the character which warrants its separation from *Vulpes*.

Enhydrocyon, Cope, Bulletin U. S. Geological Survey, Terrs. v, 56, 1879.

Two species from the White River beds of Oregon are known.

Tomarctus, Cope, Ann. Report U. S. Geol. Surv. Terrs. 1873 (74), p. 519. Paleontological Bulletin, 1873, Aug. 20, 1873.

One species known from the Loup Fork beds of Colorado. It is uncertain whether this genus has two or three premolars. Should it have three it must be compared with the *Brachycyon* of Filhol. But the inferior sectorial tooth of that genus is as yet unknown.

Speothus, Lund, 1843. *Cuon*, Hodgs.

One extinct species of this genus was found by Lund in caves in Brazil. Another species, *Speothus primævus*, is now living in

[1] According to the figures of Temminck and Schlegel.

the Himalaya region. Several other recent species have been named, but they are said by some authors to be varieties only of the *S. primævus*.

Synagodus, Cope, gen. nov.

The characters of this genus have been pointed out in the analytical key. They are evidently as important as those which define the divisions which are regarded as genera by naturalists. It is not unlikely that the typical species has been heretofore estimated as a variety of *Canis familiaris*, but it exhibits two trenchant generic dental characters not found in *Canis*, and three unique specific characters in the teeth, besides two characters of the cranium found in but one or two of the subspecies of *Canis familiaris*.

The generic characters alluded to are: (1) the absence of the second inferior tubercular molar, and (2) the absence of the internal tubercle of the inferior sectorial. The absence of the second inferior tubercular is evidently not one of those abnormal cases which occur in various species of *Canis* from time to time; for the first tubercular molar is smaller than in any known species of *Canis*, and has but one root, a character which some persons might regard as being the third of the generic category. The premolars are 4—4, and of the usual form; the first in both jaws is one-rooted.

It is uncertain whether any species of this genus exists in the wild state. Should such not be the case, we can only predicate the former existence of such an one entirely different from the *Canis familiaris*, and which has given origin to the existing one below described.

Synagodus mansuetus, sp. nov.

Two crania represent this species in the Museum of the Academy of Natural Sciences. They agree in all essential particulars. The incisor and premolar teeth present no peculiarities (the latter are without marginal lobes), and the superior sectorial is normal. The first tubercular has less transverse extent than in the *Canidæ* generally, and its median crest and inner cingulum are confounded, a character which I have not found in any of the other species accessible. Thus the crown of this tooth consists of an external pair of tubercles, a basin, and a stout inner marginal prominence. The second tuberculars are abnormally small in one specimen, and in the other they are wanting. The III. and IV. inferior premolars have marginal posterior lobes. The inferior sectorial, as already stated, has no inner tubercle. Its heel is peculiar in the great elevation, and submedian position of one of its borders, approaching *Temnocyon* in this respect. The other edge is, however, distinct, thus forming an unsymmetrical basin. The first inferior tubercular is small, one-rooted, and the crown is subround, and with a single median tubercle. In the other usual species of *Canis*, *Vulpes*, and of many other genera of the family, this tooth is elongate, two-rooted, and supports at least two tubercles.

The general form of the crania resembles those of some of the terriers. The brain-case is full and convex, the orbits are lateral, and the muzzle is moderately elongate and narrowed. The osseous surfaces are generally smooth, and there is no indication of the ridge bounding the temporal fossa above. There is a deep sinus of the superior border of the foramen magnum, a character above noted as occurring in a subspecies included under *Canis familiaris*.

I have been unable to ascertain whether the species now described is one of the forms which have been referred to *Canis familiaris* under a subspecific name. One of the specimens was presented to the Academy many years ago by Dr. Paul Goddard, under the name of lap-dog. The form of the head shows that it is not one of the forms of *Canis extrarius hispanicus* (of Fitzinger's Work on Dogs), which are represented by the King Charles Spaniel, and other lap-dogs. As I can find nothing concerning it in the books I give it a provisional specific name.

The origin of the characters of this genus is doubtless to be traced to prehistoric time, if not to an early tertiary geologic age. Perhaps some of the species' characters are of later origin; such as the obliteration of the superior border ridges of the temporal fossæ, and the large sinus of the foramen magnum. These characters, seen in a lesser degree in a domesticated true *Canis*, as above mentioned, are evidently an adaptation to an enlarged brain; the one to the increased cerebral hemispheres, the other to the protuberant vermis of the cerebellum. Whether these characters are due to a prolonged domestication, and abnormal nutrition within human habitations, remains to be ascertained. I remark here that two crania of dogs found mummied in Egypt by Mr.

Gliddon, and now in the Museum of the Academy, present all the normal details of structure of *Canis familiaris*.

The reduction in the number of teeth has been carried further, and is probably of more modern origin in the new genus to be described below.

Dysodus, gen. nov.

The characters of this genus, already indicated in the analytical table, are as follows: I. $\frac{3}{3}$; C. $\frac{1}{1}$; P. m. $\frac{2}{2}$; M. $\frac{2}{1}$; inferior sectorial without internal tubercle. The incisive formula might with propriety read $\frac{0}{0}$, since these teeth are shed at an early age; and for the same reason the tuberculars might be stated $\frac{1}{1}$, since the last one of the upper jaw is equally evanescent. I, however, give the genus the benefit of the possible future discovery of species in which the teeth in question may not be so early caducous, and rely on the restricted diagnosis. It is thus apparent that the genus *Dysodus* is distinguished from *Synagodus* by the absence of two premolars from each jaw. While the genera agree in other respects, their typical species are very different.

This genus probably diverged from that now represented by *Synagodus*, at a comparatively late period. Although it exhibits a degree of dental reduction greater than that form, I admit that the possibility of its having come off from *Canis* rather than from *Synagodus* is worthy of consideration. This is suggested by the fact that the remaining (first) tubercular molar of the inferior series is, in *D. pravus*, more like that of the species of *Canis* in all respects, among others, in having two roots.

In *D. pravus* the superior third premolar is sometimes shed, like the incisors, having the formula, I. $\frac{0}{0}$; C. $\frac{1}{1}$; Pm. $\frac{1}{2}$; M. $\frac{1}{2}$. I have excluded this character from the generic diagnosis, as in the case of the incisor and superior tubercular teeth, because they are at the present time *unstable;* that is, the parts in question are in process of metamorphosis. When characters are thus variable, they cannot be used as the bases of natural divisions, but when they are *stable*, we are compelled to recognize them. The characters which I have included in the diagnoses of *Synagodus* and *Dysodus* I have thought to be of this character, and I am by no means sure that the absence of the superior incisor teeth should not be placed in the same category. But none of these characters, whether stable or unstable, can be regarded as monstrosities, such as multiplied digits, fissured palate, etc. They are, on the contrary, in the direct line of numerical succession of parts already represented by the genera of *Canidæ*, and of all digitigrade *Carnivora.* This, as already stated, consists in the reduction in the number of the teeth and their tubercles, forming a series which, commencing with the generalized extinct type *Amphicyon*, approaches more and more nearly to the *Felidæ*. In the inferior sectorial, the genus *Dysodus* approaches nearest of all *Canidæ* to some of the earliest genera of cats, as *Hoplophoneus* (although easily distinguishable), while in the reduction of its premolars it approaches the modern forms of that family. In the early shedding of the incisors it reaches a condition not found in any carnivora, but one which marks the extreme of development of the ungulate mammals in various lines; e. g., *Ruminantia*, *Omnivora*, and *Amblypoda.*

Dysodus pravus, sp. nov.

This species, which is known as the Japanese sleeve dog, is represented in the Museum of the Academy of Natural Sciences by a complete skeleton, with the crania of two other individuals. These all belong to adult animals of a single litter, which were born in the United States. The parents of these dogs were procured in Japan by Dr. W. S. W. Ruschenberger, U. S. N., now President of the Academy. Other specimens have been brought to the United States by officers of the navy. Dr. J. E. Gray figures a skull of the same dog in the Proceedings of the Zoölogical Society of London for 1867.

The crania in the Academy's collection are almost exactly alike, and resemble the one figured by Dr. Gray so far as can be discovered. But Dr. Gray's specimen was probably young, as the incisor teeth and a premolar in each jaw have not yet been shed, and there are some cranial fontanelles still remaining.

The characters displayed by the skulls are as follows: The muzzle is excessively abbreviated, and the forehead very convex. The brain-case is almost globular, and the zygomata proportionably prominent. The superior marginal ridge of the temporal fossa is prominent, and those of opposite sides are well separated as far as the posterior parietal region. Here they approach each other abruptly, forming a wide sagittal crest. The muscular insertions and other osseous ridges of the supra, ex- and basi-occipital regions are strongly marked. The postorbital process is prominent and decurved. The vertical sinus of the superior border of the foramen magnum is deeply excavated. The external surface of the brain case and of the zygomata is minutely rugose.

There are no lobes of the posterior border of the anterior superior premolars, while they are present on the two inferior premolars. The superior sectorial is normal, while the first superior tubercular is like that of *Synagodus mansuetus*, without distinct median crest or tubercle. The heel of the inferior sectorial is also like that of the species just mentioned; one border is much more elevated than the other, and forms a cutting edge. The inferior tubercular is small, is longitudinally oval, and supports two low tubercles. This is one of the most important points of difference between this species and the *S. mansuetus*. In none of the specimens is there any trace of the second tubercular.

The skeleton is that of a dog of the size of a rather small black-and-tan terrier.

Dr. Ruschenberger states that the incisor teeth of the dogs were shed at an age of about six months. He also informs me that they did not breed after coming to this country. Dr. Gray states that these dogs are fed largely on vegetable food in Japan, and have an artificial existence in various respects. They are, according to Dr. Ruschenberger, uncommon and expensive in Japan.

I have been unable to discover that any name whether varietal or specific has been given to this dog.

Icticyon, Lund.

One existing and one extinct species have been found in Brazil; the latter in the caves. I describe a species from Oregon which I cannot separate from them generically.

Icticyon crassivultus, sp. nov.

This dog is so far represented by a skull, which, while it lacks the parietal and occipital regions, is otherwise nearly complete, having both mandibular rami. The dental formula is, I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{1}{2}$. The single superior tubercular molar is similar in general to that of other *Canidæ*. The inferior sectorial has an internal cusp, and posterior heel, the latter with a low cutting edge on one side. Inferior tubercular well developed.

The dental formula of this animal is that of *Icticyon*, Lund, of which a species has been found in the cave deposit of Brazil, and another still lives in that region.

Char. specif. The snout is short and robust, and the profile from the parietal region is straight and descending. The premaxillary border projects but little beyond the line of the extremity of the nasal bones. The muzzle is slightly contracted in front of the orbit and above the fundus of the canine alveoli. The latter cause a swelling on the side. The infraorbital region is somewhat cracked, but appears to have been nearly flat medially; laterally it descends steeply to the supraorbital border. The orbit is not large, and the zygomatic fossa is short. The nasal bones are narrowed posteriorly, a little contracted medially, and expanded anteriorly, their lateral portions being produced along the pre-maxillaries. Their combined nasal border is concave, and is without the notches of some forms. The *foramen infraorbitale exterius* is of medium size, and issues above the interval between the sectorial tooth and the one in advance of it. The mandibular ramus is quite robust, and its inferior border is gently convex. The masseteric fossa is bounded by elevated borders, especially inferiorly, and the angular hook is prominent and robust. The condyle is situated on the horizontal line of the tubercular molar, or a little above the others, and has a wide transverse extent, chiefly inwards. The coronoid process is high and wide, and is turned backwards so as to vertically overhang the condyle. Its anterior border is wide below, and becomes horizontal above.

The teeth partake of the robust character of the skull, with the exception of the incisors. Of these the crowns of the external are long and narrow, and the median small in the premaxillaries, while those of the lower jaw are all small. The canines in both jaws are quite robust, and those of the lower jaw are rather abruptly recurved. The first premolar is small, and has a simple crown and single root. The crowns of the other premolars are wide at the base, and form each a simple cone, with a short posterior basal heel. The upper sectorial is relatively not long, but is robust, and with thick blades. The internal heel is well developed, as in *Canis*, while a cingulum represents an anterior lobe. The tubercular molar is narrower in fore and aft diameter than in *Temnocyon coryphæus* or *Canis latrans*, although it presents the same details. These are a wide obtuse external cingulum; two external tubercles; a median obtuse tubercle, and a wide internal cingulum. The premolars of the lower jaw are similar to those of the maxillary bone. The inferior sectorial is quite robust, and the internal cusp is well developed. The heel is shorter than the blades of the crown, and is wide and without tubercles in its somewhat worn condition. Its external border rises to an edge. The tubercular is wider than the corresponding tooth in the cotemporary species of *Canidæ*, although not so wide as long. Its crown rises in two low tubercles which stand transversely near the middle.

Measurements.	M.
Length of skull to orbit (axial)	.049
Depth of skull to orbit (axial)	.042
Interobital width	.040
Width of nares	.017
Length of superior molar series	.038
Length of bases of three premolars	.019
Length of base of sectorial	.013
Width of sectorial in front	.009
Width of first tubercular anteroposterior	.006
Width of first tubercular transverse	.014
Length of mandible to angle	.093
Elevation at coronoid	.051
Elevation at sectorial	.020
Length of inferior molar series	.045
Length of inferior sectorial	.014
Length of heel of inferior sectorial	.003
Length of inferior tubercular	.006
Width of inferior tubercular	.005

Van der Hœven has given[1] descriptions and figures of the skull and dentition of the *Icticyon venaticus* of Lund, of Brazil. From these it appears that the present species differs from the latter in the greater development of the inner part of the tubercular molar of the superior series; in *I. venaticus* this part is much reduced. The tubercular molar of the lower jaw is also much smaller in the living species, the angular and coronoid processes less developed, and the condyle less extended transversely. The cranium of the *I. crassivultus* is much more robust, but not much longer than that of *I. venaticus*.

Discovered by J. L. Wortman in the Truckee beds of the White River, Tertiary of the John Day River region of Oregon.

[1] Over het Geslacht Icticyon; wis. en natuurk. Verh. der Koninkl. Akademie, Amsterdam, Deel. III.

General Observations.

In both *Canidæ* and *Felidæ* the reduction of the dental series is connected with a contraction of the facial part of the skull, either posteriorly or anteriorly. *Enhydrocyon* is an example of anterior abbreviation, and *Icticyon* of posterior contraction among *Canidæ*, while *Smilodon* and *Lynx* exhibit the anterior reduction in *Felidæ*. I have already pointed out that this reduction is accompanied by a corresponding increase in the size of the sectorial teeth. But the reduction in the number of teeth in geologic time has not been confined to the *Carnivora*, but belongs to the Ungulates and Primates as well. The small number of teeth is generally associated with high specialization among Mammalia generally. The genera *Synagodus* and *Dysodus* are the most specialized of the *Canidæ*.

I may here refer to the frequently observed reduced dentition of man. Darwin first pointed out the significance of the absence of the third molars from the standpoint of evolution, citing American cases; and I have observed the similar bearing of the absence of the external superior incisors.[1] These reductions are very frequent in the United States, and probably elsewhere among civilized nations, but statistics on this point are yet wanting. My friend Dr. C. N. Pierce, an experienced and scientific dentist of this city, informs me that he knows of twenty-eight families in which the external superior incisors are absent; to these, four families may be added, which have fallen under my own observation: that the absence of one or both pairs of the third molars is still more common, is confirmed by Dr. Pierce's experience.

It is evident that we have characters which, if stable, would indicate two or three genera of *Hominidæ* additional to *Homo*. They are unstable at present; that is, they are not yet invariably found in any race or species of man, or, in other words, are not so associated with other physical characters as to form a correlated index of them. But experience in paleontology and zoölogy renders it almost certain that these dental characters will at some future time assume this degree of importance by becoming stable. This is already indicated by the fact of their being constant in families at the present time. As to what races will be thus distinguished

[1] Proceedings American Philosophical Society, 1871, p. 234.

generically, it is not easy to indicate, but all those with prognathous crania may be safely excluded. It is improbable that Mongolian races will early participate in such a modification, as they have a tendency to prognathism, and a generally strong dental development.

Since the reduction in the number of teeth is intimately connected with orthognathism, it is easy to suppose that it is primarily due to the diminished space allowed by the contracted maxillary arcade. This contraction is doubtless due to a deficiency of building material, consequent on a transfer of force to some other part of the structure during the period of growth. This transfer may be to the superior parts of the cranium, which is extended to contain an enlarged brain. As the loss of a tooth from each side has so far been sufficient to accommodate the dentition to the space which it is to occupy, it is not likely that the absence of both I. 2, and M. III. will become established. The reduction in the inferior series is less, and I do not know of any examples of the absence of the external incisors of the lower jaw. The loss of the third inferior molars is, on the other hand, very common. It then may be reasonably maintained that two genera of *Hominidæ* will be at some future day added to *Homo;* that the latter will include the inferior races of men, and the future the superior; that, although in specific characters there may be a want of greater constancy in the species of the new genera as compared with each other than as compared with the primitive and true *Homo*, they will present cases of what is elsewhere known in zoölogy, that the same or nearly the same specific characters may be found in different genera. Under such circumstances the form referred to a new genus becomes at the same time distinct species. The genera of *Hominidæ* will then, if the characters become constant, be as follows:—

I. $\frac{2}{2}$; C. $\frac{1}{1}$; Pm. $\frac{2}{2}$; M. $\frac{3}{3}$;	*Homo.*
I. $\frac{1}{2}$; C. $\frac{1}{1}$; Pm. $\frac{2}{2}$; M. $\frac{3}{3}$;	*Metanthropos.*
I. $\frac{2}{2}$; C. $\frac{1}{1}$; Pm. $\frac{2}{2}$; M. $\frac{2}{2}$;	*Epanthropos.*

JULY 15.

The President, Dr. RUSCHENBERGER, in the chair.

Fourteen persons present.

The death of J. B. McCreary, a member, was announced.

JULY 22.

Dr. JOSEPH LEIDY in the chair.

Sixteen persons present.

Explosion of a Diamond.—Prof. LEIDY exhibited a black agate sleeve button, having mounted upon it, centrally in a raised gold band, a rose diamond about 7 mm. broad. It had been submitted to him by Mr. Ernst Kretzmar, jeweller, who informed him that the person who wore it recently was leaning with his head upon his hand, on a window ledge in the sun, when the diamond exploded audibly, and with sufficient force to drive a fragment into his hand, and another into his forehead. On examining the diamond, the fractured surface, following a cleavage plane, exhibits apparently the remains of a thin cavity, such as is sometimes seen in quartz crystals. The fracture also exposes a conspicuous particle of coal. Prof. Leidy thought that the explosion had been due to the sudden expansion of a volatile liquid contained in the cavity, as frequently occurs in cavities in many minerals.

Mr. Goldsmith thought that the liquid might be carbonic acid, as he was impressed with the idea that diamonds originated from this material in the liquid condition.

JULY 29.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-four persons present.

The deaths of Francis Garden Smyth, M.D., a member, and Prof. Edouard Spach, a correspondent, were announced.

Remarks on Orgyia—Prof. LEIDY remarked that *Orgyia leucostigma*, which now seriously infested the shade trees of our city, especially the horse-chestnuts and silver-maples, had recently passed into the moth stage. The trunks of the trees, and the surrounding railing of the square opposite to the Academy exhibit a profusion of cocoons. In seeking for specimens of the male moth, he had collected only three, in a walk along one side of the square, from the railing, where hundreds of the wingless females were to be obtained, as they rested with their foamy white masses of eggs on their cocoons. From the fewness of the males he was led to suspect that the females might, perhaps, in many instances, deposit the eggs in an unfecundated condition. To ascertain if this were so, he collected several dozen cocoons with pupæ of females, distinguished by their comparatively robust character, and placed them in a covered box in his study in the third story of a back building, separated from the nearest place where there were other cocoons by the front building and the width of the street in front of his house. As the females came out of the cocoons, distended with eggs, these, with the exception of a few which appeared to be accidentally dropped in several individuals, were retained. After some days, as none of the females laid their eggs, the box was uncovered, and on the second morning subsequently, several individuals had deposited masses of eggs, though no males were present in the box. However, on examining the vicinity, four male moths were detected on the outside of the curtain of the window in which the box had been placed, from which it was supposed that the females had been visited by males attracted during the night from the neighborhood.

The case related reminded him that some years ago a collector of butterflies in the suburbs, informed him that he frequently obtained male specimens of the Cecropia and Luna moths by pinning females to the side of the window, when, in the morning after, he would almost certainly find males in conjunction with them. The means by which the males thus find their mates at night and in out-of-the-way places were not obvious, as the insects appear to be incapable of producing sounds or scents that are appreciable to our senses.

J. M. Taylor was elected a member.

Gustav Mayr, of Vienna, and C. Emery, of Palermo, were elected correspondents.

AUGUST 5.

The President, Dr. RUSCHENBERGER, in the chair.

Sixteen persons present.

AUGUST 12.

The President, Dr. RUSCHENBERGER, in the chair.

Eighteen persons present.

AUGUST 19.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty-three persons present.

AUGUST 29.

The President, Dr. RUSCHENBERGER, in the chair.

Fourteen persons present.

SEPTEMBER 2.

The President, Dr. RUSCHENBERGER, in the chair.

Twenty persons present.

SEPTEMBER 5.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-eight persons present.

A paper entitled "Description of a New Branchipod," by John A. Ryder, was presented for publication.

On Myrmecocystus Mexicanus, Wesm.—Rev. H. C. McCOOK exhibited several glass formicaries containing a large number of living specimens of the honey ant, *Myrmecocystus Mexicanus*, Wesmael. These embraced three worker castes, major, minor, and dwarf, the honey-bearer, and the fertile queen. The artificial nests had been brought from the Garden of the Gods, Colorado, where the honey-ant had been discovered by Mr. McCook. They had previously been supposed to be confined to a more southern latitude. The nests are found on the tops or southern slopes of ridges. In exterior architecture they are small gravel-covered moundlets, truncated cones, pierced in the centre by a gate, or perpendicular opening from three to six inches deep. The interior architecture was illustrated by numerous specimens brought from excavated nests. It consists of a series of underground galleries and chambers, cut through the gravel and sandstone to the distance of nearly eight feet in length, two to four feet beneath the surface, and about ten to twelve inches in width at the widest part. The honey-bearers were found hanging in groups to the roofs of the honey chambers by their feet; their large globular abdomens looking like bunches of small Delaware grapes. About eight to ten chambers, containing each an average of about thirty honey-bearers, were found. The workers cared for the honey-bearers when the chambers were opened, and dragged them into the unopened parts.

The ants proved to be nocturnal in their habits, remaining within doors until after sunset, about 7.30 P. M., each evening, when the workers issued forth in column, and dispersed among the clumps of scrub oak, *Quercus undulata.* Here they sought the galls made by a species of *Cynips*, which grows abundantly on the bushes, and licked therefrom a sweet exudation which issued in small transparent beads from the surface. From 11.30 P. M. to about 3.30 A. M., when the first streakings of dawn began to appear, the workers returned home laden with the honey. This appears to be fed to the sedentary honey-bearers by disgorging it in the usual way, and remains within the globular abdomens as a store for future use. The economy of this habit appears to resemble that of the bee; the exception being that the bee's honey is stored within the inorganic substance of a waxen cell, while the ant's is lodged within the organic tissue of the living insect.

The above is a brief abstract of observations presented in detail, together with others not here referred to, which will appear in full in subsequent reports of the Academy's Proceedings.

Notices of some Animals on the Coast of New Jersey.—Prof. Leidy exhibited a valve of the beach-clam, *Mactra solidissima*, which he picked up among the numerous dead and bleaching shells of Brigantine Beach, N. J. It attracted his attention from its apparently having a fungus growing upon it. The fungus-like excrescence presented a remarkable resemblance to a *Polyporus* growing from the stem of a tree. It is an outgrowth from the lip of the shell, evidently dependent on an abnormal condition of the mantle of the living animal.

Prof. Leidy also stated that he had picked up on the beach at Atlantic City, N. J., another valve of the beach-clam, which had been recently cast on shore. The inner surface of the shell was covered with a multitude of the beautiful ciliated infusorian, *Freia ampulla.* The little creatures were still alive, and their curved, flask-like cases were of a deep green color.

Prof. Leidy further remarked that while at Atlantic City, Mr. Philips had directed his attention to two interesting animals, recently collected. One of these he recognized as the *Bicidium parasiticum*, a parasitic anemone or Actinia, found on the large jelly fish, *Cyanea arctica*, so frequently thrown on shore. The other was a parasite of the shrimp, *Palæmonetes vulgaris*, which he recognized as the curious Isopod, *Bopyrus.* Many of the shrimps were infested with the parasite, the presence of which produced a conspicuous hemispherical tumor on one side of the carapace.

SEPTEMBER 16.

The president, Dr. RUSCHENBERGER, in the chair.

Twenty-two persons present.

The following was ordered to be printed:—

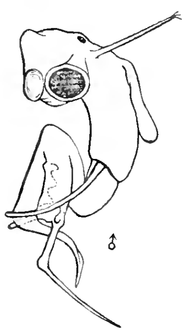
DESCRIPTION OF A NEW BRANCHIPOD.

BY JOHN A. RYDER.

Upon examining a pair of Branchipods which were kindly handed me by Mr. D. S. Holman, and which had been collected near Woodbury, N. J., I find them to be a form hitherto undescribed. I accordingly propose a name for the species.

Streptocephalus sealii, nov. sp.

In form and size this species resembles *S. torvicornis*, Waga, but the third joint of the second antenna differs from that species in the details of its structure, and the ovigerous sacs of the females are not blue as in Waga's animal. The inner branch of the terminal joint of the male claspers is the shortest instead of the longest, as in *S. torvicornis;* at the interior anterior margin of the short branch, there are two unequal lobes, extending forwards and lying flat against the laminar posterior border of the anterior branch; at the lower posterior angle of this lamina, or blade of the forward branch, there is a well-marked, somewhat falcate process, which fits between the lower lobular process of the posterior branch and its scythe-shaped lower extremity. The anterior branch then crosses the posterior at nearly right angles, and for about a third of its length maintains a pretty uniform thickness, and is straight, when it suddenly swells and bends forwards, and as suddenly contracts, and tapers for its remaining two-thirds, ending in a slender, slightly-curved, pointed extremity. The first joint is long and robust, and from its apex externally, the cylindrical, curved, antenniform organ arises, which is about as long as the filiform first antennæ. The second joint is very tortuous, and is strongly bent and twisted upon itself. The third joint, which bears the complex terminal appendages, is wide; the appendages close against each other like the blades of a scissors, whilst the processes of their opposing margins interlock as has been already described, and as can be fully understood by reference to


♂

the accompanying cut of the head of the male. The front of the head is prolonged into a straight beak, which hangs down nearly vertically between the first joints of the claspers, and is flattened antero-posteriorly, and emarginate at its tip. The antenniform appendage is much longer than in *S. texanus*, Packard, whilst the terminal branches of the claspers are widely different from those of that species in their shape and relative proportions. The male organs are very feebly armed with a few short spines, and are nearly straight.

The cephalic horns of the female are twisted upon themselves, slightly bent and flattened at their extremities, which are fringed with short hairs. The large lateral, ovoid, pedunculate, apparently glandular organs behind the eyes, are the same in size and shape in both sexes. The ovigerous sacs are large, nearly half as long as the abdomen, conical in form, and contain a great number of ochraceous eggs, more numerous and much smaller than those of *Chirocephalus holmanii* from the same locality. The male is of a beautiful green, deeper about the head, as though saturated with acetate of copper; the female, on the other hand, is yellow with a tinge of green, verging to brownish in parts, and is very nearly of the same size as the male, if not a little larger. This similarity in the size of the sexes, with a tendency in the females to be largest, is observed only in *S. torvicornis*, as far as I am aware. The two rather long, plumose, tapering branches of the tail are red in both sexes, but of a much brighter red in the female; more slender in the male. Length 27 mm.

I name the species for Mr. W. P. Seal, who collected the first typical specimens; the same gentleman has since furnished me with an additional supply of examples.

The known species of this genus are accordingly as follows:—

Streptocephalus torvicornis, Waga, ♂ 1 inch, ♀ about 14 lin., Warsaw, Poland.

S. cafer, Lovén, 15 mm. long, Cape of Good Hope.

S. similis, Baird, ♂ 8 lin., ♀ 6 lin. long, St. Domingo.

S. texanus, Packard, ♂ .65 in.. ♀ .55 in. long, Texas.

S. watsonii, Packard, ♂ 16 mm., ♀ 12–18 mm., Ellis, Kansas.

S. sealii, Ryder, 27 mm. long, New Jersey.

All of the species are found in fresh water.

The distribution of the species of the foregoing genus, and the resemblance existing in some features between the Polish and New

Jersey species is very remarkable. Why such a resemblance should exist between two fresh-water crustaceans separated from each other by a salt ocean 3000 miles wide, and nearly a thousand miles of land besides, is a problem yet to be solved by chorologists and biologists. Indeed, the distribution of both branchipods and phyllopods in general, is not a little singular, and all those who have the opportunity of acquiring any data in regard to the subject should be careful to put them on record.

Sept. 23.

The President, Dr. Ruschenberger, in the chair.

Thirty-five persons present.

Sept. 30.

The President, Dr. Ruschenberger, in the chair.

Thirty-two persons present.

The death of Edward Peace, M.D., a member, was announced.

On Cristatella Idae.—Prof. Leidy remarked that a few days ago, while rambling in the Park with his little daughter, she had called his attention to what she supposed to be numerous caterpillars at the bottom of a brook. On examination they proved to be an extraordinary accumulation of *Cristatella Idae*. This species of polyzoon, or fresh-water ciliated polyp, he had discovered at Newport, R. I., upwards of twenty years ago, and described in the Proceedings of this Academy (1858–59). He had repeatedly sought for it in the vicinity of Philadelphia, but had never found it until now.

The development of the Cristatella in the locality indicated is most remarkable and wonderful for its extent. Thousands of vermicular groups spread over the bottom of the brook for about twenty feet of length and a yard diminishing to a foot in breadth. They invest all the submerged stones and plants, and are so closely crowded as to intertwine with one another, leaving only narrow intervals, without room for movement except by mutual displacement. The groups are all attached to a common basal membrane, from which, however, they are capable of separating themselves. A large patch of the membrane covered with groups of the Cristatella was raised and placed in a dish of water, and after a couple of days most of the groups glided away from the membrane to the bottom and sides of the dish. The basal membrane is amber colored, homogeneous, and obscurely granular. A patch of it, four inches long by two and a half inches wide, closely covered with groups of the polyp, preserved in alcohol, was presented as a specimen for the museum.

It would appear that in the development and growth of the Cristatella groups, they from time to time break up into smaller groups, and retain their connection only through the basal membrane, which seems to be of an excrementitious character

The basal membrane of the Cristatella was further interesting from the circumstance that in the intervals of the groups of polyps it harbored multitudes of *Difflugia corona*.

At this season the Cristatella groups are full of statoblasts or winter eggs, in all stages of development. The mature statoblasts, including the annulus, but excluding the marginal anchor spines, measure from 1.15 mm. to 1.225 mm. in breadth. Of fifteen specimens, seven measured 1.2 mm. in breadth. The number of anchor spines usually ranges from 60 to 70; but in a few specimens as low as 53 and as high as 74 were counted. Both in size and the number of spines they considerably exceed those of *Cristatella mucedo* and *C. ophidoidea.*

The individual polyps of *Cristatella Idae* when fully extended are about 3 mm. in length, and their arms support about 80 tentacles. The stomach is chocolate brown; sometimes lighter yellowish or greenish-brown.

The same locality was further remarkable for its profusion of other animals, especially for the abundance of flesh-colored Hydras, and the groups of Vorticellas. Tufts of Anacharis were white from the latter.

Lieut. C. A. H. McAuley, U.S.A., was elected a correspondent.

OCTOBER 7.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty persons present.

On Amœba Blattæ.—Prof. LEIDY remarked that while perusing the communication of Prof. Bütschli on "Flagellata and other related Organisms" (Beiträge zur Kenntniss der Flagellaten und einiger verwandten Organismen), in the Zeitschrift für wissenschaftliche Zoologie, 1878, 205, his attention was especially attracted by the description of a parasitic amœboid living in the intestine of the cockroach, *Blatta orientalis.* It recalled to mind that he had observed the same creature a number of years ago, in association with the ciliated infusorian he had described as *Nyctotherus ovalis.* At that time he had viewed it as a young form of a Gregarina, and had intended giving it and other parasites of the cockroach more critical examination, but failed to do so. The parasitic amœboid, which Prof. Bütschli describes under the name of *Amœba Blattæ* is particularly interesting on account of its habit and its somewhat peculiar character. Prof. L. had recently examined some cockroaches, and found abundance of the amœboid in association with *Nyctotherus ovalis*, *Lophomonas blattarum*, *Oxyurus gracilis*, and *O. appendiculatus*, and an algoid plant.

The amœboid he thought was worthy of a generic distinction from the true *Amœba* holding a position between this and *Protamœba.* From the former it differed in the absence of a contractile vesicle and commonly also of vacuoles, and in the want of differentiation of endosarc and ectosarc; and from the latter in the possession of a well-defined nucleus. He proposed for it the following name with distinctive characters:—

ENDAMŒBA.

General character and habit of *Amœba;* composed of colorless, homogeneous, granular protoplasm, in the ordinary normal active condition without distinction of ectosarc and endosarc; with a distinct nucleated nucleus, but ordinarily with neither contractile vesicle nor vacuoles.

ENDAMŒBA BLATTÆ.

Eine art Proteus. Seibold: Beitr. z. Naturges, d. wirb. Thiere, 1839, *fide* Stein.
Amöbenform. Stein: Organismus d. Infusionstheire, 1867, II., 345.
Amœba Blattæ. Bütschli: Zeits. f. wis. Zoologie, 1878, xxx. 273, Taf. xv., Fig. 26.

Initial form globular passing into spheroidal, oval, or variously lobate forms, mostly clavate and moving with the broader pole in advance. Protoplasm finely granular, and when in motion more or less distinctly striate. Nucleus spherical, granular, with a large nucleolus. Distinct food particles commonly few or none. Size of globular forms 0.054 mm. to 0.075 mm. in diameter; elongated forms 0.075 mm. by 0.06 mm. to 0.15 mm. by 0.09 mm. Parasitic in the large intestine of *Blatta orientalis.*

The *Endamœba blattæ* affords a good example of a primitive, active *nucleated organic corpuscle*, or a so-called *organic cell without a cell wall.* In the encysted condition it would be a complete nucleated organic cell. *Endamœba* may be recommended as a convenient illustration of a primitive form of the organic cell on account of its comparatively ready access.

OCTOBER 14.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-two persons present.

On the Supposed Sensitive Character of the Glands of the Asclepiadaceæ.—Mr. E. POTTS, referring to a communication made a year ago to the Academy and published in its Proceedings for 1878, p. 283, with regard to the supposed discovery of a sensitive contractile power analogous to that of *Dionea*, in the stigmatic glands of the Asclepiadaceæ, said that during the past summer he had given many hours to a careful examination of the subject, resulting in an entire failure to confirm his former position. This examination had embraced at least five species of the typical genus—*Asclepias*, and single species of each of the allied genera,—*Araujia*, *Physianthus*, *Hoya*, *Gonolobus*, and *Stapelia.*

The phenomena which, last year, were regarded as showing great probability, if not convincing proof, of the contractile power referred to, were:—the grasping of a slender hair by said glands with sufficient force to allow of the withdrawal of the pollen-masses; and a coincident change in the appearance of the jaws or lips of the same glands. The facts are undoubtedly as stated; but the circumstances attending the change had been imperfectly noted or their significance misinterpreted. The lips of the glands in their primary, undisturbed position, which had been thought to be separated by a sensible distance, allowing of the insertion of the foot or proboscis of an insect were now seen to be thickened and chamferred off along the upper edge, leaving a wedge-shaped groove, but still touching one another at the lower surface. No accidental or intended intrusion would therefore be successful in reaching the inner surface of the cylindrical gland; and by very many experiments it was amply proven that no amount of touching or pressure upon the *edges* of this groove was followed by any change of position.

He then explained how the removal of these glands and their associated pollinia *was* effected by insect agency, calling attention to the narrow passage left between the rigid proximate edges of the adjacent anthers; showing that it was widest at their lower extremity, and quickly narrowing, led up into, and was continuous or coincident with the before-named groove through the gland; so that the foot of fly or bee inserted below while the insect was crawling over the flower, was almost necessarily drawn along it until it reached and entered the gland. The very delicate attachment of the latter to the stigma was then easily ruptured, and the insect escaped, carrying glands and pollinia with it. Experiment showed that it was only when the glands were so far removed from their proper position that the caudicles or arms connecting them with the pollen masses were relieved from the restraint in which they had been held on the curved surface of the stigma—that their lips completely closed upon the intended substance, giving them the changed appearance formerly misunderstood.

A comparatively high magnifying power and delicate manipulation of the light further showed, just below the meeting edges of the anthers, a series of fine spicula-like hairs inclined upwards, having a tendency to guide into and restrain within the passage any object which had once entered at the widened end. In some species, noticeably in *Araujia albens*, the nectarial reservoir was shown to be placed immediately below this opened passage, and when the moths which frequent them thrust their proboscis down into the tubular corolla in search of their honeyed food, they are almost certain to be caught, not by the glands primarily, but by these trap-like edges of the anthers. Here, according to many observers, they are held till they die; or, if successful in tearing themselves away, leave the entangled organ behind them in their flight.

In this particular species, alone, of those examined, the release of the insect was not effected when it had successfully drawn foot or tongue along the whole length of this anther trap, as the gland which then receives it is firmly attached to the stigma by a broad ligament at its upper end; and all, excepting possibly the most powerful insects, are still held, while from other species of the family they fly off bearing the pollen masses with them. These in turn are caught in similar channels of other flowers, and lodged against the under surface of the stigma, when their pollen tubes are protruded and fertilization effected.

This, if not necessarily *cross* fertilization is, at least, fertilization by pollen from the same or other flowers placed by an extraneous force against the stigmatic surfaces; and that the singular arrangement of parts just mentioned, apparently so wonderfully calculated to facilitate it, *is* made use of, is very evident. In the course of his observations upon a cultivated plant of *Asclepias curassavicum* during the season of insect visitation, it was rare to find a mature flower which had not lost some of its glands and pollen masses, and very frequently all were missing. In many of these, the pollinia from other flowers were to be found in the situation before stated; and it was a very noticeable fact that from 50 to 80 per cent. of the flowers in these groups were fertilized, while those from which insects were excluded failed to produce a single fertile follicle. A bee captured upon this plant carried upon its legs and tongue thirty of the glands, representing sixty pollen masses. By far the larger number of the latter had been torn away from the glands since their removal, and possibly were the agents in making fertile nearly the same number of flowers.

A very singular fact on the opposite side of the account was mentioned by Mr. Meehan in the Botanical Section: that *Araujia albens* rarely fruited when exposed to insects in the open air, but in green-houses produced pods freely.

On Amber containing Fossil Insects.—Mr. E. Goldsmith called attention to a specimen of amber collected by Mr. Wm. L. Mactier at Nantucket Island, Mass., in which were several well-preserved fossil ants, a fly, and probably small species of coleoptera The specimen also contains a dicotyledonous leaf, of a cinnamon brown color, with the edges free, and the impression of another. This was the first specimen of American amber examined by him in which a trace of imbedded insects could be observed, although this may have been owing to the fact that the others were cretaceous, and therefore, on account of their age, opaque.

The amber from Nantucket Island is probably tertiary, and is of a fine pale claret color without being at all variegated. The specimen examined was an irregular mass of about eleven centimetres in length, somewhat pointed at one end and thicker and rounder at the other, with longitudinal furrows. It is a little heavier than water. The lustre is resinous, but if freshly fractured it is glassy. The form of the fracture is conchoidal and perfectly smooth. Hardness between two and three. The specimen resembles in its external aspect fossil copal so much that it may be easily mistaken for that material. The fresh vitreous lustre of the amber, however, remains after repeated rubbing and exposure, while copal becomes dull under such treatment. The amber may be worked with a file or an edge tool into even surfaces; under like treatment copal crumbles, and gives an uneven glistening plane. When the finger is rubbed to and fro on the amber it will not powder or become mealy like copal. When a portion of the specimen was gently heated in a glass tube closed on one end a dense gas was obtained having the odor of burning fat. After cooling minute radiating groups of crystals were noticed; fossil copal gives no such indications. The amber burns with a yellow smoking flame, emitting an odor not so disagreeable as that given off during distillation, and leaves some unconsumed carbon. The powder is white, and, if brought in contact with oil of vitriol, it will readily dissolve, forming a ruby red solution, which, when poured into water, gives a nearly colorless precipitate partially in a crystalline state. It is decomposed by nitric acid, forming at first a soft yellow compound which afterwards dissolves. If the excess of the nitric acid be evaporated and water added, thin plates of a golden-yellow color form. These plates appear to be succinic acid; they easily dissolve in caustic ammonia, and the solution affords, with a solution of sesquichloride of iron, the well-known cinnamon-brown precipitate of succinate of iron. Both solutions were perfectly neutral. From the solution of the succinate ammonia the succinic acid can be separated on the addition of nitric acid. This process for observing succinic acid in amber is especially applicable when but a small quantity of the acid is present, in which case the process by sublimation fails or becomes uncertain. Chloroform is a good solvent for amber, but alcohol, ether, and bisulphide of carbon dissolve it only sparingly. Copal when kept in ether swells to a greater volume; amber does not increase in bulk.

October 21.

The President, Dr. Ruschenberger, in the chair.

Thirty-one members present.

A paper entitled "On some New Eocene Fossils from the Claiborne Marine Formation of Alabama," by Angelo Heilprin, was presented for publication.

Ward's Natural Science Establishment.—Prof. Leidy stated that the reputation of Prof. Henry A. Ward's "Natural Science Establishment," at Rochester, N. Y., was such, that lately he had been induced to make it a visit. Though he had seen collections of casts of fossils and skeletons in the museums of colleges and other institutions, from Prof. Ward's establishment, he had not been prepared to find it so extensively representing all departments of natural history as it proved to be, and even in Europe he had seen no dealer's stock that was equal to it. For the variety of its objects, and the excellence of preservation and preparation of the specimens, he recommended it to the Academy and to others as a source from whence to supply the wants and deficiencies of their cabinets. The collection of skeletons is large, and is admirable for the cleanness, whiteness, and perfect mounting of the specimens. A few thousand dollars expended in this department would be of much importance to the museum of the Academy. A collection of glass models of invertebrate animals, made by Leopold Blaschka, of Dresden, had especially attracted his attention. The models are remarkable for their accuracy and beauty, and they supply a means of illustration which has long been felt. They represent soft and delicate forms which cannot be satisfactorily preserved, and others too minute to be examined with the naked eye. Moreover their price is so moderate, that it is to be hoped that the Academy may make early provision to obtain a series. Prof. L. exhibited specimens, such as the Red Coral, *Corallium rubrum*, of the natural size and magnified; the hydroid polyp, *Hydractinia echinata*, which lives on the shell of the Hermit Crab, etc. Prof. L. added that at the present time when society was awakened to the importance of the study of natural history, Prof. Ward was worthy of the highest commendation for the ability and energy he had displayed in accumulating so ample a means for its illustration.

October 28.

The President, Dr. Ruschenberger, in the chair.

Forty-nine persons present.

The following papers were presented for publication:—

"Revision of the Palæocrinoidea, Part I., the Families Ichthyocrinidæ and Cyathocrinidæ," by Charles Wachsmuth and Frank Springer.

"A Comparison of the Eocene Mollusca of the Southeastern United States and Western Europe in relation to the determination of identical forms," by Angelo Heilprin.

The death of William H. Gumbes, a member, was announced.

Variations in Thuja and Retinospora.—Mr. Thomas Meehan referred to his observations reported to the Academy many years ago, showing that the plant known in gardens as *Thuja ericoides* was but a form of arbor vitæ that had carried its juvenescent condition through life, instead of changing its character for the "adult" condition after its first three months of existence, as arbor vitæs generally do. Out of a large number of trees of this form that had been growing on his grounds for fifteen years, one had assumed the normal adult condition. Since he had first recorded his observations, most of the leading botanists had come to regard these plants as he did, and there seemed no need of further evidence; but this changed plant had now produced fruit for the first time, specimens of which he exhibited. It was exactly *Thuja occidentalis*. These juvenescent forms after fifteen years' growth had shown only this single disposition to assume the final or adult condition or to flower. He also exhibited a similar juvenescent form known as *Retinospora squarrosa*, one plant of which out of some hundreds had developed to *Retinospora obtusa*. In the case of the arbor vitæ the change from the juvenescent to the adult form was gradual; in *Retinospora* it was by a single leap. Each condition had its separate color, and separate chemical principles, the latter point having been called to Meehan's observation by Dr. Sterry Hunt; but this was characteristic of all such morphological changes. There was a difference in the rind of orange and in its pulp,—in the flesh of the peach and in its kernel, though all were morphologically the same. It was, however, worth remembering that with morphological changes there was often change in cell structure, as well as in sensible properties. Mr. Meehan further called attention to the almost identical characters of the two juvenescent forms exhibited—while in the adult they were so widely divided—for there were in all Coniferæ probably no two genera better marked in the characters derived from their fructification than *Retinospora* and *Thuja*.

Russell S. Hill was elected a member.

NOVEMBER 4.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-four persons present.

A paper entitled "On the Pacific Species of Caulolatilus," by W. N. Lockington, was presented for publication.

The following were ordered to be printed:—

ON SOME NEW EOCENE FOSSILS FROM THE CLAIBORNE MARINE FORMATION OF ALABAMA.

BY ANGELO HEILPRIN.

The following species of fossils (with the exception of *Rostellaria Whitfieldi*) were picked out from an accumulated mass of Claiborne sand and shell, deposited in the American Museum of Natural History, New York City, and being of more than ordinary interest, as in part pertaining to genera hitherto not recognized as belonging to the formation, I have deemed them worthy of description.

TEINOSTOMA, H. & A. Adams.

Teinostoma rotula, nob. Pl. xiii., fig. 1.

Shell orbicular, depressed; polished; whorls three, body-whorl with an impressed line immediately below the suture; umbilicus small, surrounded by a broad callous area; aperture nearly circular; inner lip expanded into a callus near the umbilical region.

Diameter .2 inch.

Claiborne, Alabama.

This is the first species of *Teinostoma* described as such existing in the Eocene formations of the United States. Mr. Lea's *Rotella nana* (*Umbonium*, Conrad), also from Claiborne, which I have not had an opportunity to examine, may prove to be a *Teinostoma*.

DELPHINULA, Roissy.

Delphinula solaroïdes, nob. P. xiii., fig. 2.

Shell turbinate, depressed, broadly umbilicate; whorls four, channeled below the suture, and ornamented with obtuse ribs radiating from about the centre of the upper surface; umbilicus with a central unrolling prominent crenulated line, and intermediate finer lines; margin crenulated; peristome continuous, trumpet shaped. Nacreous.

Diameter $\frac{1}{7}$ inch.

Claiborne, Ala.

This species could readily be mistaken for a *Solarium*, from all species of which, however, it is distinguished by its pearly iridescence.

SOLARIUM, Lamarck.

Solarium striato-granulatum, nob. Pl. xiii., fig. 3.

Shell conical, depressed; whorls five, slightly convex, and ornamented with four principal revolving lines of granules; margin acute, crenulated, and carinated only on the inferior surface; base with three prominent crenulated lines surrounding the umbilicus, and with about three or four almost simple lines.

Diameter $\frac{3}{4}$ inch.

Claiborne, Ala.

NATICA, (Adans.) Lam.

Natica bi-sulcata, nob. Pl. xiii., fig. 4.

Shell subglobose; spire but slightly elevated; whorls four, smooth, the body-whorl with radiating sulci on the summit; mouth semi-lunate, about $\frac{3}{4}$ the length of shell; columella slightly thickened, the callus reflected above the middle; umbilicus broad, doubly grooved, the grooves transversely striated.

Length .3 inch.

Claiborne, Ala.

This species differs mainly from the *N. magno-umbilicata* of Lea in having the umbilicus doubly grooved.

ODOSTOMIA, Fleming.

Odostomia lævigata, nob. Pl. xiii., fig. 5.

Only a fragment of this species has come to my observation, but its characters are sufficiently defined to distinguish it from all the other species of *Odostomia* existing in our tertiary formations. It mainly differs from the *Actæon* (*Odostomia*) *melanellus* of Lea in the subangulate form of the body-whorl, and in the columellar plait, which in our species is transverse, and not oblique.

Length ?.

Claiborne, Ala.

TORNATELLA, Lamarck.

Tornatella bicincta, nob. Pl. xiii., fig. 6.

Shell ovate, spire elevated; whorls about six, the body-whorl with numerous revolving lines closely beset with punctures, and two broad smooth bands on the superior portion; two or three of the remaining whorls also with two smooth bands; mouth narrow, about $\frac{3}{5}$ the length of shell.

Length .4 inch.

Claiborne, Ala.

This species differs from the *Actæon* (*Tornatella*) *lineatus* of Lea (*A. idoneus?* Conrad) in having two smooth bands on the upper portion of the body-whorl instead of one. Mr. Lea mentions having in his cabinet a species from the Paris basin also with two bands, but I fail to discover the same described in the work of M. Deshayes.

PISANIA, Bivon.

Pisania bucciniformis, nob. Pl. xiii., fig. 7.

A fragment only of this, the first described species of true *Pisania* existing in the Eocene formations of the United States has come to my notice. The body-whorl is about $\frac{2}{5}$ inch in length, striated on the inferior portion, and with a slightly impressed line beneath the suture; mouth about $\frac{3}{4}$ length of body-whorl; canal almost obsolete; columella arcuate, wrinkled at base; outer lip striated within by about seven elevated ridges.

Length ?.

Claiborne, Ala.

The *Pisania Claibornensis* of Whitfield (Am. Journ. Conchol., vol. i., p. 259) appears from the description and figure to be more nearly related to *Triton*.

CONUS, L.

Conus pulcherrimus, nob. Pl. xiii., fig. 8.

Shell conical; spire elevated; whorls about seven, slightly concave above, granularly crenulated on the angle, and transversely striated; a prominent simple line below the angle, and one of granulations beneath the suture. Aperture?

Length about $\frac{1}{2}$ inch.

Claiborne, Ala.

PLEUROTOMA, Lam.

Pleurotoma insignifica, nob. Pl. xiii., fig. 9.

Shell fusiform, with prominent revolving lines below the middle of the whorl; spire elevated; whorls about five, angular; canal short, obliquely curved; mouth contracted.

Length $\frac{1}{4}$ inch.

Claiborne, Ala.

The description and figure of *Fusus nanus* as given by Lea in his "Contributions," agree in all essential respects with the above. No mention is made of the sinuated lines of growth peculiar to the Pleurotomæ, which in our specimens are very distinct. Although I have not had an opportunity to examine Mr. Lea's specimens, it appears to me, nevertheless, highly probable that his *Fusus* will prove to be a *Pleurotoma*.

Pleurotoma denticula, Baterot. Pl. xiii., fig. 10.

This species, which is one of the most widely diffused of all fossil Pleurotomæ, has to my knowledge not been hitherto described as occurring in any American formation. The *P. nodocarinata*, Gabb (unfortunately very poorly figured), in the collections of the Academy belongs to this species. Specimens are to be found also in the Claiborne accumulation of the American Museum of Natural History, New York.

MELANIA, Lam.

Melania Claibornensis, nob. Pl. xiii., fig. 11.

Shell elongated, turreted; whorls eight, of which the first three are smooth, and the rest furnished with longitudinal folds, those on the body-whorl terminating at about the middle; folds cut by numerous deeply impressed revolving lines, giving a somewhat imbricated appearance; mouth elongated, oval contracted above, and expanding at the base; columella broad, flattened.

Length .3 inch.

Claiborne, Ala.

This species, to which I have provisionally applied the specific name of *Claibornensis*, is doubly interesting as being the only essentially fresh-water gasteropod found in the Claiborne marine formation and of being at the same time most intimately related to a species found in the Paris basin, *Melania mixta*, Deshayes. It agrees essentially with all the characters as given by Deshayes, and on comparison with his specimens will in all probability prove to be identical.

RISSOINA, D'Orbigny.

Rissoina plicato-varicosa, nob. Pl. xiii., fig. 12.

Shell sub-turreted; whorls about seven, convex, ornamented with numerous longitudinal folds (on the body-whorl from 10 to 12), and disfigured by several prominent varices; revolving lines numerous, less prominent on the middle of the whorls; aperture ovate, produced into a short canal.

Length $\frac{1}{4}$ inch.

Claiborne, Ala.

This species closely resembles, but is less slender, than the *Rissoa inchoata*. Desh., of the Paris basin.

MESOSTOMA, Deshayes.

Mesostoma rugosa, nob. Pl. xiii., fig. 13.

Shell conico-turbinate; whorls about seven, scalariform, the first three smooth, the rest ornamented with oblique longitudinal plications, which are crossed by five prominent and a number of lesser revolving ridges, giving the whole a cancellate appearance; the folds on the body-whorl cease abruptly below the middle; aperture sub-circular, dilated, and produced into a short oblique canal; outer lip somewhat crenulated by the terminations of the revolving ridges.

Length .4 inches.

Claiborne, Ala.

Four species in all are catalogued as belonging to this genus, all from the Eocene of France. The above species differs from the *M. grata*, Desh., of the Paris basin only in the number of its revolving ridges. The *Cerithioderma prima* of Conrad, from the American Eocene, is a *Mesostoma*.

Note.—There is some difficulty in determining the priority in the institution of the genera *Mesostoma* and *Cerithioderma*. Tate (Appendix to Woodward's "Manual," 1868) quotes the genus *Mesostoma* from the year 1864, whereas that portion of Deshayes's work, wherein the genus is described, bears the date of 1858. This is the second year of the publication of the entire work, and as the first volume (Lamellibranchiata) was not completely issued until 1860, it is highly probable that the genus was not characterized prior to that year. Conrad published his genus *Cerithioderma* in March, 1860 (J. A. N. S., vol. iv., 2d series), as founded upon a single species *C. prima*, but as his characterization is vague and very meagre, it appears more natural to accept the genus of Deshayes, which has already been accepted by most conchologists.

ROSTELLARIA, Lam.

Rostellaria Whitfieldi, nob. Pl. xiii., fig. 14.

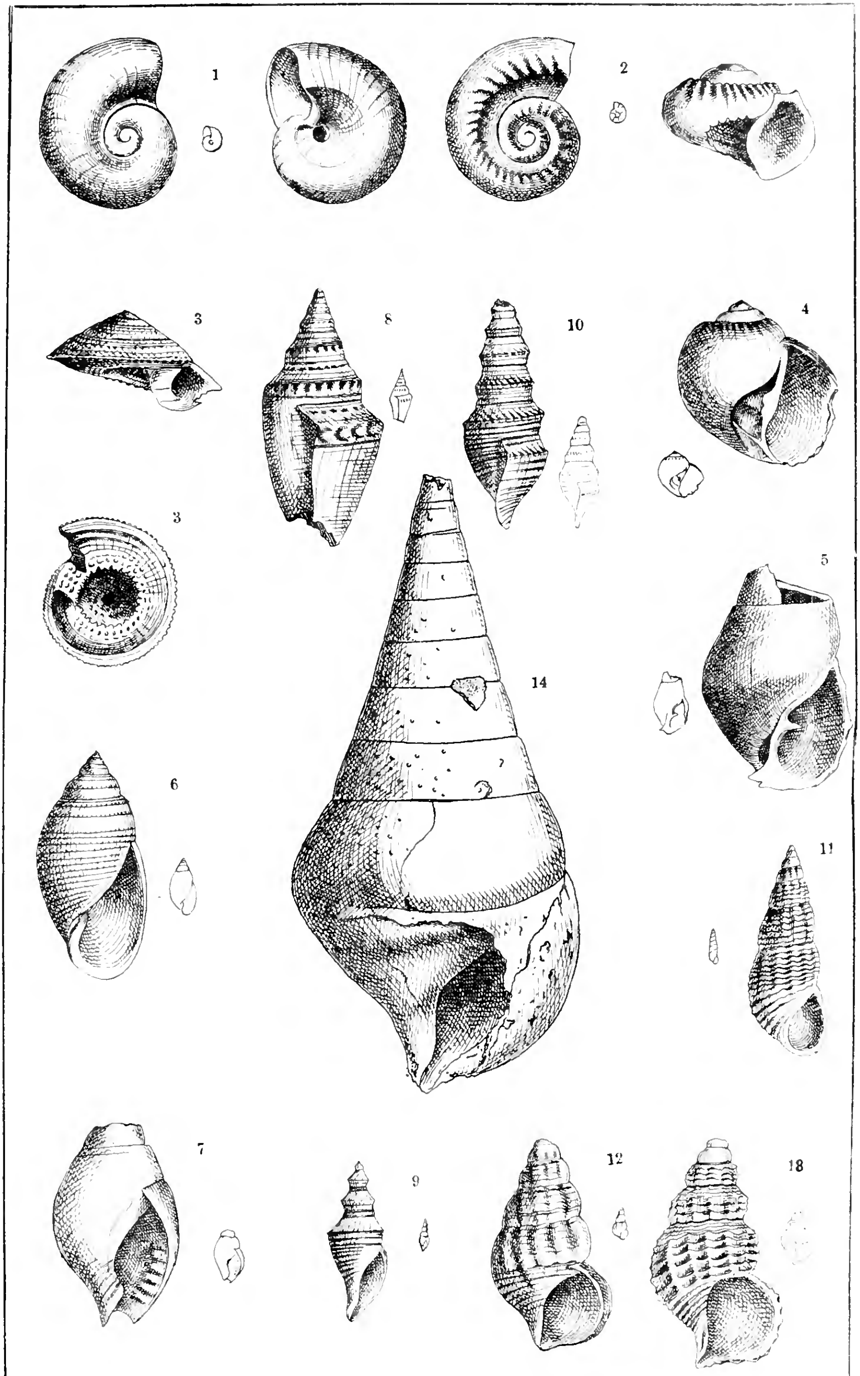
Shell fusiform ; spire tapering, consisting of about nine flattened volutions; body-whorl sub-angulate beneath ; columella flexuous, with traces of an obtuse fold; outer lip with a swollen prominence in the apertural region ; wing ?

Length 3–4 inches.

Claiborne, Ala.

Named in honor of R. P. Whitfield, Esq., the distinguished American paleontologist and colaborer with Prof. James Hall in the great work on the paleontology of the State of New York.

Two specimens of this species, both unfortunately bereft of their wings, are in possession of the American Museum of Natural History of New York. Their characters are so decidedly at variance with those of any other American Eocene *Rostellaria*, that we feel no hesitation in applying to them a specific name, although the broken nature of our specimens necessitates an incomplete description. Allied species occur in the London clay and in the Paris basin.



A H del.

HEILPRIN ON EOCENE FOSSILS.

A COMPARISON OF THE EOCENE MOLLUSCA OF THE SOUTHEASTERN UNITED STATES AND WESTERN EUROPE IN RELATION TO THE DETERMINATION OF IDENTICAL FORMS.

BY ANGELO HEILPRIN.

The study of the fauna, whether extinct or living, of any country resolves itself into two distinct methods of investigation, the general and the comparative. In the general method we look upon an assemblage or community of animal forms as constituting an integral part of the country it characterizes, and we then consider it only in relation to that country and to itself (the animal forms *inter se*). In the second or comparative method we no longer regard this community as constituting a whole or unit, but merely as a part of a more extensive community, and we now view it in the relation of a part to a whole. This comparative system of investigation, which, it will be manifest, involves a thorough general acquaintance with all or most extraneous faunæ as well as the one under special consideration, is one of great difficulty, and one that requires more than an ordinary amount of acumen in its pursuit, for in the broad facts of geographical distribution are connected some of the profoundest biological and physical problems. The study of comparative or geographical zoölogy constitutes one of the essential factors of biological science, for without a true understanding of the general affinities of scattered groups of animals, our conception of the organic universe would be one of disjointed parts instead of a continuous whole. We know, in fact, little of a whole unless we comprehend its relation to its component parts, and *per contra*, we know little of a part unless we understand the relation it bears to the whole.

The subject of geographical distribution in its bearings on geology, whether considered in its broader sense as pertaining to groups, or in the more limited sense as pertaining to the individuals composing those groups, cannot be over-estimated. It is by the recurrence over broad or scattered areas of certain related animal types, and sometimes even over the most remote areas of identical specific forms, that the palæontologist is enabled to arrange and classify his strata. One single well-determined fossil will, in the absence of further data, frequently determine approximately, and sometimes exactly, certain geological horizons, and although we cannot in most instances, as Prof. Huxley has forcibly pointed out, positively, or even approximately, correlate, as far as age is concerned, distantly separated formations, we can to a very great extent correlate the cosmical conditions under which the formations in question were deposited. The correct determination, therefore, of all organic remains is one of the greatest importance.

Unfortunately for the development of the science, the doctrine that identical specific forms cannot, or ought not, occur over widely separated areas has taken root in the minds of a few of the most eminent scientific investigators, the baneful effects of whose authority in relation to this special line of research, will be encountered by the student at almost every step in his investigations. The science of geographical palæontology, at least as far as the invertebrata are concerned, may be said to be in this country still in a state of infancy, a circumstance partly due to the limited number of workers in the field, and partly to the influences just stated.

I have endeavored in the following pages to summarize as nearly as possible the results obtained from a series of comparisons between the Eocene mollusca of Western Europe and that of the Southeastern United States, undertaken with the view of determining with a certain amount of precision the number of identical and very nearly related species. My comparisons were in a number of cases made between actual specimens, and those mainly determined in the localities to which they belong; where no specimens could be obtained I was compelled to content myself with the various analyses of the descriptions and figures afforded by the works of the most competent authorities. The result shows a far greater intimate relationship to exist between the two faunæ than one is led to suppose from an examination of the "Check List" prepared by Mr. Conrad for the Smithsonian Institution for 1866, where, in fact, only about five species are enumerated as common to the Eocene deposits of both shores of the Atlantic, viz.: *Ostrea* (*Gryphostrea*) *eversa*, Deshayes; *Cardita planicosta*, Lam.; ? *Phorus* (*Onustus*) *extensus*, Sow.; *Hippocrenes columbaria*, Defr.; and (?) *Voluta* (*Volutilithes*) *mutata*, Desh. In addition to these Conrad enumerated in 1833 ("Fossil shells of the Tertiary Formations," p. 34) the following: *Solarium patulum*, Lam.; *S. canali-*

culatum, Lam.; *Bulimus* (*Niso*) *terebellatus*, Lam.; *Sigaretus canaliculatus*, Sow.; *Calyptræa* (*Trochita*) *trochiformis*, Lam.; *Pyrula tricarinata*, Lam.; *Avicula trigona*, Lam.; *Cytherea erycinoides*, Lam.; *C. suberycinoides*, Desh.; *Corbis lamellosa*, Lam.; and *Fistulana elongata*, Desh., most of which on examination prove to be as well American as European forms. In the Appendix to Morton's Synopsis ("Synopsis of the Organic Remains of the Cretaceous Group," 1834) only six European species are recognized as occurring in the American formation: *Solarium canaliculatum*, Lam.; *S. patulum*, Lam.; *Bulimus terebellatus*, Lam.; *Cardita planicosta*, Lam.; *Corbis lamellosa*, Lam.; and *Fistulana elongata*, Desh. In the list published by Conrad in 1846 (Amer. Journ. Science, 2d ser. vol. i. p. 219), of the preceding enumerations only two species are retained as being "analogous" to transatlantic forms, *Cytherea Mortoni*, Con (*Cytherea erycinoides*, Lam.; and *C. suberycinoides*, Desh.) and *Avicula limula*, Con. (*A. trigona*, Lam.), but in addition we have five new ones catalogued: *Cardita Blandingi*, Con. (*C. acuticosta*, Lam.); *C. rotunda*, Lea. (*C. asperula*, Desh.); *Cardium Nicolleti*, Con. (*C. semigranosum* [—*granulatum*], Sow.); *Turritella Mortoni*, Con. (=?); and *Rostellaria laqueata*, Con. (*R. fissurella*, Lam.). Finally, all species considered identical prior to 1866 are rejected as such with one exception (*Cardita planicosta*) in the Smithsonian List. The reasons for so doing, which, in the majority of cases, I believe, are not stated, appear to me incomprehensible.

In the introduction to his "Contributions to Geology," 1833, p. 19, Mr. Lea states that he is "not perfectly satisfied that a single species is strictly analogous to those from the Eocene Period of Europe . . . . .", but in a note (pp. 207, 208) makes the following comparisons: *Pasithea umbilicata*, Lea, with *Bulimus terebellatus*, Lam.; *Venericardia rotunda*, Lea, with *V. squamosa*, Lam.; *Pectunculus obliqua(nus)*, Lea, with *P. nanus*, Desh.; *Ostrea divaricata*, Lea, with *O. flabellula*, Lam.; and *Solen Blainvillii*, Lea, with *Solen effusus*, Lam.

The list herewith appended, and which it is my intention to complete at a future date, will, I trust, increase our knowledge on the interesting questions of relationship and geographical distribution.

Ostrea divaricata, Lea. "Contributions to Geology," p. 90, pl. 3, fig. 69.
O. sellæformis, Conrad, *pars* ?

This oyster is referred without doubt both by Nyst ("*Coquilles et Polypiers Fossiles*," 1843, p. 323) and Giebel (*Repertorium* to Goldfuss' "*Petrefacta Germaniæ*," 1866, p. 41) to the *O. flabellula* of Lamarck, which is a very variable, and one of the most widely diffused forms of fossil oyster. It is cited by D'Orbigny (*Prodr. de paléon.*) as occurring at Claiborne, Ala., and by Deshayes (*Animaux s. vert., bassin de Paris*) also at Cutch in India and Cairo in Egypt.

Pecten Deshayesii, Lea. Contr. p. 87, pl. 3, fig. 66
(*et P. Lyelli*, acc. to Conrad ?).

This *Pecten* is referred with but little doubt by Nyst (*Coqu. et Pol.*, p. 288) to *P. opercularis*, Lamk., which species, however, belongs to a much more recent period than the Eocene of Alabama. On the assurance of identity Nyst in 1836 founded upon a new Belgian *Pecten* the specific name of *Deshayesii*, but his fossil must be carefully distinguished from the American one in question. Having seen but one example of Lea's species I am unable to make the proper comparisons.

Cardita rotunda, Lea. Contr. p. 70, pl. 2, fig. 48, as *Venericardia*.

This species very closely resembles the *Cardita imbricata* of Lamarck, to which, in the absence of specimens, it is with some hesitation referred by Nyst (p. 209), and also by Bronn (*Index Palæontologicus*, I. 226). The only difference that I could detect between the two species, on an examination of numerous specimens from Grignon, France, and Claiborne, Ala., was that in the *C. imbricata* there was a tendency in the ribs of the posterior slope to become crowded. As some specimens of both forms, however, could not readily be distinguished from each other, I believe this circumstance to be mainly accidental, and therefore consider the *C. rotunda* as certainly nothing more than a mere variety of *C. imbricata*.

Cardita planicosta, Lamk.

This species of *Cardita*, which is so extensively distributed over the Eocene deposits of Europe, is certainly identical with the similar forms of *Cardita* found in the same formation of the United States. Lea (Cont. p. 19) states that according to his observations the American species differs from the European in the number of its costæ (about 29 instead of 34), but on an examination of numerous French specimens I found the number to be frequently only 29.

Cardium Nicolleti, Conrad. J. A. N. S., viii. p. 190.

This *Cardium* will, I believe, on close examination prove to be the *C. semigranulatum* of Sowerby (Mineral Conchology, II. p. 99). It does not differ from a species of *Cardium* in the Academy Museum marked "*C. semistriatum*, London Clay," but as the *C. semistriatum*, Deshayes, differs in the arrangement of its granulated striæ from the specimen in question marked *semistriatum*, and as the last agrees in characters with the description accorded by Sowerby to *C. semigranulatum*, it is highly probable that the names have been simply reversed.

Corbis (Gafrarium) lirata, Con. A. J. Science, I., 2d ser. p. 401.

This species was originally described by Conrad as the *C. lamellosa*, Lam., with the characters of which it was found to agree in all essential respects. I have been unable to note any material difference between the two species in question, and do not hesitate, after an examination of a number of specimens representing Lamarck's type, to unite the two under the one specific name of *lamellosa.*

Limopsis ellipsis, Lea. Contr. p. 78, pl. 3, fig. 56, as *Pectunculus.*

This species closely resembles in general characters the *L.* (*Stalagmium !*) *Nystii* of Galeotti, from which it mainly differs in the greater number of teeth both in the anterior and posterior series, the number in each series rarely falling below twelve.

Limopsis aviculoides, Con. Foss. Shells of Tert., p. 39, as *Pectunculus.*
(*Pectunculus obliquus*, Lea.)

Bronn (*Index Palæont.*, ii., p. 936) allies this species with the *Limopsis nana* of Deshayes, from which it differs very materially in the greater elevation of the umbones and cardinal region. Nyst considers it as closely related to *Trigonocœlia auritoides*, Gal., but the obliquity in form is much greater in the American species. It differs from the *Limopsis aurita* of Sassi (*Arca aurita*, Brocchi, "*Conchiologia Fossile Subapennina*," ii., p. 485) in having a crenulated margin.

Corbula oniscus, Con. A. J. Science xxiii., p. 341.
C. Murchisonii, Lea.

This species is referred by Bronn (*Index Palæont.*) to the *C. rugosa* of Lamarck, to the description of which, as given by Deshayes ("*Coquilles Fossiles*," i., p. 51) it agrees in all essential respects. As in the case of the French species it frequently resolves itself into two layers, the inner of which may at first sight be readily mistaken for a new species (*C. bicostata?* Nyst). The *C. gibba*, Olivi, which, according to Nyst, is the equivalent of *C. Murchisonii*, Lea, is a Miocene (?), Pliocene, and living species. I have been unable to institute direct comparisons for want of specimens.

Cytherea Mortoni, Con. J. A. N. S., vii., p. 150.

This species of *Cytherea* was originally confounded by Conrad with the *C. erycinoides*, Lam. (Foss. Shells of Tert., 1832, p. 34), but a close examination shows the latter to be comparatively more elevated, and its ribs to be proportionately much more robust.

Trochita trochiformis, Lea. Contr., p. 96, pl. 3, fig. 76.

This species, described as new by Mr. Lea in 1833, is synonymous with *T.* (*Calyptræa*) *trochiformis* of Lamarck (*Trochus apertus*, Brand.).

Cylichna galba, Con. Foss. Shells of Tert., p. 34, as *Volvaria*.
(*Bulla St. Hillairii*, Lea.)

This species appears to me to be erroneously referred by Bronn to *Bulla constricta*, Sow. (Miner. Conch., vol. v., p. 96), as Sowerby's species has no fold on the columella, at least no mention is made of it in his description, nor does it appear in his figure. Our species appears to be closely allied to if not identical with *Bulla Brocchii*, Bronn, an Italian (Miocene?) species (Brocchi, *Conch. Foss. Subapenn.*, ii., p. 277, as *Bulla ovulata?* Lam.).

Cyprædia fenestralis, Con. Proc. A. N. S., vii. p. 262.

This appears to me to be identical with *Cypræa* (*Luponia*, Gray) *elegans* of Defrance, from which I cannot discover any distinguishing characters. Conrad states that no mention is made by Deshayes in his description of the fossil of the Paris basin of "microscopical regular lines," but an examination of a specimen in the Academy collection shows them to be present.

Tornatella (Actæon) pomilia, Con. Foss. Shells of Tert., p. 45.

Actæon punctatus, Lea.
Monoptygma elegans, Lea.
=*Tornatella inflata?* Férussac.

Tornatella (Tornatellæa) bella, Con.

A comparison of this species with Sowerby's description and figure of *Actæon simulatus* (*Bulla simulata*, Brander) leaves no doubt that the two species are identical. Nor does a comparison of actual specimens, from Alabama and Barton, England, show any varying characters.

Fusus (Bulbifusus) inauratus, Con. Foss. Shells of Tert., p. 29.

This species is more closely allied to *F. bulbiformis*, Lam., than to *F. ficulneus*, Lam., to which last it is doubtfully referred by Bronn (p. 512). It differs from the former, however, in having the canal more produced, in the whorls being strongly subangulate above, and in the superior ones being crenulated on their basal margins.

Pyrula penita, Con. Foss. Shells of Tert., p 32.
P. tricarinata, Con.
P. cancellata, Lea.
P. elegantissima, Lea.

I am disposed to consider the above as identical with *Pyrula nexilis*, Lam. (and var. *P. tricarinata*, Lam.), which is a most variable fossil. Both American and European forms appear in the most diverse stages of convexity and angulation. Conrad, although he subsequently separated the transatlantic forms into two distinct species, states (Foss. Shells of Tert., 2d ed., p. 39), "that the variety is not distinct I am assured by comparison of many specimens." I am also inclined to unite with the above the *P.* (*Fusus*) *Mississippiensis*, Con.

Oliva bombylis, Con. Foss. Shells of Tert., 2d ed., p. 42.
(*O. constricta*, Lea.)

Differs from the *O. mitreola*, Lam., in having the plications at base less numerous and somewhat less regular, and in wanting the upper of the two impressed revolving lines on the body whorl. In the absence of the line it agrees more closely with *O. nitidula*, which was separated by Deshayes from the *O. mitreola* as a distinct species. The *O. Brocchii*, Bronn (*Voluta ispidula*, L. var. Brocchi "*Conch. Foss. Subapenn.*," ii., p. 315, pl. iii., fig. 16), which is as well a Miocene, and perhaps even living species (Bronn, iii., p. 481), appears to be very clearly related to our species.

Cancellaria tortiplica, Con. Am. Journ. of Conchol., vol. i., p. 211.

On an examination of specimens of this species and *C. evulsa*, Brander (from Barton, England) I find the two to be most intimately allied to each other, the main difference being that the *C.*

tortiplica is somewhat more slender and elevated. As this may be only an accidental feature in the few examples which have come under my notice, I feel but little hesitation in uniting the two as one species. Bronn and Nyst (p. 477) refer with some doubt the *C. parva* of Lea to Brander's type, but this diminutive Alabama species has only two plaits on the columella, and is destitute of varices.

Niso umbilicata, Lea. Contr., p. 103, as *Pasithea*.
Niso terebellatus, Lamk.

I have been unable to detect the slightest difference between specimens obtained from both species.

Sigaretus canaliculatus, Sow. Min. Conch., iv., p. 115.

This shell is mentioned by Conrad (Foss. Shells of Tert., 2d ed., p. 34) as occurring at Claiborne, Ala. It is probably identical with *S. declivus* and *S. bilix*, Con., which differ among themselves about as much as they do from the European species.

Solarium ornatum, Lea. Contr., p. 120.

This species is placed without doubt by Bronn (ii., p. 1153) as synonymous with *S. canaliculatum*, Lam. The description and figures as given by Deshayes (*Coqu. Foss.*, ii., p. 221) answer perfectly to the American species, and I feel no doubt but that an examination of specimens of both species will prove their identity. The *S. canaliculatum* is mentioned by Conrad (Foss. Shells of Tert., 2d ed., p. 34) as occurring in the Alabama Eocene deposits.

Pleurotoma denticula, Bast. Descrip. Géol. du Bass. Ter. Sud-ouest de la France, 1825, p. 63.

On a comparison of specimens of the *P. nodo-carinata*, Gabb (J. A. N. S., 2d series, vol. iv., p. 379), with the exhaustive analysis of the above species as given by Mr. F. E. Edwards in his "Monograph of the Eocene Mollusca" of England (Reports of the Palæontographical Society), I feel no hesitation in including it among the numerous varieties of Basterot's species. No mention is made by Gabb of a division of the central crenulation into a double series, but at least some of the specimens deposited in the Academy Museum, and marked with his specific name, show this feature distinctly. The *P. denticula* is a very widely distributed species of *Pleurotoma*, its range in Europe extending from England through Belgium (Nyst, "*Coqu. et Pol. Foss.*" p. 526) and France (Basterot, *sup.*; Grateloup "*Conchyl. Foss. des Terr. Ter.*," atlas, pl. 11 (20) fig. 8) to North Italy (Bellardi "*Monog. Pleurot. Foss. del Piem.*," *Memorie della Reale Accademia di Torino*, 2d ser., vol. ix., p. 576). This species corresponds probably to some extent with Sowerby's *P. comma.* Unquestionable specimens of *P. denticula* from the Eocene of Alabama are to be found in the American Museum of Natural History of New York.

Mesostoma rugosa, nob. Proc. A. N. S., Oct. 1879.

This species might readily be mistaken for the *M. grata*, Desh., of the Paris basin, from which it differs only in the greater number of its revolving ridges.

Melania Claibornensis, nob. Proc. A. N. S., Oct. 1879.

This diminutive *Melania*, which to my knowledge constitutes the only essentially fresh-water gasteropod found to the present time in the Claiborne marine formation, cannot in its characters be readily distinguished from the *M. mixta*, Desh., of the Paris basin (description and fig. in Desh. "*Animaux s. vert.*"). Having observed but one specimen, and not wishing to definitely deduce its affinities from the characters drawn from a single example, I have provisionally applied to the American shell the specific name which it bears above.

A close comparison of the Eocene mollusca of the east and west Atlantic shores will, I am confident, reveal a larger number of identical forms than those enumerated in the above list. The *Naticidæ* and *Pectunculidæ*, two families requiring acute revision, appear more especially to be intimately related in their specific forms.

REVISION OF THE PALÆOCRINOIDEA.

BY CHARLES WACHSMUTH AND FRANK SPRINGER.

Introduction.

According to Miller's catalogue of American paleozoic fossils, there have been described, in this country alone, up to the summer of 1877, about 800 species of Crinoids, not including Blastoids and Cystideans. If we add to this number some 400 species from Europe —an estimate which is certainly not exaggerated when we remember that Schultze described from the Devonian of the Eifel alone 73 species; DeKoninck and Le Hon from Belgium 45; and Angelin from the Silurian of Sweden 176—we have from both countries about 1250 species. Making due allowance for synonyms, we have possibly 1000 good species, which are distributed among from 150 to 175 genera. Many of the latter were established at a time when our knowledge of the Crinoids was in its infancy. They were frequently founded upon one or two species, often, indeed, on a single imperfect specimen; which resulted in many defective, insufficient, and not unfrequently incorrect descriptions, producing endless perplexing complications afterwards

There was a time when nearly every fossil Crinoid was *Encrinites*. This was the case almost until 1821, when J. S. Miller described his well-known genera *Poteriocrinus*, *Actinocrinus*, *Platycrinus*, *Rhodocrinus*, and *Cyathocrinus*, which have been universally adopted by the later paleontologists—with the exception, perhaps, of *Cyathocrinus*, which was badly defined by him. As new species were discovered, the founding of additional genera progressed, and generic distinctions came to be recognized between groups of forms, which substantially agreed in the arrangement of the plates of the body, but differed in the anal plates, the construction of the arms, and other characters to which but little attention had before been paid. Through such separations it resulted in many cases that the parental genus was divided up into a number of genera, and it finally became evident that some of the features which had been considered of mere generic importance, were family characters. The majority of the genera thus established have been adopted by most of our leading paleontologists, but by some entirely ignored. It is a singular fact that European authors have commonly refused to accept our genera of *Actinocrinidæ*, while they sustained those of the *Cyathocrinidæ*, which are certainly no better defined. This is doubtless due to the fact that in Europe the *Actinocrinidæ* do not abound in such wonderful variety as in this country. If our European brethren had to deal with nearly 300 species, as we have, they would perhaps be more ready to accept our divisions.

As early as 1842 T. Austin and T. Austin, Jr. (Rec. & Foss. Crinoidea), undertook to subdivide the Crinoidea into families, but they were not very successful, as they placed together types of very distinct groups. Roemer (Lethæa Geognostica, 1855, 3d Ausgabe) made another attempt in the same direction. He was the first author who pointed out correctly the relations of the Blastoids and Cystideans with the true Crinoids; and, if he was not so fortunate in establishing his families, we must consider how imperfectly Crinoids were known at that time. Some of Roemer's family names are still in use, but scarcely two of our present authors interpret them alike.

The late Prof. Angelin[1] divided the Silurian Crinoids of Sweden into four sections: *Trimera*, *Tetramera*, *Pentamera*, and *Polymera*. A subdivision according to the number of basal plates may facilitate elementary studies, but it is certainly not a natural classification. Genera which are evidently intimately related—for instance, *Platycrinus* and *Dichocrinus*, *Melocrinus* and *Rhodocrinus*—are thereby widely separated, while very distinct types, such as *Rhodocrinus* and *Poteriocrinus*, are brought together. Angelin arranged his 40 genera of Swedish Crinoids under 23 families; but, as he gave no diagnoses of them, we are at a loss to know upon what principle his families were established.

In the second part of an article on the "Internal and External Structure of Paleozoic Crinoids," by Chas. Wachsmuth, published in the August and September numbers of the Amer. Journ. Sci., 1877, one of the writers gave a minute description of the summit

[1] In the *Iconographia Crinoideorum in stratis Sueciæ Siluricis fossilium, auctore N. P. Angelin*, opus posthumum edendum curavit Regia Academia Sueciæ, cum tabulis XXIX. This is one of the finest illustrated works on Crinoids that has ever been published, and it must be regarded as a great loss to science that the distinguished author died before the completion of his work.

or ventral disk of the earlier Crinoids, and reached the conclusion that the construction of the vault affords good characters for a separation into families. He distinguished three principal plans —though he admitted the existence of a number of others—upon which the summit is constructed:—

1. The summit composed of a more or less pliable, sometimes perhaps squamous, integument, yielding to motion in the body and arms.

2. The summit composed of solid plates with a porous ventral sac, located posteriorly on the disc, and closed at the top. Anal opening rarely observed, but probably lateral.

3. The summit composed of heavy immovable plates, closely joining and forming a dome arching the entire oral side. Anal opening directly through the wall of the dome or at the extremity of a tube, the so-called proboscis.

We have since given this subject our special attention, and find that these diversities in the construction of the ventral portion of the body bear a striking relation to the general arrangement of the plates of the dorsal side; that the parental genera to which we have referred have each their own peculiar summit structure, and that the genera into which they were subsequently subdivided are characterized by mere differentiations of the original plan. We find that *Ichthyocrinus* and its congeners, *Taxocrinus*, *Mespilocrinus*, etc., which are embraced in almost the same generic formula, possess summit structure No. 1; that in *Cyathocrinus*, *Poteriocrinus*, *Heterocrinus*, and all genera with five basals, five subradials, and five radials, the summit structure agrees with No. 2; and that the *Actinocrinidæ*, *Platycrinidæ*, and *Rhodocrinidæ*, with their numerous genera, are constructed like No. 3. We consider that the last three groups are subdivisions of one great group, and propose to introduce them hereafter as subfamilies. These three, or, as we may say, five families thus indicated, include more than one-half of all known paleozoic Crinoids. The others we leave for future consideration.

The absence of an external oral aperture is most remarkable in the anatomy of the earlier Crinoids. The actinostome, or oral centre, is situated beneath the vault, and forms the radial centre of a peculiar skeleton of tubular passages which connect with the arms. These passages beneath the vault are evidently homologous with the food grooves and ambulacral canals at the peristome of recent Crinoids, the vault being thus a mere covering or protection. That the mouth was internal in the majority, if not all paleozoic Crinoids, as well as all the Cystideans and Blastoids, is very significant, and impresses us most forcibly with the idea that the earlier Crinoids form a distinct group, and that the solid covering may have been essential under the conditions that prevailed in paleozoic times.

The genus *Lichinocrinus*, which Hall describes from the Lower Silurian of Cincinnati, affords an instructive example in this respect. In this interesting form, the oral or ventral side was always attached to a shell, coral or other foreign substance; the dorsal side has a long stem, but whether this was attached to the bottom or not, is not known. The oral side, when found detached, which is of very rare occurrence, shows a large number of striæ, which converge to a very small opening in the centre. According to our interpretation, this opening is the mouth, the striæ the food passages, and the shell to which the ventral side is attached, takes the place of the vault, which is as yet undeveloped.

Another very characteristic distinction between ancient and recent Crinoids is to be found in the comparatively large size and massive body plates in the fossil, contrasted with the diminutive body and very long and highly developed arms of recent types; and the same is even more strikingly true as to Blastoids and Cystideans. To illustrate, we might say that in the *Pentacrinidæ* they are fully developed; that they are in progress of growth in paleozoic Crinoids, and that they are only budding or sprouting in Blastoids and Cystideans; while in *Lichinocrinus*, which is probably still lower in the scale of organization, the arms have not yet made their appearance.

Upon these distinctions, principally, Wachsmuth (Am. Journ. Sci., Sept. 1877, p. 190) proposed to separate the paleozoic from the recent Crinoids, under the name PALÆOCRINOIDEA, as a suborder of the Crinoids, of equal rank with the BLASTOIDEA and CYSTIDEA.

To facilitate a better understanding of the two groups, we now direct attention to certain organs which have been known to exist in Cystideans and Blastoids, and which we think existed in a modified form in the Paleocrinoids. These organs, which were called "hydrospires" by Billings (Am. Journ. Sci., July, 1869, p. 75), occupy rather large spaces within the body in the first-named groups, and this may perhaps explain in a measure the comparatively large size of the calyx in the older Crinoids generally. The hydrospires were located within the perivisceral cavity, connected with the inner floor of the test, and communicated, so far as ascertained, through the test with the outside water. In the Cystideans the hydrospires are of a rhomboidal shape—each rhomb being divided into two triangles by a suture between two of the plates (Pl. 17, Figs. 7, 8.). In *Caryocrinus ornatus*, each of the four sides of the rhombs is bordered by a row of small tubercles (Pl. 17, Fig. 6), some of which have a single pore in the apex, while others are perforated by two to twenty or more. The pores penetrate through the plates, but do not communicate directly with the visceral cavity of the body. Internally, each hydrospire consists of a number of flattened tubes, arranged parallel to each other, and each tube receives two of the pores, one at each end. In a large hydrospire, there are about twenty or more tubes. Whatever may have been the special function of these tubes, naturalists generally agree that they belong to the respiratory system, and we infer from the distribution of the pores in variable numbers at and about the apices of the tubercles, that they very probably served as a madreporic apparatus, through which water for respiration was introduced and expelled. In other genera of the Cystideans, we find in the test one or more striated rhombs with fissures and pores, somewhat resembling the madreporic body of other Echinoderms.

In the Blastoids, there are certain orifices arranged around the actinal pole, which have been called ovarian apertures on account of their supposed resemblance to similar openings in the Ophiurans, but if they were connected with the reproductive organs, which is by no means proved, they evidently had additional important functions. These openings appear in various forms. We find in the earlier types fissures arranged on the upper portion of the body; at a later period slits along each side of the ambulacra, and in the latest and higher types, five pairs of orifices which surround the oral centre. None of these openings communicate with the general cavity of the body, but they all connect with peculiar organs closely resembling the internal tubes of *Caryocrinus*, and which are also called "hydrospires." The hydrospires of the Blastoids, though actually arranged interradially, are located beneath the ambulacra, and occupy the perivisceral cavity, extending laterally for some distance beyond the sinus along the inner side of the forked plate. In most genera, they are constructed upon the same general plan. There are ten sacs (compare Pl. 17, Fig. 5) which do not connect with each other, disposed in pairs, one pair to each ambulacrum, and each pair separated by the lancet piece. Toward the visceral cavity, they are folded into a number of longitudinal plications, which show neither pores nor passages. The inner and outer folds alternate with each other, and are distended at their closed ends. On approaching the apex of the body, they coalesce to form two separate sets of tubes. The tubes from the inner folds are formed by the adhesion of the walls of the outer, and, *vice versa*, so that the folds which open toward the visceral cavity give rise to the outer set of tubes, while those opening in the opposite direction become the inner tubes. The former terminate within coridors leading to the so-called ovarian orifices, those of each two adjoining hydrospires of two different ambulacra terminating in one orifice; while, the latter communicate with an annular organ located against the inner wall of the test and surrounding the oral centre. The number of folds varies from three to nine or more. The walls of the sacs, which were evidently composed of fine membranous substance, must have been strengthened by the secretion of calcareons particles, or they would not be found so well preserved; and they were flexible since we find the folds in various degrees of expansion. *In Codaster*, one of the earliest and probably one of the lowest type of the Blastoids, and in *Codonites*, its subcarboniferous representative, there is in place of the folded sacs a large number of tubes placed side by side, and arranged parallel with the external fissures or grooves. This structure of the hydrospires so closely resembles that of some of the Cystideans that Billings proposed to remove *Codaster* from the Blastoids and place it among the Cystideans. This we cannot endorse, but we do agree with him, that whatever may have been the functions of the calycine pores, pectinated rhombs, and internal tubes in the Cystideans, those of the parallel tubes or folded sacs in the Blastoids must have been very similar if not identical.[1]

1 We have given above the description of the hydrospires in *Pentremites*. Those of *Granatocrinus* and *Nucleocrinus* vary in some of the details. One of us, who devoted much time to the study of the Blastoids, made a large number of sections of the hydrospires, in different genera, and finds

No such organs have ever been described in the true Crinoids neither from the Palæocrinoidea nor the Pentacrinidæ.

We have given so minute a description of the hydrospires as they occur in the Cystideans and Blastoids, partly because they have been indifferently known, but also in order that we may better compare with them certain organic structures, which we have discovered in some Paleocrinoids, and which we think still further distinguish the latter from recent Crinoids, while at the same time indicating a closer relationship with the Blastoids and Cystideans.

Wachsmuth, in Am. Journ. Sci., Aug. 1877, p. 126, noted a marked difference between the proboscis in the *Actinocrinidæ* and that in the *Cyathocrinidæ.* He considered the former a mere anal tube, or prolongation of the anal opening; but this organ in the *Cyathocrinidæ* he believed to be an essential part of the body, in which the anal opening, here located laterally and low down, is of but secondary importance, and therefore proposed to call it "ventral sac" instead of proboscis. We have since had occasion to examine the ventral sac in several most excellent specimens, particularly with reference to the pores to which he called attention, and have become convinced that these are very probably the homologues of the calycine pores in the Cystideans. The plates of the ventral sac in the *Cyathocrinidæ* are usually comparatively large, rather thin, hexagonal pieces, longitudinally arranged, alternating with those of the adjoining rows. The pores perforate the plate at each angle. It is now very interesting to observe that in some species—for instance, *Poteriocrinus Missouriensis*, Shum. *Pot.* (*Scaphiocrinus*) *unicus* Hall, there are in place of the pores slit-like fissures of considerable length. Four of these fissures—sometimes six—connect with those of the plates of the adjacent row, those of each half of a plate meeting corresponding slits in two different plates, so that one half of the fissures point upward and the other downward. We have filed several of the plates to the very bottom, and have found that the fissures pass entirely through them, and in many cases, where they have been observed, they form longitudinal depressions along the ventral sac, caused by the thinning of the plates toward the fissures. In some species,

that they form excellent generic distinctions. It is really astonishing how beautifully in some instances, these delicate organs have been preserved.

the fissures occur not only at the lateral, but also at the upper and lower sides of the plates, meeting here in like manner with the slits of the adjoining plates. In species in which the plates are provided with three slits to a side, the median one is larger than the other two, thus forming with the corresponding slits of the adjoining plate the figure of a quadrangle or rhomb, divided into two triangles, exactly as Billings describes the parallel canals which compose the hydrospires in *Caryocrinus*. Indeed, the similarity which seems to exist in this respect between the two groups, is so striking, that we can scarcely doubt that both structures were adapted to the performance of the same functions. It is true that the hydrospires in *Caryocrinus* are located on the aboral, and in the *Cyathocrinidæ* on the oral side of the body, but it must be remembered, as already shown (Am. Journ. Sci., Sept. 1877, p. 190) that the entire test of paleozoic Crinoids forms a part of the abactinal system, and the position of the hydrospires in Cystideans is by no means confined to the aboral side, nor to the oral in Paleocrinoids. We find in the genus *Porocrinus*, Billings, which forms a kind of link between Cystideans and Paleocrinoids (the arrangement of the plates of the calyx is exactly like that of all *Cyathocrinidæ*), that the hydrospires are altogether confined to the calyx. In the sutures between the plates, there exist a number of striated, poriferous areas, resembling the pectinated rhombs in their structure, and though their form and position are somewhat different from those of any other known Crinoid or Cystidean, there can be no doubt that they performed in the animal the same office. Unfortunately we do not know whether this genus had a poriferous ventral sac; nor have we been able to ascertain whether the longitudinal depressions on the ventral sac which we have noticed above, were covered—perhaps by perforated plates, such as Billings observed upon the tubercles of *Caryocrinus*—or only the pores and fissures, but we are inclined to think the former was the case, since we found in some other specimens of *P. unicus*, no depressions, but at the same time no fissures nor pores.

In many of the *Actinocrinidæ*, *Platycinidæ*, and *Rhodocrinidæ*, which are provided with a simple anal tube or an anal opening directly through the vault, the respiratory organs were probably located within the main body, at least there are many facts which seem to indicate this. In an article on page 248 of the Proceedings of the Acad. Nat. Sci. Phila., 1878, we noted the existence of certain pores or openings located between the arm bases and separated from the arm passages by a thin partition. Their number varies from ten to twenty or more. In *Batocrinus*, where they are most conspicuous, there are twenty, no matter whether the species has more or less than twenty arms. They are about one-third the size of the arm passages, with which they are in very near the same horizontal plane. There are two pores to each interradial field, one to the left of one arm, and one to the right of another. Ten other pores have a radial position, two within each of the five axillary spaces which form the median portion of the rays. In *Strotocrinus*, which has an enormous body, each arm has a pore, and so in *Steganocrinus*, *Eucladocrinus*, and apparently in all genera in which the arms branch off alternately. Other genera have only ten pores. In *Ollacrinus* the pores are represented by two longitudinal passages through the tubular extensions of the interradial series, or the false arms as usually called.

As these openings, especially in *Batocrinus*, are comparatively large, it is somewhat surprising that they have never been mentioned by other paleontologists. Their position corresponds almost exactly with that of the so-called ovarian apertures of the Blastoids though they are placed at a greater distance from the radial centre. The openings in both groups are situated within the brachial zone or at the extreme border of the summit. In the Blastoids the ventral disc or summit is reduced to the minimum in size, being composed only of the covering of the ventral opening; and this explains why the orifices are here found close to the radial centre, while in the forms above named they are located away from it. The pseudambulacral fields of the Blastoids represent the ventral groove of a recumbent arm, and the small passages which enter the body near the apex and beneath the central covering are the homologues of the arm passages in the true Crinoids. (Compare Pl. 17, Fig. 4.) The so-called ovarian openings are therefore located beside the arms, just as the pores in *Batocrinus*, and this strongly indicates a similarity in their functions.

In addition to this the perivisceral cavity in the *Actinocrinidæ* contains a number of chambers, and, from the brachial zone down to the base, is separated from the visceral cavity by a peculiar partition or network, pierced by innumerable pores and passages leading toward the visceral cavity which contains the digestive apparatus. Whether the above described pores communicated with these chambers cannot be determined from the fossil, but we may perhaps infer this from their position, and also that the chambers themselves were or contained organs similar to those described as hydrospires in other groups of the Crinoidea.

Folded sacs or parallel tubes, as in the Blastoids, have not hitherto been noticed in the Palæocrinoidea. That they existed in some groups of the latter is almost certain. The so-called "consolidating apparatus" of *Cupressocrinus* (Pl. 17, Fig. 3) is in our opinion a true set of hydrospires, arranged in pairs exactly as in Blastoids, but spreading out horizontally instead of vertically. Angelin (Iconogr. Crin., Pl. VIII. Fig. 7, *a*, *b*) figures a *Crotalocrinus*, in which the consolidating apparatus—or hydrospires, as we believe —is most excellently preserved. Even the inner tubes can be traced, and, if there existed still a doubt whether the closely related *Cupressocrinus* had its ventral side firmly closed, Angelin's figure, Pl. VIII. Fig. 6, ought to remove it. There seems to be in *Crotalocrinus* not only a solid integument covering the entire ventral disc and inclosing the hydrospires, but we judge from Fig. 7 of the preceding plate, that the oral centre or median space between the hydrospires had even a double covering.

It seems to us that there can scarcely be a doubt but that the consolidating plates of *Cyathocrinus* (Pl. 17, Fig. 2) are homologous with the oral plates of the Pentacrinoid larva (Pl. 17, Fig. 1), and ought to be designated as such; and further, that the so-called consolidating plates of *Cupressocrinus* are the homologues of the deltoid pieces of the Blastoids (Pl. 17, Fig. 4). It will be seen that all four occupy the same relative position in the respective types. There are five interradial plates, which join at their sides, extending inward, but so as to leave an opening at the oral centre. The affinities, indeed, are so striking that we think it not unreasonable to suppose that the hydrospires are metamorphosed oral plates. The construction of the deltoid pieces is very complicated, only the median or deltoid portion being visible externally. They are extended laterally, in spade-shaped appendages (Pl. 17, Fig. 4), which pass under the ambulacral fields and are hidden by them. To these appendages the folds of the hydrospires are attached, being suspended on each side of the ambulacrum, or modified arm, and partly covered by it. In the so-called consolidating plates of *Cupressocrinus* we find precisely the same structure. Each plate has lateral extensions, each of which supports a set of folds which incline in opposite directions. The number of folds varies in different species, *Cupressocrinus abbreviatus* having apparently seven, and *C. gracilis* but two or three, and so in the Blastoids, *Pentremites pyriformis* has seven folds and *P. Godoni* but five. As the folds of two different plates are not connected laterally, a sort of depression or groove is formed in a radial direction, which evidently contained the food passage, covering the sutures between the plates as the pseudambulacral folds cover those of the deltoid pieces in the Blastoids. The so-called consolidating plates with their folds, of *Cupressocrinus*, and the deltoid pieces with their appended hydrospires in Blastoids, being not only analogous in position but also almost identical ih structure, it is very evident that they had a similar office in the animal organism, and that if these organs in Blastoids were respiratory, the hydrospires in *Cupressocrinus* and *Crotalocrinus* had the same functions.

This view of the relations of the parts under consideration suggests a possible analogy in the general structure of Blastoids and Paleocrinoids, in which we may consider that the ambulacrum is a recumbent arm; the lower part of the forked plate up to the ambulacrum is the first radial—in *Blastoidocrinus*, the oldest known Blastoid, the suture is visible—that the two sides of the fork, instead of being interradial, form together a second radial, and the small summit plates are homologous with those which cover the central opening between the oral plates in *Cyathocrinus*, or to the entire vault in the *Actinocrinidæ*, etc., in which the oral plates do not exist—at least not externally. The food groove and ambulacral canal are located upon the pseudambulacral fold, which represents the ventral groove in the arms of the Crinoids, and are likewise covered by two rows of alternating plates. If these homologies be correct, it is evident that there is a much closer relation between Paleocrinoids and Blastoids in fundamental structure than has been heretofore supposed, and as we find in the former the representatives both of parallel tubes and folded sacs, it is evident that their hydrospires are constructed upon a cystidean and blastoidean plan combined.

We have now noticed the principal forms in which these organs have been observed; there are, however, a large number of forms in which no trace of them has as yet been discovered. These include among others the *Ichthyocrinidæ*, and a few genera of the *Actinocrinidæ* and *Cyathocrinidæ*. In the *Ichthyocrinidæ*, respiration may have been carried on through the pliant vault, aided by the expansions and contractions which the flexible nature of the skeleton could produce. In the *Actinocrinidæ*, however, the body, as in the Blastoids, is perfectly rigid, the plates heavy and firmly cemented together. There are no other openings in the body but the anal aperture, the arm passages, a passage through the column and the pores between the arm bases which we have described. In some genera, however, the last-named pores apparently do not exist. The introduction of water through the anal tube need not be considered for a moment, nor through the arms, which in no group of the Echinoderms perform such an office. Let us examine the column.

The construction of the column varies in different genera. It is perforated throughout the centre by a passage connecting with the interior of the body, which in some cases is a simple, small, round opening, while in others it is very large and marked by a peculiarly complicated internal structure. In the latter, the tubular cavity extends to all the branches which spring off rather numerously toward the root. It is mostly pentamerous, though in some cases tri- or quadri-partite ; it is sometimes regularly pentagonal, and sometimes divided into five petaloid chambers which unite at the centre. The walls within appear as if built up of thin laminæ, with spaces between, sometimes pectinated, and variously sculptured, all producing a great multiplication of exposed surfaces. In some the articulating faces of the stem segments are covered with striæ, radiating from the centre, which resemble minute pores penetrating the walls. We have found the very base of one of these large columns just as it was attached to the rock or other flat surface. It is very broad and deeply channelled on the bottom, and there are numerous branches or unattached cyrrhi, all of which are perforated, and through which there was ample communication with the surrounding water. In addition to this, there are large pores near the base of the column, leading from without into the main cavity directly through the walls.

Such an extraordinary structure was not necessary, if the column was merely an attachment or anchor for the Crinoid. That it was a means of communication between the water outside and the internal organs of the body for some purpose we entertain no doubt, and the large amount of surface exposed by means of the complex lamellar structure, is strongly suggestive of the principle which prevails in the respiratory apparatus in the animal kingdom generally. We have said that some *Actinocrinidæ* probably do not possess the pores in the body. It is very significant that it is in these very forms that we find columns such as we have just described. Indeed, in general, so far as we have been able to observe, we have found it to be the rule, that those types which have a perforated ventral sac are without pores in the calyx; that those with calycine pores do not possess a perforated ventral sac, and that in forms with a flexible vault, or with perforated ventral sac, or with pores in the body walls, the column is generally destitute of any such complex structure, and has only a small, simple aperture. There may be exceptions to this; in fact we know of some, but these relate exclusively to very large species, in which the openings in the main body, which we suppose to be respiratory passages, are inadequate to supply the immense body. The most remarkable examples of this kind are *Megistocrinus* and *Barycrinus*. The former, which belongs to the *Actinocrinidæ*, has species with larger bodily capacity than has been discovered in any other genus. It has generally only ten primary arms, and most probably only ten respiratory pores in the body. *Barycrinus* attains by far the greatest size of the *Cyathocrinidæ*, and the column of this genus like that of *Megistocrinus* is not only very strong, but its central cavity is exceedingly large and complicated. We thus have in these two genera apparently another mode of communication from the outside, which may have been either a cause or an effect of their extreme size.

All these facts have led us to suppose that the column was in some cases, and perhaps more or less in the Paleocrinoids generally, subservient to respiration. This supposition would not only account for the complicated structure of the column where it exits, but furnish a plausible explanation as to how the introduction of water was effected in species in which apparently no other openings are present.

With these observations, which we hope will at least be suggestive of some interesting points, and perhaps stimulate more detailed observation, we pass to another matter of considerable importance as bearing upon classification.

Prof. P. Herbert Carpenter, in a valuable paper (Quarterly Journ. Microscop. Sci., vol. xviii (new series), p. 351), on the "Oral and Apical Systems of the Echinoderms," undertakes to determine the homologies between that system of plates in the calcareous skeleton of the Echini known as apical plates, and certain parts of the calyx of Crinoids, both recent and fossil. He considers the basals of recent Crinoids to be homologous to the genital plates, and the radials to the ocular plates of the Echini, and he traces the homology to the Palæocrinoidea, in respect to which, however, he advances the opinion that the first ring of plates resting upon the upper stem segment, which have heretofore been nominated "basals" are in many types not basals at all. He regards the set of plates which lie next below the radials as the true "basals," no matter whether they rest directly upon the stem, as in *Platycrinus*, or are separated from it by another ring of plates, as in *Cyathocrinus;* so that the "subradials" of most American authors, or "parabasals" as they are generally termed in Europe, are "basals" according to his view. The lowest or proximal ring of plates, in types having "subradials," he calls "underbasals," and these he believes to be unrepresented in the other types of Crinoids and all other Echinoderms. The central plate of the apical system, represented by the central disk or subanal plate of the Echini, is thought by Carpenter to be the homologue of the terminal joint at the base of the stem in all pedunculated Crinoids, and in the Pentacrinoid larva of *Comatula*, and of the central plate in *Marsupites.*

In several respects these views conflict with those of A. Agassiz and Lovén, who regard the subanal plate of the Echini as the homologue of the centro-dorsal plate of *Comatula;* and both these as representing the "basals" of the Crinoids, by which term they designate the first ring of plates above the stem in all types. They consider the single plate in the apical system of the Echini as the equivalent of the basalia of the Crinoids metamorphosed into one.

Carpenter's reasoning in regard to the basal plates is, that, as the genitals in the Echini, and the basals in most Paleocrinoids, which are generally considered to be their homologues, are situated *interradially* with regard to the general symmetry of the body, we must expect to find the genitals in Paleocrinoids in the same relative position; and that in forms like *Cyathocrinus*, which have two rings of plates below the radials, the lower or proximal plates are situated in line with the radials, and hence cannot be the true basals. He holds that the same order of plates cannot be radial in one genus and interradial in another. This argument is unquestionably a very strong one, and we are enabled to confirm it by a number of interesting observations.

Let us consider the first ring of plates resting upon the upper stem joint in Crinoids, where it consists of less than five, as a metamorphosed representative of a set of five plates, in which two or more have been united by anchylosis. It will be observed that in nearly all types with but one ring of plates below the radials, *i.e.*, forms without "subradials," the proximal ring is so placed that the angles alternate with those of the radials, so that the whole set, whether five plates or not, may very appropriately be considered as *interradial* with regard to the general structure of the body.

In forms like *Platycrinus*, *Symbathocrinus*, etc., in which the radials rest directly upon a basal disc composed of three unequal plates, if we bisect the two larger, we obtain five equal plates, which occupy an interradial position. This is actually done in *Belemnocrinus*, which in the apical system has the identical structure of *Rhizocrinus*, and most of the recent Crinoids, viz., five basals, interradially situated, supporting five radials.

In *Melocrinus* and *Eucalyptocrinus*, where the proximal ring consists of four plates, we may divide the larger one and thus obtain five plates, which, though not wholly regular in form, are all interradial in position.

In *Actinocrinus* which has three equal plates in the basal disc, and *Dichocrinus* which has two, and allied genera, an apparent difficulty is presented, for if we subdivide these plates we have six basals instead of five. But here the structure is precisely the same in principle as in the foregoing cases. The six plates are interradial in position, and the presence of the anal plate in the same range with the first radials necessitates an additional plate in the basal ring for its support, so that the two plates which support it are equivalent to one. The anal plates are actually nothing more than an interradial series with a special function, viz., the support of the anal apparatus within the body, and of an opening in the vault, which may be either directly through the test, or prolonged into a tube. In some of the *Ichthyocrinidæ*, the anal is not distinguishable from any interradial series. The presence of the anal series as an element in the structure of many Paleocrinoids, may be largely due to the solid dome, which has to be penetrated by a special aperture, requiring some modification of the general structure below to accommodate it. It seems to have no direct representative in the apical system of the recent Echinoderms, but we may be justified in considering it as a specialized interradial, and in that case the basals of the forms under consideration are found to conform entirely to Carpenter's interpretation, being interradially disposed. We find a most interesting confirmation of this view in a specimen of *Actinocrinus* (*Strotocrinus*) *umbrosus*, which has abnormally no first anal plate, the first radials joining at their sides. The anal series in form and proportions is very similar to the other interradials, being chiefly distinguished by having three plates in the second range instead of two, as in the others. Accordingly, we find the basal disc in this specimen reduced to three *unequal* plates, and if we bisect the two larger, we obtain five equal plates, interradially situated, just as in *Platycrinus*. Nature herself, in this isolated specimen, has thus beautifully illustrated our argument. It is well to note in this connection that in *Platycrinus*, and all genera with three unequal plates in the proximal ring, the small plate is never, so far as we have observed, on the anal side, and this is the case with the abnormal specimen above described, the small plate being situated below the suture of the left posterior and lateral rays. *Why* this is so we are as yet unable to explain.

In forms like *Cyathocrinus*, *Rhodocrinus*, etc., which have two rings of five plates each, the proximal plates are radially situated, and, therefore, according to Carpenter, cannot be basals or homologous to the genitals, but the second ring of plates or "subradials," being interradial in position, are the true basals and the homologues of the genitals. If, now, we examine those types with two rings below the radials, in which the proximal ring consists of less than five plates, we shall find his idea still further confirmed.

In the *Ichthyocrinidæ* (except *Calpiocrinus?*) which have in the proximal ring three unequal plates, they are so proportioned and so situated that if we divide them by two additional sutures into five about equal plates, *these five will be radially situated*, and exactly equivalent to the corresponding set of plates in *Cyathocrinus*. In *Gissocrinus*, one of Angelin's Upper Silurian genera from Gotland, which is in every other respect a true *Cyathocri-*

nus, there are but three unequal plates in the proximal ring, showing here an actual metamorphosis of five plates into three.

In *Cupressocrinus*, which has a single central plate below the "subradials," pierced by the quadripartite perforation of the column, it might at first seem difficult to subdivide the proximal plate in this manner. But it will be noted that it is really radial in position, since its five external angles alternate with those of the "subradials," and furthermore, we find that nature has done it for us in a precisely similar case. *Myrtillocrinus*, whose base is perforated by a quadrangular foramen, has its proximal ring divided into five small pieces, alternating with "subradials" and hence radial in position. (15th New York Regents' Rep., p. 142.)

It is worthy of note that in the form last discussed—those with two rings below the radials—the proximal plates are almost invariably very small, and in many cases so minute as to be hidden by the column, thus in their insignificance affording an argument against comparing them with the genitals. They seem to be early developed, for they are as large in the young as in the adult, and do not show much increase in proportions in later geological epochs.

In some *Cyathocrinidæ*, the proximal ring sometimes attains considerable proportionate size, and it seems to have developed in geological time, for we find in the Lower Silurian genus *Heterocrinus* that this set of plates is represented in an extremely rudimentary stage, being only faintly visible between the sutures of the basals—"subradials"—and these plates seem to be minute in most similar Silurian genera. Yet it must not be overlooked that in many cases where the proximal plates are scarcely visible externally, they are quite prominent internally, often larger than the "subradials." This is especially the case in forms with a concave base.

In most genera with one ring of plates below the radials, the proximal plates are large and prominent, contrasting in a marked degree with the proximal plates in the two forms last considered.

There are a few genera, anomalous in structure, which cannot, with our present knowledge of them, be satisfactorily brought within the above comparison—such as *Calceocrinus*, *Catillocrinus*, *Pisocrinus*, and perhaps others.

The Blastoids, with their uniform arrangement of plates, agree well with Carpenter's interpretation, the three basals being divisible into five plates interradially arranged.

All these facts seem to indicate that the "subradials," in genera where they exist, are really the basals, and in such simple forms as *Cyathocrinus*, it seems very reasonable to consider these plates as the homologues of the genitals, and the radials as the ocular plates in the apical system of the Echini. In more complex forms, such as the *Actinocrinidæ*, *Rhodocrinidæ*, *Ichthyocrinidæ*, etc., there would seem at first to be an objection to this interpretation, arising from the fact that there are several other orders of plates, both radial and interradial, within the body walls, and that in these cases, as in *Cyathocrinidæ*, we should find the homologues of the apical plates of the Echini in the *entire calyx*, or the whole series of plates of the aboral side up to the region of the arms, and not in the two rings alone which Carpenter points out as such; in other words, that the apical plates in the Echini cannot be homologized with some few plates in the calyx of Palæocrinoidea.

In the younger stages of Paleocrinoids, the higher series of radials are unconnected by interradial or axillary plates, as may be seen most beautifully illustrated in the growth of *Strotocrinus*.[1]

It is also probable that at a still earlier period in the life of these Crinoids, the second and third primary radials constituted a free ray, as in the more simply constructed *Cyathocrinus*. In *Actinocrinus*, etc., the basals, which according to Carpenter are homologous to the "subradials" in other families, and the genitals in Echini, develop very early in the young, and attain almost their full size when even the first radials are comparatively much smaller. We have in our possession a *Cyathocrinus*, not more than half an inch in length including the arms and a portion of the column, in which, while the proximal plates are comparatively small, the so-called "subradials" are developed to an extraordinary degree, far more than the radials. The specimen in this stage looks remarkably like Billing's Lower Silurian genus *Hybocrinus*, in which the first interradial ring of plates is enormously prominent and gibbous, while the proximal ring is apparently wanting, or if it exists, is very minute.

[1] See our paper on "Transition forms in Crinoids," Proceed. Acad. Nat. Sci. Philad., 1878, p. 233, and also pp. 229–235 for illustrations of development in the parts in question in successive epochs.

It is now a very important fact that these two rings of plates—the first radials and the interradial set of plates next below them—are the only ones which are found in *all Crinoids from the earliest geological ages to the present time.* It thus appears that the evidence derived from the embryology of the Pentacrinoid, and the observed mode and order of development in the Paleocrinoids during individual life, is fully and beautifully confirmed by the geological history of Crinoids.

All this evidence seems to us to be conclusive, and to prove satisfactorily that the two rings of plates regarded by Carpenter as genitals and oculars, are the fundamental parts in the aboral side of the calcareous skeleton, and that the subsequent orders of radials and interradials are to be considered as supplementary to them, and as the products of growth in the individual and development in geological time.

Our conclusions being thus in harmony with Prof. Carpenter's views, we think it both logical and expedient to adopt his terms, and call the first ring of plates below the radials "basals" in all cases, and the second ring below, or the proximal plates when there are two rings, "underbasals," thus discontinuing the term "subradials" altogether.

We cannot, however, agree with Carpenter in supposing, as he does, p. 374, that the underbasals have no representative in the apical system of other Crinoids or Echinoderms. We incline to the opinion of Agassiz, Lovén, and others, that they are homologous with the central disc or subanal plate of the Echini, and with the centro-dorsal plate of *Comatula.* In the paleozoic genus *Agassizocrinus*, which was evidently pedunculate in its earlier stages, but became a freefloater when mature, we find in the proximal ring in young specimens five plates with a central perforation in the disc, and a distinct articulating scar for the attachment of the column. In the free stages, however, every trace of the central foramen and of the columnar attachment has disappeared, and in most of the specimens not even a vestige of the sutures formerly existing between the plates can be detected. In some they can still be faintly observed, but only near the edges upon which the succeeding plates rest, and not in the median portion of the disc. Another example of this is seen in *Edriocrinus* (New York Geol. Rep., vol. iii. pp. 119–20) in which the bodies are when young attached to each other or to other solid bodies, and in maturity become free, and a calcareous deposit is secreted around the base, which covers and obliterates the sutures between the plates. Here again we have an actual metamorphosis—during the life of the individual—of five plates into one, and this seems to us to be strongly confirmatory of the views of Agassiz and Lovén. We are inclined to think that the plate within the ring of underbasals when it exists, as in *Marsupites*, represents the column of Crinoids generally.

Having thus discussed the relations and distinctions between some groups of the Crinoids and the differences between the *Palæocrinoidea* and the *Stomatocrinoidea*—so we should like to call all Crinoids which have an external mouth—we think it proper to indicate briefly the principles which we shall endeavor to follow in our more detailed work.

Classification.

In attempting to make a systematic classification of the Paleocrinoids into families and genera, we encounter the difficulties which usually confront us when we undertake to ascertain and define any divisions as they exist in nature. We can readily recognize in groups of fossils certain broad characters by which it seems natural and satisfactory to bring them together, and we generally find in the characteristic types of the respective groups an association of other characters, by which they appear sharply marked; and so long as we have to deal with typical forms in isolated specimens or groups, the work is simple enough. But when we begin to investigate large collections, and in a measure to study comparatively all the known material from specimens or descriptions, we find the subject bristling with perplexing questions. Types are found to shade into one another, characters are commingled through processes of transition, which sadly interfere with the nice definitions we think we have worked out. How to deal with such forms has always been a troublesome question with naturalists, and the diverse methods of treating it have given rise to much confusion. We have found it especially perplexing in endeavoring to define the *genera* of the Crinoids. We find for instance, two groups, each embracing a number of species, and we discover general characters which nicely separate them. Further researches presently reveal to us certain forms, including perhaps several species, which, while agreeing with one group in most of the characters, persistently differ from it in some one feature, and perhaps in this feature they agree with the other group. The question then arises, what is to be done in cases where there are aberrant forms, departing from one type in the direction of another, and blending the characters of the two? Are we to say that our groupings are worthless, and the two must be thrown into one? This produces confusion, and stands in the way of systematic study; and besides we will then probably be no nearer the truth, for we shall doubtless find a similar relation between the group thus formed and some other, which will demand a similar consolidation. On the other hand, shall we stand by the distinctions we have discovered, and range our transitional or aberrant forms into subgroups by themselves, and designate them by proper appellations? We are clearly of the opinion that the latter, judiciously pursued, is the true course, both with regard to convenience of study, and to facilitate the discovery of a natural classification. Without entering into any discussion of the value of these or any other groups as expressions of actual divisions in nature, we propose to adopt this method of treatment, and to recognize subgenera or subgroups of whatever dignity, as the facts may seem to warrant. In so doing we find it decidedly preferable to give each group a name by itself, and consider it as standing alone in its proper rank, and not to name it parenthetically as a mere adjunct to the parent group. If we err on the side of too narrow distinctions, this will only lead to renewed researches and ultimately to the truth.

By adopting this course we are also enabled to retain many generic names founded upon good characters as revealed to the authors by the material at their command, and thus give to many investigators deserved credit for work which would otherwise have to be wholly ignored.

We have in some cases found it necessary to revise and reconstruct the genus in order to bring, if possible, some order out of the confusion into which its literature had fallen. In doing this we have endeavored to give effect to the evident intention of the founder of the genus, and to improve the diagnosis by the aid of more extensive material than he had access to, as well as by the aid of the labors of other investigators.

It will be well in this connection to point out the structural distinctions which we regard as important in the separation of families and genera. On a former page we have alluded to the dome, which we believe affords excellent characters for separation into families. The general plan upon which it is constructed, whether rigid or flexible, composed of movable or immovable plates; with large oral plates, or covered with numerous small pieces; whether provided with a ventral sac; the location of the anus; all of these in our opinion form good family distinctions. Next to the vault must be considered the general construction of the calyx; the elements of which it consists; whether it has a subbasal zone; the presence or absence of interradials as a rule; whether the animal was pedunculate or free floating; and last but not least, the structure and position of the respiratory organs.

Among the best *generic* characters in these Crinoids, we find the following: The general form of the body; the distribution and arrangement of the different plates, both in the vault and in the calyx, particularly the plates of the anal area and their proportions; the form and position of the apical dome plates, the position of the anus and whether consisting of a proboscis or simple opening; the form of the column, the shape and proportional size of its central passage; the construction of the arms and pinnulæ.

The arms and pinnulæ of the Palæocrinoidea have not received the attention which they deserve, at least not as to their generic importance. A careful study of these organs, as they occur in different genera, has convinced us, that not only the arms, but also the pinnulæ, in their variation, in their presence or absence, afford generic characters. Only of late years has attention been drawn to the ambulacral groove of the arm, when it was shown from actual observation that in some genera the furrow is covered by small plates alternately arranged. Meek and Worthen describe the arms of *Symbathocrinus* as being covered by two rows of single plates, arranged in alternation, and a similar structure has been discovered to exist in the arms of *Crotalocrinus* and *Enallocrinus*. In *Cupressocrinus*, according to Schultze, the furrow is braced over like a roof. In *Cyathocrinus Iowensis*, according to Wachsmuth, and apparently in *Gissocrinus*, Angelin, the furrow is covered by two rows of two successive plates, the plates of one row alternating with those of the other. In *Cyathocrinus longimanus*, Angl. (Iconogr. Crin. Pl. 26, Figs. 4, 5), there are in place of only two, a series of five successive plates from each side, alternately arranged. The plates of each side taper toward the end and infold over the furrow, covering it as perfectly, and in the same manner as in the two former cases. Angelin gives no description, but in his table of contents, he calls the successive plates from each side "pinnulæ."

It is easily seen that the covering to which we refer in the above-mentioned genera, is constructed upon exactly the same principle. It makes but little difference whether there are two single plates or two rows of plates alternating with each other, and it seems evident to us that if in one case they represent pinnulæ, we may well consider them to be the same in the other. It is here important to note that in those genera in which the ambulacral groove is thus covered, no regular pinnules have ever been observed, and moreover the construction is such that no additional pinnulæ could have existed; while on the other hand no covering has ever been discovered in forms with true pinnulæ. From our observation we are of opinion that the pinnulæ generally in the Palæocrinoidea served partly as a cover or protection for the furrow. In a specimen of *Graphiocrinus tortuosus*, Hall, in our collection, the pinnulæ cover the furrow so perfectly that we were for some time led to consider them as a solid integument composed of regular spiniferous plates. With a good magnifier, however, we clearly detected the joints of the pinnulæ, which are here so placed that the little spines with which their sides are provided stand up erect. In the *Actinocrinidæ* and *Platycrinidæ* the pinnulæ are long, comparatively slender, and so closely arranged side by side that it appears as if they were connected laterally, which we think is really the case in some groups. When the arms are closed, the two series of pinnulæ of one arm are laid upon each other so neatly, that the arm furrow must have been thereby perfectly shut off from the surrounding water. No additional covering has yet been observed in these genera, and it was evidently unnecessary.

All this seems to point to the conclusion that the pinnulæ had the same functions, partly at least, as the alternate plates in *Cyathocrinus*, etc., and as both have the same position, and evidently could be opened and closed by the animal, we do not hesitate to consider the latter as the homologue of the former, or in fact as rudimentary pinnulæ.

Terminology, etc.

There is considerable confusion in the literature of Crinoids—even among contemporaneous writers—as to the terms employed to designate the different parts of the animal. It is to be regretted that there is not some means of establishing uniformity in this respect, as this would no doubt promote better results in investigation. We believe it to be especially desirable, and for the interest of science, that there should be a better understanding on this subject between Zoologists and Paleontologists, so that the same terms may be used, so far as possible, for similar parts in both fossil and living forms. We will not assume to say how this should be brought about, but would be glad to see it undertaken by those of more experience and authority in both fields.

To avoid misunderstanding of our work we give herewith a list of the principal terms employed, with the definitions as understood and used by us. We do not seek so much to introduce new terms as to select the best—in our judgment—of those already known to our branch of science, and then to use them consistently.

Explanation of Terms.

Root = extremity of column, where attached.

Cyrrhi = radicular appendages, springing from the periphery of column joints, or in *Comatula* from the centro-dorsal plate

Column or stem = jointed cylindrical structure below the body.

Body = the frame of the animal, excluding column and arms.

Test = the calcareous shell inclosing the internal organs.

Calyx = the dorsal cup, or the test of the *abactinal* or dorsal side up to the arms = aboral side.

Vault, dome, summit = the test above the arms; the plated covering on the ventral side = *oral side* = *actinal side*.

Ventral sac = vertical extension of the vault in its posterior area, closed at the extremity.

Anal tube or proboscis = posterior vertical elongation of the vault, with anal opening at its extremity. The term "proboscis" is so generally used that we feel compelled to retain it, although there is a serious objection to its use. The word implies that it is an oral organ used for feeding, which is, beyond the slightest doubt, directly contrary to the fact.

Posterior side = the anal side of the body.

Anterior side = the side opposite the anal area.

Right or left = viewed from the posterior side.

Rays = the whole collective succession of plates from the first radial up.

Free rays = radial extensions of the body unconnected by interradial plates.

Arms = radial extensions or branches from the body with a furrow on the ventral side.

Pinnules = small, jointed, solid appendages, alternately arranged along the arms.

Tentacles = soft prehensile organs along the ambulacral furrow of the arms and pinnules.

Ambulacral furrow = groove on the ventral side of the arms and pinnules, containing ambulacral canal and food passages.

Proximal plates = those next to the column.

Underbasals = the second ring of plates below the radials, heretofore called "basals" = pelvis of European authors.

Basals = the first ring of plates below the radials, interradially disposed, equivalent to "subradials" and "parabasals," both of which terms are discontinued by us.

Radials = all the plates of the body above the basals, radially situated.

Primary radials = those in the rays below the first bifurcation.

Secondary radials = those between the first and second bifurcation.

Tertiary radials = those between the second and third bifurcation (and so on up to the arms).

Brachials = free radial plates supporting the arms. In our former descriptions we have used the term "brachials" for that series of radial plates within the body walls which leads to an arm opening—following Hall and others. Finding, however, that this term has been previously applied to the "free radials" by Johannes Müller, and has been adopted by Roemer, Schultze, and the zoölogists generally, we propose to discontinue it as applied to the former plates, which hereafter will be designated simply as radials of their respective orders.

Interradials = plates between the rays and forming a part of the body.

Axillary plates = plates between the divisions of the rays = intersupraradials of Hall and other authors.

Interbrachials = plates between the arm openings of each ray. This term is not strictly correct, when taken in connection with our definition of "brachials," but it has been long used in this sense, and as no confusion is likely to arise, we think it best to retain it.

Anals = the series of interradial plates which support the anal opening or tube.

Apical dome plates = the system of plates in the vault which occupy a position analogous to that of the apical plates of the calyx. They consist: 1, of a central plate at the apex of the dome; 2, of five large plates (there are generally four large and two small ones, the two latter equivalent to one, being separated by the anal area), arranged around the apex, interradially disposed, and corresponding to the first radials; 3, of five radial dome plates, alternating with the last, and corresponding to the first radials. Wachsmuth, Amer. Journ. Sci., Sept. 1877, p. 187, called the first seven of these plates "apical plates." This must be changed to avoid confusion, as the genitals and oculars of Echini are designated by the same term. We now apply the term "apical dome plates" to the whole system of principal vault pieces. These plates, which have no representation in the structure of the Stomatocrinoidea nor Echini, exist in a greatly reduced form in the Blastoids, but are specially characteristic of the Actinocrinidæ, Platycrinidæ, etc. The single plate at the apex we propose to call the *central dome plates;* the first ring of interradials surrounding it, *the proximal dome plates*, and the next ring radially situated, the *radial dome plates.*

Oral plates = large interradial plates, covering in form of a pyramid the oral side of the Pentacrinoid larva (Wyville Thomson and Carpenter) ≐ consolidating plates in *Cyathocrinus* (Wachsmuth) = deltoid pieces in Blastoidea. The term "consolidating plates" is discontinued.

Hydrospires = certain organic structures in connection with the inner walls of the test, composed of parallel tubes or folded sacs, probably in connection with the water system.

Respiratory pores or orifices = openings through the test, in connection with the hydrospires, apparently for the introduction of water for respiratory purposes.

In the discussion of the different genera we shall give with each a full list of the species which belong to it, *in our opinion*, independent of the opinion of others, and this will cause many changes in the reference of species. It cannot be expected that these lists will be free from mistakes, though we have studied each species with great care, the majority of them from the specimens, and besides our own extensive collections, one of us had occasion a few years ago to examine the original collections of De Konnick and Schultze, now in the Museum of Comparative Zoology at Cambridge. Nor can it be expected that in a general work on Crinoids like this, we shall give a full list of synonyms, and we have not attempted to do so. This can only be thoroughly done by the collector who has given his attention for years to the fossils of his own locality, and is able to identify them from the least fragment. We shall give the synonyms of the subcarboniferous Crinoids of the Mississippi Valley which we have made our special study, and we hope that investigators will do the same for other localities and formations. We shall feel under special obligations to any of our scientific friends for any information they may be able to furnish us, either in the way of specimens or observations which may contribute to a more thorough understanding and truthful presentation of the subject. We particularly desire this, as we intend to embody the results of all our investigations in this field in a future work to be issued with ample illustrations.

We take this opportunity to tender our thanks to Prof. A. Agassiz, of Cambridge; Prof. A. H. Worthen, of Illinois; Prof. S. H. Calvin, of Iowa City; Prof. A. G. Wetherby, of Cincinnati; Dr. James Knapp, of Louisville; Dr. Harrod, of Canton; Dr. K. Zittel, of Munich; Dr. F. Roemer, of Breslau; and to Prof. Trautschold, of Moscow, Russ., for valuable assistance courteously extended to us in the loan of books or specimens.

Note.—Species founded upon mere fragments of column are not recognized by us, and their names are enumerated only in the list of synonyms and doubtful species.

All species marked in front with an * are referred to said genus for the first time.

PALÆOCRINOIDEA.

A SUBORDER OF THE CRINOIDEA.

Body, as compared with recent Crinoids, larger; arms shorter; test stronger. The latter is arranged on various plans, but is always composed of solid plates of which the interradials, in contrast to the *Stomatocrinoidea*, constitute important elements. Plates of the aboral or dorsal side forming a cup, closed on the ventral or oral side by a more or less solid integument, without external food grooves or oral aperture.

The food conveyed through openings at the base of the arms into the body, and carried to the oral centre by means of internal or subtegminal passages. Anus either in form of a plated tube or a simple opening, subcentral or lateral.

The introduction of water for respiratory purposes seems to have been effected through small openings or pores which penetrate the test. These openings, which in some groups were located in the oral, in others in the aboral regions, seem to have been connected with peculiar organs within the body, closely resembling the so-called hydrospires of Cystideans and Blastoids.

The Paleocrinoids, with but few exceptions, were pedunculate, attached during lifetime. Flourishing abundantly in the Silurian seas, they reach their climax in the Subcarboniferous, as well in variety of form as in number of individuals, and they disappear almost entirely during the Carboniferous, few forms, if any, surviving as late as Mezozoic times.

FAMILY I.—ICHTHYOCRINIDÆ.

(Diagram Pl. 15, Fig. 1.)

General form of the body including arms, globose to pyriform. Column strong, perforation of medium size, generally pentangular.

Underbasals three, of unequal size; always small, often rudimentary and not visible externally, being hidden by the column. Basals five, moderately small, sometimes scarcely appearing beyond the column (in *Calpiocrinus* probably absent or imperfectly developed). Primary radials, three to five by five, almost equal in form and size. Radials of each order smaller by half than those of the preceding, and of uniform size. Arms bifurcating, short, strong, tapering upward, the tips infolding; composed of single joints. Pinnulæ unknown. In most of the genera, the arms lie side by side touching laterally, so as to form with the calyx an apparently compact wall. Radial and arm plates frequently have undulating sutures or additional patelloid plates. The radials up to the second or even the third order form a part of the body, being connected laterally either by a sort of squamous integument, composed of very minute, irregular plates, or by distinct interradial and axillary plates, the former varying in number from one to thirty or more, the anal area containing frequently a few additional plates. Anus unknown, except in *Taxocrinus* and *Onychocrinus*, which have a small lateral tube. Ventral disc rarely preserved; composed of a more or less soft or scaly integument, yielding to motion in the body and arms.

This family might very appropriately be called the Articulates of the Paleozoic Crinoids, being especially distinguished in most of its species by a peculiarity of structure which prevails throughout the rays and arms. The plates have rather shallow excavations on their outer upper margins, corresponding to projections on the lower edge of the succeeding plates, which sometimes take the form of superficial patelloid plates, independently articulated, and sometimes anchylosed with the margin of the plate above. This feature produces what seems to be an articulate structure in the whole skeleton, and indicates that the body as well as the arms was somewhat flexible. The interradial areas are sometimes found depressed and in other cases distended, showing that there had been some expansion or contraction of the body walls due to the mobility of the radial parts, and indicating likewise flexibility in the vault. This feature, which is found so far as we know, in no other family, together with the fact that in most of the genera a ventral covering has never been found preserved, leads us to infer that this portion of the body was more or less composed of rather fragile perhaps scaly material, instead of solid plates. If these Crinoids had been provided with a rigid dome, the little projections along the radial and arm plates would have interfered with the spreading of the arms, which is rather facilitated by the mobility of the dorsal side, and the pliant nature of the vault. Such motions would be likewise aided by the patelloid plates, which are generally found in large species, and in those in which the interradial spaces are comparatively rigid.

In *Onychocrinus*, the genus which evidently possessed the greatest expansive power, the radial areas being frequently found spread out horizontally, there are toward the inner or ventral side of the rays rather large plates, to which smaller ones are joined, which connect with the interradial series. They decrease in size and thickness inwardly, and connect with the dome plates. In a specimen of *Onychocrinus exsculptus*, Lyon, and another of *O. diversus*, Hall, we found the median portion of the vault preserved, the plates being irregularly arranged, rather large and thin. This important observation goes far toward proving that the *Ichthyocrinidæ* had no external oral aperture, for if any of the family were likely to have it, it would be *Onychocrinus*.

The *Ichthyocrinidæ* are nearest related to the *Cyathocrinidæ*, from which they differ in having several orders of radials included within the body; in the articulate structure of the radial portions; in the presence of interradial plates within the regions of the calyx, and in the pliant vault.

The separation of the genera in this family has always been attended with difficulty, and it cannot be denied that several of them shade into one another in a most perplexing manner. They are very closely related, and yet there is a *habitus*, peculiar to typical forms of each genus, which is not easily described, but which is readily perceived when large collections are brought together, and which Paleontologists discerned at an early day. It is the gradations—*the transition forms*—which make trouble, and have given rise to continual modifications of the generic formulæ in hope of reconciling them with new discoveries. While we cannot expect that the divisions we have made are wholly free from errors, yet we find when we arrange the different species according to the generic characters herein given, that the groupings are more nearly conformable to the recognized habitus of the fossils than any we have been able to make heretofore, and we are encouraged to hope that we may have approximated more closely to the natural divisions.

The *Ichthyocrinidæ* range from the Lower Silurian to the close of the Subcarboniferous.

We recognize the following genera:—

1. ICHTHYOCRINUS Conrad.

1836. *Euryocrinus*. Phill. Geology of Yorksh., p. 205.
1842. *Ichthyocrinus*, Conrad. Journ. Acad. Nat. Sci. Philad., vol. viii. p. 279.
1851. *Ichthyocrinus*, d'Orbigny. Cours. élem. Pal. ii. p. 144.
1851. *Ichthyocrinus*, Hall. Geol. Rep. N. York, vol. ii. p. 195.
1878. *Ichthyocrinus*, Angelin. Iconogr. Crinoid., p. 13.
1878. *Ichthyocrinus*, Wachs. & Springer. Proceed. Acad. Nat. Sci. Philad., p. 252.

A. Typical form.

General form of body, including arms, ovoid to pyriform, with almost equilateral pentamerous symmetry. Calyx bowl or cup-shaped. Underbasals three, rudimentary, of unequal size, sometimes seen only within the calyx. Basals five, very small, their upper angles acute. Radial plates of adjacent rays alternately arranged. Primary radials three to four by five, wide and short, height about equal, but increasing in width rapidly upward, the plates being wider at their upper margins than at the lower. Secondary and tertiary radials similar in form to the primaries, quadrangular in general outline, though really pentangular and hexangular, those of the same order of equal height, and half the width of those of the next order. Arms twenty to sixty or more, accumbent, infolding at the tips, and forming with the calyx an apparently solid structure. They are composed of single joints which are heavy, wider than high, quadrangular, usually with waving sutures. Arm furrows shallow, tripartite. Pinnulæ unknown. Interradial and anal plates generally absent or undeveloped at the outside, *I. nobilis*, Wachs. & Spr. alone, to our knowledge, possessing both; they are longitudinally arranged, but the anal side cannot be distinguished. Vault unknown. Column composed of very short joints near the top, increasing gradually in length downwards. Central perforation of medium size, pentagonal.

The most striking feature of this genus, by which it is easily recognized, is its symmetrical, equilateral figure, and this pervades the whole body.

Hall, in his diagram (Geol. Rep., N. York, vol. ii., pl. 45, fig. 2), figures a small intercalated plate in line with the subradials, which is evidently accidental. He does not mention it in his generic description, nor can we find it in any of our specimens. Angelin mentions a single anal plate, which is not to be found in his figure. The presence of anal, interradial, and even axillary plates in *I. nobilis* which, as far as known, is the latest representative of the genus, is very instructive, as it shows the approach to *Forbesiocrinus*. In young specimens these plates are undeveloped externally, but are plainly visible on the inner surface of the calyx.

Phillips, in 1836 (Geology of Yorksh., p. 205), described the genus *Euryocrinus*, which is possibly the same as *Ichthyocrinus*, and might be entitled to priority, but his description and figures are so unintelligible that this would be injustice to Conrad. Phillips' generic description reads as follows: "Pelvis opening pentagonal, arrangement of plates like *Encrinus*, internal cavity very large." Not much better are his figures, since they induced Bronn to consider *Euryocrinus* as a synonym of *Actinocrinus*.

Geological and Geographical distribution.—*Ichthyocrinus* is found first in the Upper Silurian, where it is represented in Europe by 3 species, in North America by 5. None have been observed in rocks of Devonian age. In the Subcarboniferous 3 species have been discovered in America, none in Europe (unless we count *Euryocrinus concavus* Phillips).

We regard the following species as belonging to this genus:—

1858. **Ichthyocrinus Burlingtonensis** Hall. Geol. Rep. Iowa, vol. i., pl. ii., p. 557. Lower Burling. limest. Burlington.

1852. **Ichthyocrinus Clintonensis** Hall. Geol. Rep. N. Y., vol. ii. p. 181, pl. 41, figs. 6 a, b, c. Niagara gr. New York State.

1865. **Ichthyocrinus Corbis** Winchell & Marcy. Memoirs Bost. Soc. Nat. Hist., vol. i., No. 1, p. 89. Niagara gr. Chicago, Ill.

Regarded by Hall as syn. of *Ichthyocr. subangularis*.

*1879. **Ichthyocrinus Gotlandicus** Wachs. & Spr. (**Ichthyocr. lævis** Angl. not Conrad.) Iconogr. Crinoid., p. 13, pl. 9, figs. 87 a–c, and pl. 22, figs. 20, 21. Upper Silur. Gotland, Swed.

The Swedish specimens, which by Angelin were identified as *I. lævis*, Conr., are very distinct from the New York species which Conrad described. The European form is pear-shaped instead of ovoid, the plates ornamented, but without any surface angularity, and with nearly straight sutures; while the New York specimens have plates with smooth but angular surface, and very distinct waving sutures. We therefore suggest their separation, and propose to call the Swedish form *I. Gotlandicus*.

1878. **Ichthyocrinus intermedius** Angelin. Iconogr. Crin., p. 13, pl. 17, fig. 7. Upper Silur. Gotland, Swed.

1842. **Ichthyocrinus lævis** Conrad (not Angl.) Type for the genus. Journ. Acad. Nat. Sci. Philad., vol. xiii. p. 279, pl. 15, fig. 16; also 1852, Hall, Pal. N. York, vol. ii. p. 195, pl. 43, fig. 2. Niagara gr. Lockport, N. Y.

1878. **Ichthyocrinus nobilis** Wach. & Spr. Proceed. Acad. Nat. Sci. Philad., p. 254. Upper Burl. and Keokuk transition bed. Burlington, Iowa.

1839. **Ichthyocrinus pyriformis** Phillips. (**Cyathocr. pyriformis.**) Sil. System, p. 672, pl. 17, fig. 6; also Iconogr. Crin., p. 13, pl. 17, fig. 6; and pl. 22, fig. 22. Upper Silur. England and Sweden.

*1852. **Ichthyocrinus simplex** Hall. (**Lecanocr. simplex.**) Geol. Rep. N. York, vol. ii. p. 202. pl. 44, figs. 2 a, b, c. Niagara gr. Lockport, N. Y.

Hall's figure evidently represents a young *Ichthyocrinus*, and not a young *Lecanocrinus* as he supposed.

1862. **Ichthyocrinus subangularis** Hall. Trans. Alban. Inst., Article xii., p. 7. Niagara gr. Waldron, Ind.

1850. **Ichthyocrinus tiaræformis** Troost. (**Cyathocr. tiaræformis.** Troost's Catal., and Geol. Rep. Iowa, vol. i., part ii., p. 558. Subcarbon. Tennessee.

B. Subgenus HOMALOCRINUS Angelin.

1878. Iconogr. Crinoid., p. 11.

We consider *Homalocrinus* not sufficiently distinct from *Ichthyocrinus* to rank it as a full genus, but propose the name for a division under *Ichthyocrinus*. The following is a translation of Angelin's generic description: "Body including arms ovoid. Basals three, small. Parabasals five, triangular, placed between the sides of the primary radials. Primary radials transverse, and in the form of a half moon. Interradials three, the lower one heptagonal and large, with two small ones above. Anals three, subequal. Rays several times dichotomizing." Angelin described *Ichthyocrinus* without interradials or anals, and it seems that upon this feature mainly he separates *Homalocrinus*. We find, however, in the only known species the anal area slightly different from the interradial, and the primary radials, instead of increasing from the base upward, as is the case in all *Ichthyocrini*, decrease in the same direction, the first radial being here the larger plate. The latter feature has induced us to retain *Homalocrinus* subgenerically and place it under *Ichthyocrinus*, with which it has the closest affinities.

1878. **Homalocrinus parabasilis** Angelin. Iconogr. Crin., p. 11, pl. 16, figs. 29, 30. Upper Silur. Gotland, Swed.

2. CLEIOCRINUS Billings.

1856. Geol. Surv. Canada, p. 276.
1859. Ib. Decade iv., p. 52.

The generic description was made from a single specimen, and this was in several respects defective. *Cleiocrinus* has, according to Billings, five basals alternating with the radials, and forming with them a belt around the column. Such a structure has never been found in any Crinoid. In the typical specimen, the comparatively large column conceals from view the lower part of the calyx, a space large enough to accommodate one or two series of plates, and analogy suggests that this may have been the case. The five plates which Billings found alternating with the primary radials, and which he called basals, are certainly interradials; and as the specimen in every visible character closely resembles *Ichthyocrinus* and allied forms, we have good reason to suppose that it, like those forms, possessed five small basals and three underbasals, both hidden by the column. The latter were probably very minute and rudimentary, since the specimen is from the Lower Silurian, where it is almost the only representative of the family. This alone induces us to try to define generic characters from a single imperfect specimen. Notwithstanding, therefore, that some of the elements are problematic, we propose until something better is found, the following:—

Revised generic description.—Calyx obconical or pyriform, with bilateral symmetry. Underbasals probably three, minute or rudimentary. Basals probably five, very small and hidden by the column. Primary radials three by five, increasing in width upwards, supporting several superior orders of radials all dichotomizing uniformly, and interlocking laterally with those of adjoining rays. Interradials, so far as known, one. Anals four to five, longitudinally arranged. *C. regius* has six orders of radials, the number of plates doubling with each bifurcation, which gives in the sixth order 64 brachials to each ray or 320 to the individual. Whether the small appendages which are seen at the top of the specimen were arms, cannot be determined from the figure.

The only known species is:

1856. **Cleiocrinus regius** Billings. Geol. Rep. Canada, p. 276; and 1859, Decade iv., p. 53, pl. 5, figs. 1 a–g. Trenton limest. Ottawa, Can.

Billings refers to this genus two other species, *C. grandis* and *C. magnificus*, which he described from mere fragments of the column, but which we cannot recognize. The fragments may belong to *C. regius*, or to almost any other genus.

3. **ANISOCRINUS** Angelin

1878. Iconogr. Crinoid., p. 13.

General form of body, including arms, ellipsoid. Calyx bowl-shaped; figure bilateral.

Underbasals three, hidden by the column. Basals of medium size, dissimilar in form. Primary radials three to five, the first widest, almost as large as second and third together; the second smallest of all. Secondary radials two, gradually increasing in size upward, the bifurcating plate almost as wide as the third primary radial. Arms apparently free above the secondary radials, accumbent as in *Ichthyocrinus*, and composed of transverse joints. Interradials one (sometimes with a small triangular piece above), very large, resting with the lower angle against the short upper lateral sides of the first radials, forming with them a compact wall. Anals two, very large, the upper one the largest plate in the body; the acute angle of the lower leaning against the basals, with the lower lateral sides resting against the adjoining subradials, and its upper lateral sides against the large first radials. The second anal plate rests upon the upper truncated side of the lower one, being in line with the interradial plates, and reaches like them up to the top of the secondary radials.

The arrangement and size of the interradial and anal plates are the characteristic features of this genus. Angelin's descriptions are rather indistinct on this point, and in order to have it properly understood, we give almost a specific description, which will probably have to be modified when more species are discovered.

Only two species are known.

1878. **Anisocrinus interradiatus** Angelin. Type for the genus. Iconogr. Crin., p. 13, pl. 22, figs. 18, 18 a. Upper Silur. Gotland.

*1852. **Anisocrinus Angelini** Wachs. & Spr. (Lecanocrinus macopetalus Angelin (not Hall). Iconogr. Crin., p. 12, pl. 19, figs. 3, 4; and pl. 22, fig. 24. Upper Silur. Gotland, Swed.

The Swedish form with its enormous interradial plate is not only specifically but even generically distinct from *Lecanocr. macropetalus*, Hall. Of the two specimens figured by Angelin, the one, pl. 19, fig. 3, agrees in every respect with *Anisocrinus*, while the other, fig. 4, differs from it in having a small, evidently abnormal plate, intercalated on the posterior side. We propose for this species the name of *Anisocrinus Angelini*, in honor of the late Prof. Angelin, the author of the genus.

4. CALPIOCRINUS Angelin.

1878. *Calpiocrinus* Angl. Iconogr. Crinoid., p. 12.
1878. *Clidochirus* Angl. (syn.). Iconogr. Crinoid., p. 12.

General form of body, with the arms closed, ovoid or pyriform. Calyx bowl-shaped, composed apparently of only one ring of plates below the radials; figure bilateral. This ring consists of three plates, one of them small, the two larger ones equal, forming together a pentagonal disc. Primary radials three by five, three times wider than high, differing in size and form; the first one lunate, the second quadrangular, the third and largest pentagonal. Secondary radials three to four, about equal in size, except those in the posterior rays whose lateral margins retreat to give space for the large anal plates. The upper secondary radials support the arms, some of which bifurcate, while others remain free. Arms similar to those of *Ichthyocrinus*, their sides closely abutting, forming a wall continuous with that of the calyx. Arm joints transverse, quadrangular. Interradials rarely more than one, which is small, wedged in between the second and third radials of adjacent rays. Anals three to five, longitudinally arranged, the lower and smallest which is almost triangular resting upon the basal plates, the upper one extending to the top of the secondary radials. Column slender, round, composed of very thin segments; central perforation small, stellate.

This genus, as described by Angelin, differs from all the rest of the family in having but one ring of plates below the radials, and this consists of three plates, unequal but apparently so proportioned as to be partly radial and partly interradial in position. The various figures, however, disagree in the latter respect. Such a structure would seem to warrant its separation into a distinct family, but as *Calpiocrinus* agrees in all other characters with the *Ichthyocrinidæ*, we feel satisfied that it naturally belongs here. We are inclined to think that in this genus the lower ring of plates is the analogue of the underbasals, and that the true basals, if not absent, are exceedingly rudimentary. We take the small triangular plate which has been called the first anal plate, to be the basal (subradial) on the posterior side which is larger in the whole family, and that the plates on the four other sides are very minute or only visible in the inside.

The presence of but one ring of plates visible below the radials, the bilateral symmetry of the calyx, and the longitudinal arrangement of the anal plates, are the most prominent characters of the genus.

Angelin, on the same page, describes the genus *Clidochirus* with a single species, which agrees with *Calpiocrinus* in every respect, except that it has no interradial plates, and four instead of three first radials—variations which may be expected even in the same species.

Geological and Geographical Distribution.—Found thus far only in the Upper Silurian of Gotland, where the following species have been discovered:

1878. **Calpiocrinus fimbriatus** Angelin. Iconogr. Crinoid., p. 12, pl. 29, figs. 77 a, b. Upper Silur. Gotland, Swed.

1878. **Calpiocrinus heterodactylus** Angelin. Iconogr. Crinoid., p. 12, pl. 3, fig. 10 a; and pl. 26, fig. 8. Upper Silur. Gotland, Swed.

1878. **Calpiocrinus humilis** Angelin. Iconogr. Crinoid., p. 12, pl. 23, figs. 28 a–c, and pl. 26, fig. 17. Upper Silur. Gotland, Swed.

1878. **Calpiocrinus ovatus** Angelin. Iconogr. Crinoid., p. 12; pl. 16, figs. 17–19. Upper Silur. Gotland, Swed.

*1878. **Calpiocrinus pyrum** Angelin. (**Clidochirus pyrum**). Iconogr. Crinoid., p. 12, pl. 22. fig. 23. Upper Silur. Gotland, Swed.

5 LECANOCRINUS Hall.

1852. *Lecanocrinus*, Hall. Geol. Rep., N. Y., vol. ii. p. 199.
1867. *Lecanocrinus*, Shultze. Monogr. Echinod. Eifl. Kalkes, p. 40.
1678. *Lecanocrinus*, Angelin. Iconogr. Crinoid., p. 12.

A. Typical form.

General form of body and arms subglobose to pyriform. Calyx bowl-shaped, unsymmetrical, plates heavy.

Underbasals three, unequal in size, larger than generally found in the family. Basals five, three pentagonal or hexagonal, the two others having an additional side for the lateral insertion of a small anal plate. Primary radials two or three by five, very short and wide, the first one largest. Secondary radials one to three or more, varying in number even in the individual. Arms precisely as in *Ichthyocrinus*. Interradials generally absent. Anal plates two, the lower one lying obliquely toward the right[1] side of

[1] It is worthy of note that in all Paleocrinoids, so far as observed, in which the anal arrangement is unsymmetrical, the odd plates are pushed out toward the right, never to the left.

the body between the two unequal basals, the adjoining radial, and the other anal plate. The second or upper and larger anal plate is interposed between the primary radials and the upper truncated side of the posterior basal. Column round, composed of rather large joints.

Hall, Schultze, and Angelin mention no interradials in their generic descriptions, but the latter figures a specimen from Gotland, which he refers to *L. macropetalus* Hall. It has one exceedingly large interradial to each area, which occupies a wide space between the rays, opposite all the primary radials, and as high as the top of the second or third secondary radial. No New York specimen of this species has ever been found with such a plate or even a trace of it, and as the two differ besides decidedly in the size of the basals, in the form and proportions of the body, and in other characters, we consider the Swedish form even generically distinct. (See *Anisocrinus Angelini*, W. & Spr.).

Geological and Geographical Distribution.—This genus is represented in the Upper Silurian by 5 species, 4 from America, and 1 from Europe. From the Devonian but a single species is known, and none from the Subcarboniferous.

The following are the known species:—

1878. **Lecanocrinus Billingsi** Angelin. Iconogr. Crinoid., p. 12, pl. 22, fig. 25 a. Upper Silur. Gotland, Swed.

1852 **Lecanocrinus calyculus**(?) Hall. Geol. Reps., N. Y., vol. ii. p. 203, pl. 46, figs. 3 a, b. Niagara gr. Upper Silur. Lockport, N. Y.

1858. **Lecanocrinus macropetalus** Hall (not Angelin). (**Anisocrinus Angelini**, W. & Spr.). Type of the genus. Geol. Rep., N. Y. Vol. ii. p. 199, pl. 45, figs. 1 a–h. Niagara gr. Lockport, N. Y.

1852. **Lecanocrinus ornatus** Hall. Geol. Rep., N. Y., vol. ii. p. 201, pl. 44, figs. 2 a–m. Niagara gr. Lockport, N. Y.

*1862. **Lecanocrinus pusillus** Hall. (**Cyathocr. pusillus.**) New Foss. of Niagara gr. p. 6, and 28th Rep., N. Y. State Cab. Nat. Hist., pl. 15, figs. 1–6. Niagara gr. Waldron, Ind.

Winchell and Marcy, Memoirs Bost. Soc. Nat. Hist., p. : 0, described a cast from the Niagara limestone of Chicago under the species *Lecanocr. pusillus*, which is probably identical with Hall's *Cyathocrinus pusillus.* The description is not sufficient to decide it fully.

1867. **Lecanocrinus Rœmeri** Schultze. Echinod. Eifl. Kalk, p. 41, pl. 3, figs. 8 a–g. Devonian. Eifel, Germ.

B. Subgenus **PYCNOSACCUS** Angelin.

1878. Iconogr. Crinoid, p. 13.

The distinction between *Pycnosaccus* and *Lecanocrinus* seems to us scarcely sufficient to warrant a full generic separation. The two agree in all essential features, except that the former, according to description, has two primary radials instead of three, and that the plates of the calyx are ornamented by radiating ridges, such as are frequently found in *Barycrinus*. Even in that genus, the ornamentation is not constant, and at the most is a very unreliable character. In *L. Rœmeri* Schultze, which has entirely smooth plates, we find in two rays only two primary radials as in *Pycnosaccus*. It is very significant that if we consider the first and second radials of *Lecanocrinus* as one plate, we obtain exactly the proportions of the first radial in *Pycnosaccus*, which in our opinion here replaces the first and second radials, while the bifurcating second radial of *Pycnosaccus* actually represents the third radial of *Lecanocrinus*. Form of body, arrangement of the anal plates, and construction and folding of the arms precisely as in *Lecanocrinus*, only that the arm plates are slightly higher.

1878. **Pycnosaccus (?) costatus** Angelin. Iconogr. Crinoid, p. 14, pl. 15, fig. 13. Upper Silur. Gotland, Swed.

(This species belongs probably to the *Cyathocrinidæ* (?)).

1878. **Pycnosaccus nodulosus** Angelin. Iconogr. Crinoid., p. 14, pl. 15, figs. 12, 14, and pl. 28, fig. 29. Upper Silur. Gotland, Swed.

1840. **Pycnosaccus scrobiculatus** Hisinger. (**Cyathocrinites scrobiculatus**(?)). Leth. Suec. Supplem. ii. p. 6, pl. 39, figs. 4 a–c; also 1878, Angelin. Iconogr. Crinoid., p. 14, pl. 15, figs. 10, 11. Upper Silur. Gotland, Swed.

6. **MESPILOCRINUS** De Koninck & Lehon.

1853. *Mespilocrinus*, de Kon. & Lehon. Recher. s. les Crin. Carb. Belg., p. 111.

1836. *Young Poteriocrinus*, Phillips. Geol. Yorksh., vol. ii. p. 205.

1866. *Lecanocrinus*, Schultze. Echinod. Eifl. Kalk., p. 40.

1859. *Mespilocrinus*, Hall. Supplem. Iowa Geol. Rep., p. 69.

General form of body with arms, globular to pyriform, very small. Calyx bilateral, though apparently unsymmetrical on account of the dextrorse arrangement of the arms.

Underbasals three, unequal; one quadrangular, the other two larger and pentangular. Basals five; four of them equal, the fifth larger and hexagonal, its upper face parallel with the lower. Radials three by five, the first forming part of the basal cup. Second radials wedgeform, shorter, but as wide as the first. The third radials support two arms which bifurcate once. The arms are extremely short, composed of very few joints, tapering rapidly upward, infolding, inclined obliquely from left to right, and when closed they fit so neatly one into the other, that it appears as if they formed together with the calyx a continuous body. Arm joints single, slightly cuneate. Interradials none. Anals one, subquadrangular, resting upon the larger basal. Column round, composed of thin joints near the body, increasing in length so rapidly towards its base, that in four inches the joints attain a length of half an inch. Central perforation of medium size.

L. Schultze, in his Monograph der Echinod. Eifl. Kalk., p. 40, pronounces *Mespilocrinus* a synonym of *Lecanocrinus*. In this he is evidently mistaken. *Lecanocrinus* has arms like *Ichthyocrinus*, while those of *Mespilocrinus*, in place of being straight, are turned to the right, and the radial and arm plates are consequently wedgeform instead of rectangular. Schultze's *Lecanocrinus Rœmeri*, on which he based the above conclusion, is a most interesting species to show the relations between the two genera. It occurs in the Devonian and zoölogically occupies an intermediate position between the Silurian form *Lecanocrinus* and *Mespilocrinus* of the Subcarboniferous. *L. Rœmeri* not only has very short arms, but they fold up almost as in *Mespilocrinus*, yet they have rectangular joints and are not deflected. The species has also the unsymmetrical arrangement of the anal area, but the odd plate is here exceedingly small, and has, when combined with the large one, exactly form and proportions of the single anal plate in *Mespilocrinus*, thus approaching and foreshadowing the bilateral form which succeeded in the Subcarboniferous.

Mespilocrinus seems to be strictly a subcarboniferous genus, and only four species are known:—

1853 **Mespilocrinus Forbesianus** De Koninck and Lehon. Recherch. Crin. Belg., p. 112, pl. ii., figs. 1 a–c. Mountain limest. England and Belgium.

1853. **Mespilocrinus granifer** De Koninck and Lehon. Recherch. Crinoid, Belg., p. 114, pl. ii , figs. 6 a–c. Mountain limest. Visé, Belgium.

1859. **Mespilocrinus Konincki** Hall. Supplem. Geol. Rep. Iowa, p. 69. Burlingt. limest. Burlington, Iowa.

1861. **Mespilocrinus scitulus** Hall. Prelim. Not. New Pal. Crinoids, p. 9. Burlingt. limest. Burlington, Iowa.

7. TAXOCRINUS Phillips.

1836. *Poteriocrinus*, Phillips (in part). Geol. Yorksh., vol. i. (not Miller).
1841. *Isocrinus*, Phillips. Pal. Foss. Cornw. (not H. von Meyer 1837).
1842. *Cladocrinus*, Austin. Ann. & Mag. Nat. Hist., vol. x. (not Agassiz).
1843. *Taxocrinus*, Phillips. Morris's Cat. Brit. Foss., p. 90.
1851. *Cyathocrinus*, Roemer. Leth. Geognost. (3te Ausgabe), p. 233 (not Miller).
1853. *Forbesiocrinus*, de Kon. & Leh. (in part). Recherch. Crinoid. Belg. p. 119.
1866. *Taxocrinus*, Schultze. Echinod. Eifl. Kalkes, p. 33.
1878. *Taxocrinus*, Angelin. Iconogr. Crinoid., p. 8.
1878. *Taxocrinus.*, sub-genus of *Ichthyocrinus*, Wachsm. & Spr. Proceed. Acad. Nat. Sci. Philad. p. 252.

According to Phillips (Morris's Catal. Brit. Foss), *Taxocrinus* has "5 basals; 3 radial plates in 5 series; arms dividing upon the third radial and frequently dichotomizing above this point; arms and branches of single series of joints, interbrachial and axillary plates."

This description embraces almost every genus of the *Ichthyocrinidæ*, among them *Forbesiocrinus*.

Johannes Müller, Monatsbericht der Berliner Akademie, March, 1858, was the first who mentioned the presence in *Taxocrinus* of three small pieces within the parabasalia—basals,—similar to those found by Hall in *Ichthyocrinus*, and in species which were supposed to be *Forbesiocrinus*. Müller's discovery was evidently overlooked by Hall, who in 1858 described his *Taxocrinus interscapularis* with five basals and no subradials; and in 1861, and even later, he refers several species with three basals and five subradials to *Forbesiocrinus*, which undoubtedly belong to *Taxocrinus*. Schultze, in his description of Phillips genus (Monogr. p. 32) calls the small plates "cryptobasalia," because they are always hidden by the column, and sometimes only visible within the calyx.

The tripartite proximal ring, rudimentary in some instances, is now admitted to belong to all the genera which we include among the *Ichthyocrinidæ*, and it therefore no longer forms a generic distinction.

The separation of *Taxocrinus* and *Forbesiocrinus* has always been a stumbling block to Paleontologists. De Koninck and Lehon gave as the principal distinction, that *Taxocrinus* had no anal nor interradial plates, while *Forbesiocrinus* had both, and sometimes a large number of them.

In 1866, both Meek & Worthen and Schultze wrote on this subject, and arrived independently at the same conclusion. The former, in an elaborate article in the Illinois Geological Report, vol. ii. p. 270, show that the same species may have sometimes no interradials, and again from one to three. They refer to *Taxocrinus* Hall's *Forbesiocrinus Thiemei*, which was described as having no interradials, but which has sometimes two, and which we have even found with as many as five regular interradial plates. The one, according to De Koninck, would be *Taxocrinus*, the other *Forbesiocrinus*. To amend the generic formula so as to admit species with one or two series of interradials, did not seem to those authors expedient, since the species exhibit such a wide range of variation in this character. Nor do they consider the presence of axillary plates which occur in both groups, nor the small patelliform supplementary pieces of some well-defined species of *Forbesiocrinus* a means of distinction, inasmuch as they are not always present in otherwise typical forms of that group; while well-marked species of *Taxocrinus* are described as showing the patelloid plates between the arm joints. Meek and Worthen therefore concluded, until more distinctive characters should be discovered, to place *Forbesiocrinus*—embracing species with many interradial and anal plates—as a mere section under *Taxocrinus*.

Schultze found in his Devonian species almost every character of *Forbesiocrinus* except the small patelloid plates, but whether these were sufficient to distinguish it from *Taxocrinus*, he did not wish to decide, and so he placed the species from the Eifel, in which these plates do not occur, under *Taxocrinus*. He, however, included with this genus species which evidently belong to very distinct genera.

Angelin, in the Iconographia Crinoideorum Sueciæ, pp. 8, 9, gives generic descriptions both of *Taxocrinus* and *Forbesiocrinus*, and ranges under the two genera several new species. His descriptions only differ, so far as we understand them, in this: that in *Forbesiocrinus* the number of primary radials is left an open question, while in *Taxocrinus* the number is fixed at 3×5; that the former had one large hexagonal anal plate (he evidently meant, to judge from his figures, "and other smaller ones succeeding"), and a considerable number of interradials, the lower one much the largest; while *Taxocrinus* has two series of anals and several interradials. The three underbasals are comparatively large in both groups. Angelin's descriptions of both genera are short, and give us but little additional information regarding their relations; on the contrary they rather increase the difficulty, as none of his species of *Taxocrinus* or *Forbesiocrinus* are true representatives of either, thus raising the question whether the Swedish species ought not to be considered as types of new genera, or at least be separated subgenerically. We prefer the latter course, and propose *Gnorimocrinus* for the former, and *Lithocrinus* for the latter.

Phillips in proposing the genus *Taxocrinus* included in it the following species, in the order in which we give them, viz., *Poteriocrinus Egertoni* Phill. 2. *Cyathocrinus tuberculatus* Miller.[1] 3. *Cyathocrinus macrodactylus;* and 4. *Cyathocrinus nobilis* Phill. The first of these, a subcarboniferous species, with no or but few interradials, must be considered, according to the most generally accepted rules of naturalists, the type of the genus. The second and third species have but one or two interradials, *T. tuberculatus*, according to Pictet's figure, one or two anals resting on the upper truncated side of the large basal. The fourth species was Koninck & Lehon's type of their genus *Forbesiocrinus*.

Now comparing the anal arrangement of the latter—or rather of *Forbesiocrinus Agassizi* Hall, which undoubtedly belongs to the same group, and in which these parts are better known—we find the large basal not truncated, and the anal series which rests directly upon it almost identical in construction with the interradial series, except that it is slightly broader, and that it consists of a few more plates. We also find in that species a considerable number of axillary pieces, which extend up to the top of the tertiary radials where the arms become free.

Referring to *Taxocrinus*, or to species with but few interradials,

[1] Roemer, considering Miller's genus *Cyathocrinus* not distinct from *Poteriocrinus*, proposed in 1851 (Foss. Fauna d. Devon. Gebirges a. Rhein, p. 8), and again in 1855 (Lethæa Geognostica, Ausgabe III. p. 233), that all species hitherto placed under Phillips' *Taxocrinus*, be arranged under *Cyathocrinus* with *C. tuberculatus*—Miller's second species—as type, and the generic formula amended accordingly. The genus *Cyathocrinus*, however, with Miller's first specios *C. planus* as type, has been accepted by almost every other paleontologist.

we find the first anal either directly upon the truncated basal as in *Taxocrinus tuberculatus*, or sometimes, in species in which the first radials join laterally, the first anal is placed opposite the second and third or even between the third radials, as in *Taxocrinus Thiemei*, but in either case, with the exception of the Swedish specimens, the anal plate has a truncated upper side, and is succeeded by from two to six similar, narrow, quadrangular plates, longitudinally arranged. The plates diminish in size upwards, and form the dorsal side of a short and slender lateral proboscis, whose ventral parts, as well as the wall supporting them, have never been found preserved, and evidently consisted of more fragile material.

Returning to the interradial series we find specimens with apparently none to three or more interradial plates, with variation even in the individual, and some with as many as nine interradials, though in no instance extending up higher than to the top of the third primary radials, above which the rays are almost always free in the fossil. This, however, was not the case in the animal. Schultze found in his *T. juglandiformis*, within the open spaces between the rays, as well as between the first divisions of the rays, a large number of very minute, uneven and twisted pieces, which evidently took the place of the larger interradial plates in all cases where those did not exist. Similar pieces were figured by Angelin in the Swedish species, and they probably were present in all *Taxocrini*.

In some well-preserved specimens of *Taxocr.* (*Forbesiocr.*) *multibrachiatus* Lyon & Cass, from Crawfordsville, Indiana, and in a *Taxocrinus ramulosus*, Hall, from Burlington, Iowa, we have had an opportunity to examine this structure. Both species have a comparatively large number of interradials, the former from three to nine, arranged in from two to four series, the other six to seven in three series. These plates are quite prominent and differ but slightly in size. The little plates in question, or the plated integument as we should rather call it—the plates seem to be imbricated—is attached to the upper series of interradials, and fills the rather large interradial space up to the top of the secondary radials, inclosing the axillary spaces between the series of the latter up to the first arm-joints, and evidently covering the entire oral side of the body. On looking at the anterior side of these specimens, the construction seems almost identical with that of *Forbesiocrinus*, except that the upper part of the interradial area is less substantial and compact; but their posterior aspect exhibits in *Taxocrinus* a small lateral proboscis, while in *Forbesiocrinus* the space is filled with heavy plates, in the latter an almost pentamerous symmetry, in *Taxocrinus* (except in the Swedish species), a distinct bilateral one. This we consider the best distinction between the two genera. (Compare Diagram, Pl. 15, Fig. 2.)

An examination of a very large series of well-preserved specimens of the two genera has led us to this conclusion, and to a modification, to this extent, of the opinion intimated by us heretofore (Proceed. Phila. Acad. Nat. Sci., 1878, p. 254), that there is no distinction between these genera. We find that in practice we can separate them quite satisfactorily by the characters herein indicated, and, accordingly, we propose the following revised generic diagnosis:—

A. Typical form.

Body, including arms, rather short, depressed; calyx cup- or bowl-shaped, with bilateral symmetry. Underbasals three, sometimes very small, unequal in size, the two larger ones pentangular, the smaller quadrangular. Basals five, four of them equal and with acute upper angles, the fifth larger, generally with truncated upper sides. Primary radials three—rarely four—by five, of nearly equal size, wider than high, quadrangular in outline, except the upper one which is pentangular. Secondary radials varying in number from three to six—the former most prevalent—slightly smaller than the primary radials, and resembling them in general form. Tertiary radials like the preceding, only comparatively smaller and supporting the arms.

Arms dichotomizing once or twice, composed of single, short joints, more or less rounded on the back; sutures frequently sinuate, and sometimes provided with supplementary patelloid plates. Interradials none to three or more—as many as nine have been observed—extending as high as the top of the second or third primary radials, with very minute, irregular plates above, which fill the entire space to the top of the secondary radials, the axillary spaces, sometimes enclosing the first arm plates, and probably covering the entire ventral side of the body.

Some species have from one to three regular axillary plates, with occasionally a single plate in the axil between the tertiary radials. Anal plates resting upon the truncated upper side of the larger basal, or sometimes placed independently in line with second and third radials. They consist of a series of from two to five narrow quadrangular plates, longitudinally arranged, the upper ones forming the dorsal side of a small lateral proboscis. Column comparatively large, rapidly tapering, composed near the body of thin joints, which gradually increase in thickness as they diminish in diameter. Central perforation of medium size, pentangular as far as observed.

Geological and Geographical Distribution.—*Taxocrinus*, so far as known, appears first in Europe, where it is represented in the Upper Silurian by 2 species, in the Devonian by 3, and in the Subcarboniferous by 2. In the United States and Canada (if we exclude *Lecanocr.(?) elegans*, from the Trenton group), it is first found in the Devonian, from which 4 species are known, and from the Subcarboniferous 13 are described.

We include in the typical form of the genus the following species:—

1856. **Taxocrinus affinis** Müller. Neue Echinod. d. Eifel, p. 244, pl. 1, figs 1, 2; also Schultze, 1866, Echinod. Eifl. Kalk., p. 34, pl. 4, fig. 2. Devonian. Eifel, Germ.

1843. **Taxocr. brevidactylus** Aust. (**Cladocrinus brevidactylus**). Ann. and Mag. Nat Hist., vol. ii, p. 198; also Rec. and Foss. Crin., p. 89, pl. 11, fig. 4. Subcarbon, Ireland.

*1863. **Taxocr. communis** Hall. (**Forbesiocr. communis**). 17th Regts. Report. N. Y. State Cab., p. 55; also 1877, Paleont. Rep. Ohio. Vol. ii. p. 169, pl. 12, figs. 3–5. Waverly group. Richfield, O.

1836. **Taxocr. Egertoni** Phillips (**Poteriocr. Egertoni**). Geol. Yorksh., ii. pl. 3, fig. 39. Subcarbon. Yorkshire, Eng.

*1858. **Taxocrinus Giddingei** Hall. (**Forbesiocrinus Giddingei**). Geol. Rep. Iowa, vol. i. pt. ii. p. 633, pl. 17, figs. 2, 4. Keokuk limest. Illinois, Iowa.

1865. **Taxocr. gracilis** Meek and Worthen. Proceed. Acad. Nat. Sci. Phila., p. 142; also Geol. Rep. Illinois, vol. iii. p. 421, pl. 13, fig. 3. Hamilton gr. Jackson Co., Ill. (not **Taxocr. gracilis** Schultze = **Rhopalocrinus gracilis**, Wachsm. and Spr.

*1867. **Taxocr. incurvus** Trautschold. (**Forbesiocr. incurvus.**) Crin. des jüngeren Bergk. Moskau, p. 31; also Kalkbr. von Mjatschkowa, p. 126, pl. 14, fig. 11, and pl. 15, fig. 3. Subcarb., near Moscow, Russ.

1858. **Taxocr. interscapularis** Hall. Geol. Rep., Iowa, vol. i., pt. ii., p. 482, pl. 1, fig. 3. Hamilton gr. New Buffalo, Iowa.

1867. **Taxocrinus juglandiformis** Schultze. Echinod. Eifl. Kalkes, p. 35, pl. 4, fig. 4. Devonian. Eifel, Germ.

*1861. **Taxocr. juvenis** Hall. (**Forbesocr. juvenis**), Bost. Journ. Nat. Hist., vol. vii. No. 2, p. 319. Lower Burl. limest., Burlington.

*1863. **Taxocr. Kelloggi** Hall. (**Forbesciocr. Kelloggi**), 17th Regts. Rep N. Y. State Cab., p. 56; also Geol. Rep., Ohio, Paleont, vol. ii. p. 171, pl. 12, fig. 1. Waverly gr., Subcarb. Richfield, Ohio.

*1862. **Taxocr. lobatus** Hall. (**Forbesiocr. lobatus**), 15th Regts. Rep. N. Y. State Cab., p. 124. Hamilton gr. Ontario Co., N. Y.

*1863. **Taxocr. lobatus** var. **tardus** Hall. (**Forbesiocr. lobatus** var. **tardus**), 17th Regt's. Rep. N. Y. State Cab., p. 56; also Geol. Rep. Ohio Paleont, vol. ii. p. 171, pl. 12, fig. 1. Waverly gr. Richfield, Ohio.

1841. **Taxocr. macrodactylus**, Phillips. (**Cyathor. macrodactylus**). Paleoz. Foss. Corniv., p. 29, pl. 15, fig. 41. Subcarbon. England.

*1858. **Taxocrinus Meeki** Hall. (**Forbesiocr. Meeki**), Geol. Rep. Iowa, vol. i., pt. ii., p. 631, pl. 17, fig. 3. Meek and Worthen, 1866, **Onychocrinus Meeki**, Geol. Rep. Illinois, vol. ii. p. 243. Keokuk limest. Keokuk, Iowa.

*1858. **Taxocr. multibrachiatus** Lyon and Cass; (**Forbesiocr. multibrachiatus**), Amer. Journ. Sci , vol. xxiii. (Labelled in most American collections **Forbesiocr. Meeki** Hall.) Keokuk limest. Crawfordsville, Ind., and in Kentucky.

*1862. **Taxocr. nuntius** Hall. (**Forbesiocr. nuntius**), 15th Regt's Rep. N. Y. State Cab., p. 124. Hamilton gr. Erie Co., N. Y.

1855. **Taxocr. Orbignii** McCoy. Synops. Foss. Brit. Pal. Rocks, p. 53, pl. 1 D., fig 1. Upper Silur. Westmoreland, Eng.

*1860. **Taxocr. ramulosus** Hall. (**Forbesiocr ramulosus**). Supplement Iowa Geol. Rep., p. 67 (not **Forbesiocr. ramulosus**, Lyon and Cass. = **Onychocrinus ramulosus**). Upper Burlington limest. Burlington. **Synon. Forbesiocr. sumbramulosus** Shumard, 1866

1851. **Taxocr. Rhenanus** F Roemer. (**Cyathocr. Rhenanus**), Foss. Fauna d. Rhein. Gebirg., p. 7, pl. 2, figs. 2 a–d. Devonian. Germany.

1860. **Taxocr. semiovatus** Meek and Worthen. Proceed. Acad. Nat. Sci. Phila., p. 389; Geol. Rep. Illinois, vol. ii. p. 272, pl. 20, figs. 4 a–b. St. Louis limest. Hardin Co., Ill

*1858. **Taxocr. Shumardianus** Hall. (**Forbesiocr. Shumardianus**), Geol. Rep. Iowa, vol. i., pt. ii., p. 671, pl. 17, fig. 1. St. Louis limest. St. Louis, Mo.

1861. **Taxocr. Thiemei** Hall. (**Forbesiocr. Thiomei**), Bost. Journ. Nat. Hist., vol. vii. No. 2, p. 317. Burlington limest. Burlington, Iowa.

Synom. **Forbesiocrinus spinifer** Hall, 1861. Bost. Journ. Nat Hist., vol. vii. No. 2, p. 318

1821. **Taxocr. tuberculatus** Miller. (**Cyathocr. tuberculatus**), Nat. History of Crinoidea, p. 88; also Goldfuss, 1826, Petref. Germaniæ, pl. 63 figs. 6 A, B. **Cladocrinus tuberculatus** Austin, Journ. Zool., xi. p. 197. Upper Silur. Dudley, Eng.

*1858. **Taxocrinus Whitfieldi** Hall. (**Forbesiocr. Whitfieldi.**) Geol. Rep. Iowa, vol. i., pl. 2, p. 632. Meek & Worthen, 1866, Geol. Rep. Illinois, vol ii. p. 243. Keokuk limest. Warsaw, Ill.

B. Subgenus **GNORIMOCRINUS** Wachsm. & Spr.
(γνωριμός, noble; κρῖνον, a lily.)

In form and general habitus closely resembling *Taxocrinus*. Arms comparatively longer, figure irregular, lacking the bilateral symmetry of that genus. The basal (subradial) on the posterior side is exceedingly large, reaching almost up to the top of the adjoining first radials. The first anal plate, instead of resting upon the truncated upper side of that basal, leans against the oblique right side and the adjoining first radial. A second series of anals, generally composed of two plates, rests above the basal and first anal plate. All succeeding pieces are small, frequently, but not always, quadrangular, and form as in *Taxocrinus* a short and narrow lateral proboscis which, however, is here pushed over toward the right side of the body, thereby destroying the symmetry which is characteristic of that genus. Arms placed apart, outer face rounded, bifurcating unequally by throwing off branches toward the inner side of the ray, the outer side forming almost a straight line. Column composed of long and short and wide and narrow joints which alternate from the top, not exclusively short joints at the top as in most *Taxocrini*.

We place here the following species:—

*1878. **Gnorimocrinus Austini** Angelin. (**Taxocr. Austini.**) Iconogr. Crin., p. 9, pl. 19, figs. 11 and 11 a. Upper Silur. Gotland, Sweden.

*1878. **Gnorimocr. distensus** Angelin.[1] (**Taxocr. distensus.**) Iconogr. Crinoid , p. 9, pl. 26, figs. 7, 7 a. Upper Silur. Gotland, Swed.

*1866. **Gnorimocr. excavatus** Shultze. (**Zeacr. excavatus.**) Echinod. d. Efl. Kalkes, p. 39, pl. 7, fig. 2. Devonian. Eifel, Germ.

This species differs from the rest in having an excavated base.

*1878. **Gnorimocr. expansus** Angelin. (**Taxocr. expansus.**) Iconogr. Crinoid., p. 9, pl. 20, figs. 15, 16. Upper Silur. Gotland, Swed.

*1878. **Gnorimocr. interbrachiatus** Angel. (**Taxocrinus interbrachiatus.**) Iconog. Crinoid., p. 8, pl. 29, figs. 9, 10. Upper Silur. Gotland, Swed.

*1879. **Gnorimocr. Loveni** Wachsm. & Spr (**Cyathocr. interbrachiatus** Angel.) Iconogr. Crinoid., p. 23, figs. 2, 2 a. Upper Silur. Gotland, Swed.

This species differs from *Cyathocrinus* both in the arrangement of the anal plates and in the presence of interradials. *Gnorimocr. interbrachiatus* being preoccupied, we have named it in honor of Prof. Lovén of Stockholm.

[1] In this species, as also *Gnorimocr. punctatus*, the irregular arrangement of the anal area is not sufficiently shown in the figures, and both may possibly belong to *Taxocrinus*.

*1878. **Gnorimocrinus oblongatus** Angelin. (**Taxocr. oblongatus.**) Iconogr. Crinoid , p. 8, pl. 20, fig. 17. Upper Silur. Gotland, Swed.

*1878. **Gnorimocrinus ovalis** Angelin. (**Taxocr. ovalis.**) Iconog. Crinoid, p. 8, pl. 20, figs. 13, 14, Upper Silur. Gotland, Swed.

*1878. **Gnorimocr. punctatus** Angelin. (**Taxocr. punctatus.**) Icongr. Crinoid., p. 9, pl. 23, figs. 4, 5 (fig 27(?)). Upper Silur. Gotland, Swed.

*1878. **Gnorimocr. rigens** Angelin. (**Taxocr. rigens.**) Iconogr. Crinoid., p. 9, pl. 11, figs. 7, 8. Upper Silur. Gotland, Swed.

*1878. **Gnorimocr. Salteri** Angl. (**Taxocr. Salteri.**) Iconogr. Crinoid., p. 9, pl. 23, figs 1, 1 a. Upper Silur. Gotland, Swed.

*1878. **Gnorimocr. tubuliferus** Angl. (**Taxocri. tubuliferus.**) Iuconogr. Crinoid., p. 9, pl. 20, figs. 11, 12. Upper Silur. Gotland, Swed.

8. **FORBESIOCRINUS** De Koninck & Lehon.

(Diagr. Pl. 15, Fig. 1.)

1853. *Forbesiocr.*, De Kon. & Leh. Recherches s. l. Crin. Belg., p. 18.
1858. *Forbesiocr.*, Hall. Geol Rep. Iowa, vol. i. pl. 2, p. 628.
1866. *Taxocrinus*, Meek & Worth. Geol. Rep. Illinois, vol. ii. p. 269.
1878. *Forbesiocrinus*, Angl. Iconogr. Crinoid., p. 9.

A. Typical form.

Comparatively larger than any other genus of the *Ichthyocrinidæ*. Body, including arms, broad, short, almost equilaterally pentamerous. Calyx very large, plates heavy and nodose, radial portions prominent. Underbasals three, small, hidden by the column, two of them of equal size, the third smaller. Basals five, four about equal, the one at the posterior side larger, rarely truncated. Primary radials three to four by five, generally four, but varying in number in the individual; large, almost equal in size and form. Secondary radials two, three, four, or more to the series, about half as large as the primary radials, and of the same general form. Tertiary radials smaller than those of the preceding order and comparatively shorter, the rays becoming free at the second, third, or fourth plate. Arms long, dichotomizing, infolding at the tips so that their full length is seldom observed. They are composed of single, short plates, slightly rounded at the back, with a deep ventral furrow. Arm joints in corresponding subdivisions of the same size, those in each succeeding order smaller by about one-half. The sutures of the radial and arm plates strongly sinuate, and partly occupied by additional patelloid plates. Interradial area extending to the top of the tertiary radials, and composed of a large number of plates, from ten to twenty or more, which decrease in size gradually upward, the lower one being about half the size of the primary radials.

Axillary plates from ten to twenty and more, with occasionally one to three within the axil of the tertiary radials. Anal area without lateral proboscis or visible aperture, slightly wider than the interradial areas and similarly arranged, with generally two plates in the first series instead of one. Dome unknown, but evidently to some extent flexile. Column large, tapering downward, with very thin joints next the body; central perforation of medium size, pentagonal.

The most important distinction between *Forbesiocrinus* and *Taxocrinus* is to be found in the construction of the anal and interradial areas. Unfortunately the type specimen of the former genus is in these particular parts very imperfect. We therefore propose, until better specimens of *Forbesiocrinus nobilis* De Kon. & Leh. are discovered, to make *Forbesiocrinus Agassizi* Hall the type of the genus. This large and beautiful species from the Burlington limestone evidently belongs to the same group, and has been found in excellent preservation.

Geographical and Geological Distribution.—Forbesiocrinus is not distinguished for a great variety of form, nor for abundance of individuals. In Europe, there has been found only one species from the Mountain limestone of England In the United States, it is represented by four species, all from the Subcarboniferous.

We recognize the following species as belonging to this genus:

1858. **Forbesiocr. Agassizi** Hall. (Proposed type). Geol. Rep. Iowa, vol. i., pt. 2, p. 631; also Suppl. Iowa Geol. Rep., p. 65. Upper Burlgt. limest. Burlington, Iowa. *Synon. F. Agassizi* var. *giganteus*, Meek & Worth. Geol. Rep. Illinois, vol. iii. p. 495, pl. 18, fig. 3.

1859. **Forbesiocr. Cestriensis** Hall. Suppl. Geol. Rep. Iowa, p. 68. Chester limest. Pope Co., Ill.

1853. **Forbosiocr. nobilis** De Kon. & Leh. (original type). Recherches s. l. Crin. Belg. p. 121, pl. 2, figs. 2 a, b. *Poteriocr. nobilis* Phill. is probably a synonym. Mountain limest. Yorkshire, Engl.

1858. **Forbesiocr. Wortheni** Hall. Geol. Rep. Iowa, vol. i., pt. 2, p. 632, pl. 17, fig. 5. Keokuk limest. Keokuk, Iowa, and Crawfordsville, Ind.

B. Subgenus **LITHOCRINUS** Wachs. & Spr.

(λιθος, a stone; κρῖνον, a lily.)

Prof. Angelin, in the Iconogr. Crinoid. Suec., p. 9, has described several Gotland species under *Forbesiocrinus*, which we propose to separate subgenerically. They differ from all subcarboniferous species of this group in having larger underbasals, fewer plates in the interradial and anal areas; in exhibiting a strong tendency to a bilateral figure instead of a pentahedral; in having comparatively much larger and higher first, and shorter second and third radials; also in the exceedingly large first interradial and first anal plate. Arms, so far as observed, free above the secondary radials, but only toward the inner side of the ray; the outer side forming almost a straight line. No pinnulæ observed. Column round, composed of alternately larger and smaller joints not tapering in diameter downward.

This division embraces the following species:—

*1878. **Lithocrinus divaricatus** Angelin. (**Forbesiocr. divaricatus**). Iconogr. Crinoid., p. 9, pl. 21, fig. 21, and pl. 28, fig. 3. Upper Silur. Gotland, Swed.

*1878 **Lithocr. Milleri** Angelin. (**Forbesiocr. Milleri.**) Iconogr. Crinoid, p. 9, pl. 21, fig. 16, and pl. 28, fig. 1. Upper Silur. Gotland, Swed.

*1878. **Lithocrinus obesus** Angelin. (**Forbesiocr. obesus.**) Iconogr. Crinoid., p. 9, pl. 21, fig. 18, and pl. 28, fig. 2. Upper Silur. Gotland, Swed.

*1878. **Lithocr. robustus** Angelin. (**Forbesiocr. robustus.**) Iconogr. Crinoid., p. 9, pl. 21, figs. 11, 12. Upper Silur. Gotland, Swed.

9. **ONYCHOCRINUS** Lyon & Casseday.

1859. *Onychocrinus*, L. & C. Am. Journ. Sci., vol. xxix. p. 77.
1861. *Onychocrinus*, Meek & Worth. Geol. Rep. Illinois, vol. ii. p. 242.
1861. *Forbesiocrinus*, Hall. Bost. Journ. Nat. Hist., vol. vii. p. 321.

Body extended in five free rays, which are sometimes spread out horizontally; arms resembling the talons of a fowl. Calyx depressed saucer or low cup-shaped.

Underbasals three, of unequal size, rarely seen beyond the column. Basals five, four with obtuse angles, the fifth with a truncated or slightly excavated upper side. Radials four to five (rarely six to seven) by five; comparatively large, almost of equal size. At the third, fourth, or fifth plate, the rays become free, after which they divide once, each division giving off the true arms. Arms very short, branching once or twice, disposed in clusters at the extremities, and in some species along their sides also; composed of single joints with waving sutures and deep ventral furrow. In the anal area there is a series of from three to five very narrow, quadrangular plates, which rests upon the truncated or slightly excavated upper side of the basal, and forms a small lateral proboscis as in *Taxocrinus*. Interradials three to twenty, perhaps more in some species; the first one large, resting between the first and second radials; the succeeding ones smaller, rapidly decreasing in size and thickness upward, and having an inward curvature. They are followed by very minute, irregular polygonal plates, which form the interradial portion of the vault. The radial summit areas consist of two rows of somewhat larger plates, alternately arranged, which extend to the ventral covering of the free rays, and probably throughout their full length. In the median portion of the vault, there are six rather thin but large apical dome plates. The summit, when the rays are extended, is not higher than the top of the second radials; general surface depressed. Column heavy, composed of very thin joints, tapering rapidly downward; central perforation above medium size, pentagonal.

Onychocrinus is most nearly related to *Taxocrinus*, with which it is almost identical in the construction of the anal portions. It differs, however, materially in the free rays, the arm structure, and its greater expansive power.

Lyon and Casseday took the free rays to be arms, and the true arms to be pinnulæ. These authors did not extend the genus to forms like their *Forbesiocr. ramulosus*, which has only four radials instead of five, as stated in their generic formula, though that species has all the other characters of the genus.

Hall has never recognized *Onychocrinus* as a genus, but placed *O. asteriæformis*, a typical form, under *Forbesiocrinus*. Meek and Worthen, evidently considering the small lateral proboscis the principal distinction between *Onychocrinus* and *Forbesiocrinus*, and not knowing that all *Taxocrini* have it, placed all species of this group in which they observed this appendage under *Onychocrinus*.

Geographical and Geological Distribution.—*Onychocrinus* has been found only in the Subcarboniferous of Ireland and the United States; it embraces the following species:—

1861. **Onychocr. asteriæformis** Hall. (**Forbesiocr. asteriæformis**), Descr. New Crin. Prelim. Not., p. 9; also Bost. Journ. Nat. Hist., vol. vii No. 2, p. 320. Meek and Worth **Onychocrinus asteriæformis** Geol. Rep., Illinois, vol. ii. p. 243. Upper Burlington limest Burlington, Iowa.

1866. **Onychocr. diversus** Meek and Worth. Proceed. Acad Nat. Sci Phila., p. 256; also Geol. Rep., Illinois, vol. iii. p. 492. Upper Burlington limest. Burlington, Iowa.

1859. **Onychocr. exsculptus** Lyon and Casseday (Typical species). Am. Journ. Sci., vol. 29, p. 78. Keokuk limest. Hardin Co., Ky., and Montgomery Co., Ind. *Synom.* **Onychocr. (Forbesiocr.) Norwoodi** Meek and Worth. Geol. Rep., Illinois, vol. ii. p. 245, pl. 17, fig. 3.

1875. **Onychocrinus magnus** Worthen. Geol. Rep., Illinois, vol vi. p. 520, pl. 31, fig. 5. St. Louis limest. Monroe Co., Ill.

1861. **Onychocrinus Monroensis** Meek and Worth. (**Forbesiocr. Monroensis**). Proceed. Acad. Nat. Sci Phila., p. 130. 1866, **Onychocr. Monroensis**, Ill. Geol. Rep., vol. ii. p. 244, pl. 17, fig. 7. Keokuk limest. Monroe Co., Illinois.

*1846. **Onychocr. polydactylus** McCoy. (**Taxocr. polydactylus**.) Synops. Carb., Ireland, p. 178, pl. 24, fig. 7. Subcarbon. Ireland.

*1859. **Onychocr. ramulosus** Lyon and Cass. (**Forbesiocr. ramulosus** L. and C., not Hall), Am. Journ. Sci., vol. 28, p. 235 Keokuk limest. Montgomery Co., Ind.

10. NIPTEROCRINUS Wachsmuth.

1868. Proceed. Acad. Nat. Sci. Phila., p. 341.
1873. Geol. Rep. Illinois, vol. v. p. 434.

This genus was originally referred by its author to the *Cyathocrinidæ*, with which, indeed, it agrees in some of its peculiarities, but a full understanding of the true nature of its structure shows that it must be classified with the *Ichthyocrinidæ*. The number of plates which constitute the proximal ring was not then, nor is now, ascertained with certainty, owing to the fact that they extend but slightly beyond the column, and, though we are inclined to think there are but three, we cannot as yet assert it positively. The first radials in some points resemble those of *Cyathocrinus*, being exceptionally large for the *Ichthyocrinidæ*. They have above a deep rounded sinus for the reception of the second radials, on each side of which, the upper margin of the plate is nearly straight and not incurved. The latter peculiarity, which was noticed in the original description, suggests the presence of an interradial structure, and the continuance of the body between the so-called free radials, otherwise this part would have to be more inflected for the support of the dome. That an interradial structure existed in the genus, is plainly seen in a specimen of *N. Wachsmuthi* M. and W., now before us, from which we infer that the interradials extend most probably even to the succeeding order. This structure alone would be sufficient to place *Nipterocrinus* among the *Ichthyocrinidæ*, but it has also the peculiar lunulate second radials, the waving sutures, and strongly marked sinuosities of the arm plates, and apparently no proboscis, not even a vestige of that organ having been discovered, though we had occasion to examine on this point some remarkably perfect specimens.

Revised Generic Diagnosis.—Body, with arms included, short; the five rays equilateral; arms divergent. Plates of calyx unusually thin, and, as far as the top of the first radials, forming a basin or depressed cup composed of immovable plates. Succeeding plates, though connected laterally, movable.

Underbasals small, scarcely extending beyond the column. Basals much smaller than the first radials, all pentangular and of equal size. Radials three to four by five. First radials comparatively much larger than in any other genus of this family; articulating face concave, and occupying less than one-half the width of the plate; the upper margins on both sides of the scar nearly straight, almost horizontal, scarcely inflected, and supporting the interradial portions which are rarely preserved, leaving in their place, in the fossil, a wide, open space between the rays. Second and third radials short, often three or four times wider than high, lunulate, resting in the concavity of the preceding plate; the bifurcating plate almost triangular. Succeeding order of plates constructed like those of the arm, only larger, all of them much wider than high, rounded on the back, with distinct waving sutures showing deep sinuosities when the arms are closed, and indicating a great mobility in these parts. Arms divergent, tapering gradually; pinnulæ unknown. No interradials to the top of the first radials, but the succeeding radials, and probably the first plate of the next order, connected by an interradial integument, the true nature of which has not been fully ascertained, being probably similar to that in *Taxocrinus*, but composed of larger plates. Column round, thick, composed near the calyx of narrow joints.

Only two species are known, and both are from the Burlington limestone:—

1873. **Nipterocrinus arboreus** Worthen. Geol. Rep. Illinois, vol. v. p. 436, pl. 4, fig. 8. Lower Burlington limest. Burlington, Iowa.

1868. **Nipterocrinus Wachsmuthi** Meek and Worth. (Type of the genus.) Proceed. Acad. Nat. Sci. Phila., p 341; also Geol. Rep. Illinois, vol. v. p. 435, pl. 2, fig. 4. Upper Burlington limest. Burlington, Iowa.

11. RHOPALOCRINUS nov. gen.

(ῥόπαλον, a club, κρῖνον, a lily.)

Schultze, in his Monogr. d. Echinod. d. Eifl. Kalkes, p. 39, describes a form under the name of *Taxocrinus gracilis*, which is very interesting, inasmuch as it combines, to some extent, the characters of several families. There are only five arms, which remain simple throughout their entire length, forming a straight line with the radials—a peculiarity found in no other genus of the *Ichthyocrinidæ*. This attracted the attention of Schultze, who suggested either a modification of the genus *Taxocrinus*, so as to admit this species, or the recognition of a new genus. In the former proposition we cannot concur, as it seems to us we must admit such peculiarities as exist in this species to be generic distinctions, or throw all forms of the *Ichthyocrinidæ* into a single genus. As to this genus, we even entertain some doubts whether it belongs to the same family.

Our genus *Rhopalocrinus*, with *R.* (*Taxocr.*) *gracilis* Schultze, as type, agrees in general form rather with *Cupressocrinus*, *Symbathocrinus* and *Graphiocrinus*—representing as many distinct families—than with *Taxocrinus;* but it differs from all of them in having a series of small plates inclosed between the rays. These plates, which Schultze calls "interbrachials," fill up, according to his description, "the intermediate spaces to the top of the second radials," being thus included within the body. If we were sure that this was the case, we should, notwithstanding the simple arm structure, place *Rhopalocrinus*, without hesitation, under the *Ichthyocrinidæ;* but, as it is, the preservation of these parts is not so satisfactory as to exclude another interpretation. The so-called interbrachial plates are seen only in one interradial space, and, as all successive plates from the radials to the tips of the arms have the same form (with the exception of the first one, which is three to four times shorter, but otherwise similar), and an almost circular articulating surface, which has never been observed in plates forming part of the body, it seems quite possible that all branches were free, and that the small plates were deposited accidentally, being either plates of the vault, or perhaps remains of the pieces which once covered the arm furrows.[1] This of

[1] The type specimen with Dr. L. Schultze's entire collection is now in the Museum of Compar. Zoölogy at Cambridge.

course would remove *Rhopalocrinus* from the *Ichthyocrinidæ*, and bring it in close relation with such genera as *Symbathocrinus* and *Pisocrinus*, with which it agrees in its arm structure and in the narrow proboscis, which probably extended in those genera to the extremities of the arms.

We propose the following generic diagnosis: General form of body, including arms, subclavate, with bilateral symmetry; plates heavy. Underbasals three, scarcely visible beyond the column. Basals five, four of them equal, regularly pentangular, the fifth much higher, becoming narrower toward the top, truncated above for the accommodation of the proboscis. Radials placed in a direct line with the arms; one ring only constituting a part of the solid body, all succeeding ones be ng more or less movable. First radial large, heavy, the articulating face occupying almost the entire width of the plate, circular, facing slightly outward, and perforated with an opening which communicates with the interior body and with a passage toward the dorsal side of the arms. Second radials, or first brachial plates, wide but short, evidently movable, probably connected interradially (between the rays) by small polygonal plates. Succeeding plates all of the same width and form as those of the preceding ring; their height, however, three or four times greater. Arms five, simple throughout, and closely resembling those of *Symbathocrinus;* length unknown, of almost uniform size up to the sixth plate. Ambulacral furrow covered by two rows of plates roofed together, with the median line elevated. Anal area supporting a lateral proboscis similar to that of *Onychocrinus*, but heavier, and probably extending up to the top of the arms, as in *Symbathocrinus.* Interradial spaces apparently filled by very small, uneven polygonal plates up to the second brachial. Column large, almost cylindrical, and composed of larger and smaller joints near the body.

The only known species is—

*1866. **Rhopalocrinus gracilis** Schultze. (**Taxocr. gracilis** Schultze, not **Taxocr. gracilis** Meek and Worth.) Monogr. Echinod. Eifl. Kalkes, p. 39, pl. 4, figs 3, 3 a. Devonian. Eifel, Germ.

Family II.—CYATHOCRINIDÆ.

The Cyathocrinidæ represent not only one of the largest but also one of the earliest groups of the Palæocrinoidea, and they survived every other family of that sub-order.

J. S. Miller, the author of *Poteriocrinus* and *Cyathocrinus*, the two principal genera, placed the former among the Semiarticulata and the latter under the Inarticulata, which he understood to represent two distinct families. *Poteriocrinus*, according to his views, had the plates of the calyx articulating imperfectly with each other, while the plates of *Cyathocrinus* were closely joined by sutures lined with muscular integument. It is unnecessary to examine Miller's divisions in detail, as they are based upon theory and incorrect observation, as is further shown by the fact that under the Inarticulata he united *Cyathocrinus* with *Actinocrinus*, *Rhodocrinus* and *Platycrinus*, which are of course totally distinct.

Thom. Austin's classification (1843, Rec. and Foss. Crin.) is equally unsatisfactory. He followed Miller in separating *Cyathocrinus* and *Poteriocrinus* into two distinct families, placing the former among the Platycrinidæ, and including therein *Caryocrinus;* and *Poteriocrinus* with *Symbathocrinus* among the Poteriocrinidæ. The former group is based simply upon the presence of but few plates in the calyx. In the Poteriocrinidæ, according to Austin, "the lower series of plates surrounding the body, rest on and articulate on the superior columnar joint, which also articulates by radiating striæ to the concealed dorso-central (basal) plate." By the "concealed dorso-central plate" Austin meant a little tripartite plate, which he and Phillips supposed they had discovered in *Poteriocrinus* within the ring of the underbasals, but which has been seen by nobody else, and in fact does not exist. The radiating striæ, however, are found between the calyx and column, and all along the latter between the joints in all pedunculate Crinoids. His disposition of *Cyathocrinus* is no better, as he arranges it in the same family with *Caryocrinus*, which is a Cystidean. With our present knowledge it is evident that Austin's divisions are wholly arbitrary, and not according to nature.

The next attempt at classification was made by Prof. Roemer

(1855, Lethæa Geognostica, Ausgabe III., Period I.), who went to the opposite extreme by uniting Miller's typical species of *Cyathocrinus* with *Poteriocrinus*, and placing the latter with *Woodocrinus*, *Homocrinus*, *Dendrocrinus*, *Mespilocrinus*, and *Thysanocrinus* under the Poteriocrinidæ. It has been explained elsewhere that Roemer adopted the generic name *Cyathocrinus* with Miller's *Cyathocrinus tuberculatus* as type for another group of Crinoids, which had been previously separated by Phillips under *Taxocrinus*, and ranged these with *Ichthyocrinus* and a number of other genera under the family name "Cyathocrinidæ." It will thus be understood that Roemer's Cyathocrinidæ really represent our Ichthyocrinidæ, and his Poteriocrinidæ our Cyathocrinidæ. He united in the former an assemblage of very distinct groups, and among his Poteriocrinidæ are found *Mespilocrinus*, which, as we believe, belongs to the Ichthyocrinidæ, and *Thysanocrinus*, which is distinct from any of these families.

Angelin, in his systematic arrangement of the Gotland Crinoids (Iconogr. Crin. Suec.), very correctly places *Sicyocrinus*, *Eus-pirocrinus*, *Ophiocrinus*, and *Botryocrinus* among the Cyathocrinidæ; but *Gissocrinus*, which closely agrees with *Cyathocrinus*, except in having three underbasals instead of five, he classes (apparently on account of this structure alone) with the Forbesiocrinidæ. We have already, in our introductory remarks, noted the difficulty of classifying the genera according to the number of proximal plates, and in *Gissocrinus* we have a good example of this.

A close and comparative study of the genera *Cyathocrinus* and *Poteriocrinus* has convinced us that, though the two are very distinct generically, they are, as between themselves and in connection with many other genera, united by very important structural features, and by right ought to be regarded as of one family. They all agree—

1. In having large oral plates supporting the ambulacral grooves and covering the ventral disc, but leaving an opening at the oral centre, which is perfectly covered by the apical dome plates. Food grooves along the vault closed by two rows of alternating pieces.

2. In the presence of a porous ventral sac, located posteriorly, and closed at the top, in which the anal functions were subordinate to other offices, probably in connection with respiration and

perhaps reproduction. Anal opening rarely observed, evidently lateral—not posterior—and low down.

3. In having the calyx constructed of only three rings of plates alternating with each other. Proximal or underbasal plates sometimes imperfectly developed or even wanting; the plates of this order rarely anchylosed. No interradials, but anal plates generally found within the calyx.

These are the dominant characters upon which we propose to establish the Cyathocrinidæ as a family.

An attempt to subdivide this family by means of differences in the construction of the anal area and presence or absence of pinnulæ into two groups, represented by *Poteriocrinus* and *Cyathocrinus*, proved unsuccessful. It is true the two typical genera are well distinguished by these characters, and most genera from the Carboniferous might readily be separated in this way; but it would be very difficult with the Silurian genera, in which the anal area is imperfectly developed. Such a division might possibly be established if we had before us the living types instead of fossils, and it is very likely that the earlier forms, which include *Heterocrinus*, *Iocrinus*, *Dendrocrinus*, *Carabocrinus*, *Hybocrinus*, and *Anomalocrinus*, in which the proximal plates or underbasals are as yet very small and scarcely visible, might also be arranged in a division by themselves. So, too, *Woodocrinus*, *Zeacrinus*, *Hydreionocrinus*, and *Cœliocrinus* are well characterized by their enormous balloon-shaped ventral sac; and in like manner *Eupachycrinus*, *Erisocrinus*, and *Stemmatocrinus*, by the dwarfing of the same organ to its minimum size, represent a transition in the direction of the Encrinidæ. All these groups apparently have some claim to be classed independently, but in doing so we should rather increase than diminish the difficulties before us, and gain nothing in the end. The genera are so closely linked together, and shade so easily from one to another, and from one group into another, that a satisfactory separation is next to impossible. But, in order to facilitate the comparative study of the genera, we have arranged them systematically in such a manner that allied types are brought together in the order in which they pass into one another, and we are confident that this arrangement will materially assist in the recognition of the genera.

The following is the list:—

CYATHOCRINIDÆ.[1]

Earlier or embryonic types:—

1. *Heterocrinus* Hall.
2. *Iocrinus* Hall.
3. *Anomalocrinus* Meek & Worth.
4. *Hybocrinus* Billings.
   Subgenus *Homocrinus* Hall.
5. *Dendrocrinus* Hall.

Typical Cyathocrinidæ:—

6. *Cyathocrinus* Miller.
7. *Lecythocrinus* Zittel (J. Müller).
8. *Gissocrinus* Angelin.
9. *Arachnocrinus* Meek & Worth.
10. *Vasocrinus* Lyon.
11. *Ophiocrinus* Angelin.
12. *Botryocrinus* Angelin.
    Subgenus *Sicyocrinus* Angl.
13. *Barycrinus* Wachsmuth.

Poteriocrinus type:—

14. *Poteriocrinus* Miller.
    Subgenus *Scaphiocrinus* Hall (modified by W. & Spr.).
    Subgenus *Parisocrinus* W. & Spr.
    Subgenus *Pachylocrinus* W. & Spr.
    Subgenus *Scytalocrinus* W. & Spr.
    Subgenus *Decadocrinus* W. & Spr.
15. *Graphiocrinus* de Kon. & Leh.
    Subgenus *Bursacrinus* Meek & Worth.
    Subgenus (?) *Phialocrinus* Trautschold.

---

[1] Since writing our classification, Prof. Zittel of Munich, with whom we have exchanged notes informs us that he has separated the genera which we have united under Cyathocrinidæ into four families. (Handbuch der Petrefactenkunde, 3te Lieferung, now in press.)

1. Hybocrinidæ } without pinnulæ, arms covered with plates.
2. Cyathocrinidæ }
3. Poteriocrinidæ } with pinnulæ.
4. Heterocrinidæ }

We doubt whether this division can be maintained practically. *Heterocrinus* is certainly more closely related to *Hybocrinus*, which he disposes under a separate family, than to *Graphiocrinus*, *Philocrinus*, *Erisocrinus*, and *Stemmatocrinus* with which he groups it. The variety of *Poteriocrinus*, which we have proposed to call *Scytalocrinus*, has such close affinities to *Graphiocrinus* that it might well be doubted whether it would be considered as a subgenus of *Poteriocrinus* or *Graphiocrinus*. If a division of the Cyathocrinidæ should prove desirable, it would seem to us more natural to bring together *Heterocrinus* with *Hybocrinus* and *Anomalocrinus*, and to place *Graphiocrinus* and allied genera under the Poteriocrinidæ; but this would interfere with the division according to pinnulæ. The difficulties in the way of a subdivision, which we have discussed at length in our general remarks on the family, do not seem to us to be obviated by the proposed arrangement of our distinguished colaborer.

Zeacrinus type:—

16. *Woodocrinus* de Koninck.
17. *Zeacrinus* Troost.
18. *Hydreionocrinus* de Koninck. Subgenus(?) *Cœliocrinus* White.

Transition forms toward *Encrinus*:—

19. *Eupachycrinus* Meek & Worth.
20. *Erisocrinus* Meek & Worth.
21. *Stemmatocrinus* Trautschold.

Genera insufficiently known:—

22. *Euspirocrinus* Angelin.
23. *Carabocrinus* Billings.
24. *Cyrtidocrinus* Angelin.
25. *Pachyocrinus* Billings.
26. *Myelodactylus* Hall.

In some species of *Heterocrinus*, one of the oldest of known genera, the underbasals or proximal plates are apparently wanting; in others they are so imperfectly developed that Meek did not think proper to recognize them by the usual term, but called them sub-basals. If it happens that these plates are absent, as seems to be sometimes the case, in species which apparently belong to the same genus, it would seem improper to separate *Heterocrinus* on that ground alone, and this consideration has induced us also to place in this family, at least for the present, the allied genera *Hybocrinus* and *Anomalocrinus*, in which as yet no trace of these plates has been discovered, but which otherwise have all the characters of the typical Cyathocrinidæ. The family relations as to these genera are not altogether clear, and it will require further study and better material before we can expect to understand them fully. For the present we will content ourselves with drawing attention to some peculiarities in the structure of these early Crinoids in hope that it may lead eventually to interesting results.

We find that in *Poteriocrinus*, *Zeacrinus*, and in fact in all typical Cyathocrinidæ in which columnar or radicular cyrrhi have been observed, these appendages are radially situated. This is best observed and traced in species with a pentagonal stem, wherein the direction can be noted even in fragmentary pieces. The cirrhi here occur always along the lateral faces, and in the last-named genera, so far as observed, they are always radial, while the acute angles which are formed into elevated ridges along the column are interradial. The very opposite is the case in *Heterocrinus* and *Iocrinus*, in which the cirrhi are interradial, and the ridges of the column radial, exactly as in *Belemnocrinus*, and apparently in the Actinocrinidæ and Platycrinidæ. This might have induced us to place *Heterocrinus* and *Iocrinus* in a separate division along with *Hybocrinus* and *Anomalocrinus*, which latter two evidently belong to the same group, if we had not discovered that the same diversity of structure apparently exists in species of another family. In all *Pentacrini*, recent or fossil, that have come under our observation, the cirrhi are radial and the ridges interradial, with the exception of *Pentacrinus Johnsoni*, in which according to Austin's figure (Rec. and Foss. Crin., Pl. 15, Fig. i.) the cirrhi are situated interradially as in *Iocrinus*. Owing to this interesting coincidence, and also to the fact that in *Dendrocrinus*, which in many respects closely resembles *Heterocrinus* and its above-named associates, this columnar structure is the same as in all typical genera, we have retained these genera for the present in this family. We also retain those genera in which the five underbasals are metamorphosed into three, as in *Gissocrinus*, contrary to Angelin and Zittel, or into a single plate, as in *Stemmatocrinus*, provided they otherwise agree with the family.

In the Cyathocrinidæ, the anal area, though constructed of comparatively few plates, affords most excellent generic distinctions in their arrangement. We note two principal forms; the one, which we may call the *Poteriocrinus* form—as it is best illustrated in that genus—is generally composed of three plates in the calyx, which are arranged unsymmetrically and always directed toward the right side of the body; the other, or *Cyathocrinus* anal arrangement, with a bilateral symmetry, consists of a single plate, which rests upon the truncate posterior basal. The former occurs in connection with regular pinnulæ along the arms; in the latter the arm furrows are covered by small alternate pieces and the pinnulæ are wanting.

There is scarcely any difficulty in referring all Cyathocrinidæ, from the Upper Silurian to the close of the Carboniferous, to one of those two groups, though the anal plates vary in form more or less in every genus. In genera from the Lower Silurian this is more difficult. Yet there appears to exist even among the latter and in connection with all others, an easy gradation which indicates that both forms had very probably the same origin, and that the later ones were gradually developed from the earlier Silurian types.

Looking first at the subgenus *Iocrinus*, one of the earliest known forms of Crinoids, we find the body up to the top of the radials perfectly equilateral, all basal and radial plates having the same form; but higher up this symmetry becomes disturbed by irregularities in the disposition of the brachial plates. There are four brachials in four of the rays, short and all quadrangular, while the right posterior radial supports a peculiar bifurcating plate of the same width as the other brachials and apparently similarly articulated. Its right sloping side supports four brachials, its left a number of large, heavy, almost quadrangular plates, longitudinally arranged, rounded on the back, which have the general appearance of arm plates, and such they have been taken to be by most authors. They are, however, plates of a rather strong ventral sac, and extend to its full length forming a highly elevated ridge (Pl. 16, Fig. 3). The plates are bordered on each side by about double their number of rather delicate pieces, altogether different and transversely arranged, which from their peculiar elongate form and relative position resemble pinnulæ belonging to an appendage that looks like an arm. Now the question arises, what shall we call the bifurcating plate which gives rise both to the right posterior ray and to the ventral tube? It was certainly a movable plate, and as we mentioned before, its mode of articulation was evidently the same as that of the brachials. Shall it likewise be called a brachial? And again, was not the ventral tube here, and in Crinoids generally, originally a modified arm? This, if true, would at once explain why the anal area leans always toward the right and never to the left side of the body. Is the plate, on the contrary, an anal plate? If so, the arms in that ray would rest upon the base of the proboscis, which is not very probable. That it is a brachial with interradial functions, is illustrated in other genera. In *Dendrocrinus*, as may be seen, Pl. 16, Fig. 5, the case is substantially the same, but in that genus a regular anal plate has already appeared within the calyx, supporting the ventral sac. Here four of the *radials* are equal instead of four brachials, and the fifth is a compound plate consisting of two successive plates of about the form of the simple ones, but slightly larger. Nobody can doubt that here both the upper and lower sections of the compound plate, which are separated by a horizontal suture, are strictly radial. Looking, however, at *Homocrinus*, Pl. 16, Fig. 6, it will be found, although it differs from *Dendrocrinus* only in having the suture between the sections of the compound plate sloping instead of horizontal, that by this in itself trifling alteration, which required no modification in the form or construction of other plates, the lower portion of the original compound radial became transformed into an anal plate. This was the first step towards a *Poterocrinus* anal arrangement, and in fact to complete it required only the interposition of a third small plate (Pl. 16, Fig. 7). In confirmation of this idea it is very significant that *Dendrocrinus* is essentially a Lower Silurian genus, that *Homocrinus* is restricted to the Niagara group, and *Poteriocrinus* is pre-eminently a subcarboniferous form.

The step from *Dendrocrinus* to *Cyathocrinus* (Pl. 16, Fig. 8) was equally simple, and required only the consolidation of the compound plate into one, the simple anal plate being already developed in the former. Sometimes, however, in genera wherein otherwise the *Cyathocrinus* anal arrangement prevails, there is found alongside of the single anal plate in some species—occasionally only in a few specimens, and in *Barycrinus* and *Botryocrinus* almost as a rule—a supplementary anal piece obliquely interposed toward the right side, standing as a witness to the common origin of this and all anal plates. That there has never been observed a single instance in which the anal area was directed toward the left—not even an abnormal case—is most significant, and is strong evidence in favor of our opinion, that the ventral sac originated in the right posterior ray. It proves also that the modifications which we have mentioned as taking place in the family in geological succession, are occasionally found within the limits of a genus.

It is to be regretted that the ventral sac, owing to its position, hidden between the arms, is so rarely observed. A better knowledge of this organ, we have no doubt, would enable us to base upon it excellent generic distinctions, and it might perhaps assist in establishing subdivisions in this family. Very little is known, for instance, of the distribution and position of the pores and fissures, of the anal opening, etc., and nothing as to its internal organization.

In the Lower Silurian the ventral sac attained large dimensions. In the age of the Niagara group, Upper Silurian, it became remarkable for its singular form, in some genera coiling upon itself, or bending in all directions. In the Devonian and earlier Subcarboniferous it attained the maximum in length, and the cylindrical form prevails, but this by degrees changed into the club-shaped form, from which in the succeeding geological epochs, toward the close of the Subcarboniferous, those monstrous balloon-shaped sacs were developed, and with these, as if a culmination had been reached, the family actually terminates. The few forms which still survive can no longer be considered as true types of the Cyathocrinidæ. They are of a type prophetic of a new family which is soon to appear, and of which *Encrinus* is the leading genus. The resemblance of *Stemmatocrinus* to *Encrinus* is indeed so strong that one may well hesitate in which of the two families—Cyathocrinidæ or Encrinidæ—it should be classed. We should probably have decided in favor of the latter, if we had seen any possibility of separating *Stemmatocrinus* from *Eupachycrinus*, and *Eupachycrinus* from *Poteriocrinus*, and so on. The only real difference which we notice between the two is that in *Encrinus* the three rings of plates which form the calyx, in the Cyathocrinidæ constitute an almost flat disc, or so shallow a cup that there would be no space for a visceral cavity if covered by solid plates, and, as no trace of a ventral covering has ever been observed, it is very probable that *Encrinus* belongs to the Stomatocrinoidea.

The free floating *Agassizocrinus* (*Astylocrinus* Roemer) is another form, in regard to which doubts might be entertained whether it ought not to be ranked with the Cyathocrinidæ. Its younger stage, wherein it was pedunculate, agrees well in general structure with *Eupachycrinus*, and is very appropriately called the Cyathocrinoid form. We think it better, however, to separate the genus by itself, as in the case of *Pentacrinus* and *Comatula*, and to place it under *Astylocrinidæ* in a distinct group.

General Family Diagnosis.—Calyx composed of only three rings of plates alternating with each other, each ring composed of five plates; all succeeding plates free. The proximal ring or underbasals not unfrequently hidden from view by the column, perhaps in some cases wanting, rarely anchylosed so as to form three plates or a single one. The plates of the second ring generally varying in form, the posterior one frequently truncate. Those of the third ring or the radials, more or less pentagonal, the right posterior one often smaller on account of interposed anal plates. The succeeding order of plates which have been generally designated as "free radials," but for which we have adopted the term "brachials," consists of one to two or more by five plates on which the arms originate.

Arms simple or branching, comparatively long; either provided with rather strong pinnulæ, alternately arranged, or, in the absence of these, the ambulacral groove is covered with two rows of alternating pieces, more or less wedge-shaped, sometimes strongly cuneiform, and interlocking.

There are from one to four anal plates within the calyx. When there is a single anal, the symmetry of the body is generally bilateral, but, in case of two or more, the form is irregular, because the plates tend obliquely toward the right side of the body. The anal plates support a ventral sac, which is cylindrical, convoluted, club- or balloon-shaped, and which occasionally attains immense proportions. The sac is bordered with rows of pores or fissures; its upper extremity closed, so far as observed; the anal opening lateral. Interradial plates proper entirely wanting.

Calyx surmounted by five large oral plates, with a central opening between them, and forming at their sutures five shallow ambulacral grooves converging toward the centre. Central opening covered by the apical dome plates, and the five grooves arched over by two rows of small immovable pieces, alternately arranged.

Column round or pentagonal.

The Cyathocrinidæ differ from the Ichthyocrinidæ in having a solid inflexible vault, built up of oral plates; in possessing but a single radial to each ray; and in the absence of interradial plates.

1. HETEROCRINUS Hall.

(Diagram Pl. 16, Fig. 2.)

1843. Hall. Geol. Rep. New York, vol. i. p. 278.
1859. Billings. Geol. Surv. Canada, Decade IV. p. 48.
1865. Meek and Worthen. Proc. Acad. Nat. Sci. Phila., p. 147.
1866. Hall. 24th Rep. N. Y. State Cab. Nat. Hist., p. 210.
1873. Meek. Geol. Surv. Ohio. Palæont., vol. i. p. 2.

The genus *Heterocrinus* varies from the typical Cyathocrinidæ in several important particulars: first, in the apparent absence of underbasals in some of the species; second, in certain irregularities in the radial plates. In the former respect it agrees with *Hybocrinus* and *Anomalocrinus*, in the latter with *Dendrocrinus*.

The irregularities in the radial parts seem at first sight to be totally at variance with the elementary plan of structure in the family, as the calyx here appears to be composed of more than five radial plates, some of the rays having apparently two or even more. Looking at Diagram Pl. 16, Fig. 2, showing the arrangement of plates in *H. simplex* Hall, it will be found that in the anterior and right posterior rays, there are three plates in succession, whereas there are four in each of the other rays. But it will be also observed that the first radial plate in the former is about equal in size to the first two plates combined in the three other rays. It is, therefore, not unreasonable to suppose that the two here represent a compound plate, and are homologous with the single radial in other Cyathocrinidæ. This interpretation fully restores the family relations, the two succeeding plates being considered as true brachials. A similar construction exists in *Dendrocrinus*, but there only the left posterior radial is compound.

The absence of underbasals in some of the species is a good illustration of our view that the underbasals do not constitute principal elements in the structure of the Palæocrinoidea, but are merely the result of growth and development in geological time. Even Meek, who calls the proximal plates in all other genera of the Cyathocrinidæ basals, substitutes for those of *Heterocrinus* the name "subbasals."

Generic Diagnosis.—General form elongate and slender. Calyx small, subcylindrical, tapering but slightly from the column upward.

Underbasals minute, in some species almost undeveloped, and appearing externally as subtrigonal points at the lower ends of the sutures between the basals; in some species apparently wanting entirely. Basals five, subequal, pentangular. Radials irregular; some of the rays differing from those of other genera in having compound instead of simple plates, which are divided by horizontal sutures; upper articulating margin straight. The radials are succeeded by two to four brachials, quadrangular, the upper one a bifurcating plate and supporting the arms.

Arms comparatively long, simple or branching, composed of single joints with almost parallel suture. Pinnulæ heavy, springing alternately from every second or third arm plate.

Anals not supported by the basals, but resting upon the upper sloping margins of the adjoining radials. They consist of a single row of plates, longitudinally arranged, the outer side rounded and forming a prominent ridge, which gives the appearance of an arm.

The ventral sac in this genus is but imperfectly known, but it is apparently not so robust as in *Iocrinus*. Column more or less pentagonal.

The genus *Heterocrinus* is known exclusively from the Lower Silurian, and has been found only in America, unless *Myelodactylus (?) heterocrinus* Angl., from the Upper Silurian, belongs to it.

The following species have been discovered :—

1859. **Heterocrinus articulosus** Billings. Geol. Rep. Canada, Dec. iv. p. 51, pl. 4, fig. 8. Trenton limest. Ottawa, Canada.

1866. **Heterocr. constrictus** Hall. 24th Rep. N. Y. State Cab. Nat. Hist , p. 210; also Geol. Surv. Ohio, Palæont., vol. i. p. 3, pl. i. figs. 10 a, b. Hudson River Gr. Cincinnati, O.

H. constrictus (var.) **contractus** Meek, 1873. Geol. Surv. Ohio, vol. i. p. 4, pl. i. fig. 11. Ibid.

1866. **Heterocr. exilis** Hall. 24th Rep. N. Y State Cab. Nat. Hist., p. 213, pl. 5, fig. 16. Hudson River Gr. Cincinnati, O.

H. exilis (var.) **exiguus** Meek, 1873. Geol. Surv. Ohio, Pal., vol. i. p. 5, pl. 1, fig. 12. Ibid.

1843. **Heterocr. heterodactylus** Hall. (Type of the genus.) Geol. Rep. N. Y., vol. i. pl. 76, fig. 11 a–o; also Geol. Surv. Ohio, Pal., vol. i. p. 12, pl. i. figs. 1 a, b (2 a, b?). Hudson River Gr. Ohio and New York.

1859. **Heterocr. inæqualis** Billings, Geol. Rep. Canada, Dec. iv. p. 51, pl. 4, fig. 7. Trenton limest. Ottawa, Canada.

1866. **Heterocr. juvenis** Hall. 24th Rep. N. Y. State Cab. Nat. Hist., p. 212, pl. 5, figs. 9, 10; also Geol. Rep. Ohio, Pal., vol. i. pl. i. figs. 3 a–c. Hudson River Gr. Cincinnati, O.

1866. **Heterocr. laxus** Hall. 24th Rep. N. Y. State Cab. Nat. Hist., p. 211, pl. 5, fig. 15; also Geol. Rep. Ohio, Pal., vol. i. p. 14, pl. i. figs. 8 a, b. Hudson River Gr. Cincinnati, O.

1843. **Heterocr. simplex** Hall. Geol. Rep. N. Y., vol i. p. 280, pl. 76, figs. 2 a–d; also Geol. Surv. Ohio, Pal., vol. i. p. 7, pl. i. figs. 4, 5 (6, 7?). Hudson River Gr. Cincinnati, O.

Syn. **Heterocr. Canadensis** Billings, 1859. Geol. Rep. Canada, Dec. iv. p. 48, pl. 4, fig. 5.

1856. **Heterocr. tenuis** Billings, Geol Rep. Canada, p. 273; also Dec. iv. p. 50, pl. 4, figs. 6 a, b. Trenton limestone. Ottawa and Montreal, Canada.

2 IOCRINUS Hall.

(Diagram Pl. 16, Fig. 3.)

1866. Desc. New Spec. Crin. by J. Hall, p. 5; reissued in 1872 in the 24th Rep. N. Y. State Cab. Nat. Hist., p. 210.

Prof. Hall, in re-describing *Heterocrinus subcrassus* Meek & Worth. as *Heterocr. (?) polyxo*, made use of the name *Iocrinus* for a subgenus. It seems that he was in doubt whether *Iocrinus* should be placed with *Heterocrinus* or *Poteriocrinus*, as he supposed these two genera to be closely related. In this Hall is certainly in error, since a close comparison proves them to be very distinct. Neither can we conceive how such forms as *Iocrinus crassus* can be referred to *Heterocrinus*. The two differ essentially in the anal arrangement, and in the form and construction of the radial plates, which are perfectly symmetrical and simple in the former, but irregular and compound in the latter. Such characters have heretofore always been considered of generic importance, and we accordingly adopt Prof. Hall's name but in a full generic sense, and propose for the genus *Iocrinus* the following:—

Generic Diagnosis.—General appearance somewhat similar to *Pentacrinus;* comparatively larger than *Heterocrinus;* arms longer and more frequently bifurcating; calyx more broadly spreading, and perfectly symmetrical up to the top of the radials, giving the form of a short, inverted, pentagonal pyramid with the five sides deeply concave.

Underbasals undeveloped. Basals small, pentagonal. Radials comparatively large, strong, all pentagonal, and of the same height; their upper margins truncated for nearly their entire breadth for the junction of the succeeding pieces. Brachials three to four in each ray, the upper one axillary, and supporting the first free divisions of the arms. In the right posterior ray there is interposed between the true brachials and radial plate a pentagonal bifurcating piece, which is evidently free and movable like the brachials, and of the same width. This peculiar plate, which is truly radial, supports on its right sloping side the usual number of brachials, and on the left a row of quadrangular plates, vertically arranged, extending to the tips of the arms, and forming the posterior wall of a large ventral tube. In external appearance these plates resemble the brachials and arm plates, only they are somewhat higher and not quite as wide; they are gibbous, and form an elevated ridge, which causes this appendage to resemble an arm or a branch of the ray, and so it was considered by Hall in his description of *Heterocr. polyxo.* Both sides of the mesial ridge are indented to accommodate other plates, of which there are two to each median plate, one abutting against the middle part, and the other opposite the suture. These lateral plates are delicate, three or four times wider than high, and, like the other, longitudinally arranged. Each of them contains a rather deep furrow, which in perfect specimens is arched over by a row of wedge-shaped plates which stand out prominently and appear very much like pinnulæ.[1]

Arms bifurcating frequently, gradually tapering; arm pieces, like the free radials, all projecting at the upper edge, thereby producing a sort of imbrication. Pinnulæ unknown.

Column strong, distinctly pentagonal, the angles in line with the radial plates of the body.

Geological position.—Lower Silurian.

The following two species are the only examples of this genus:—

*1865. **Iocrinus crassus** Meek & Worthen. (**Heterocr. crassus**), Proc. Acad. Nat. Sci. Phila., p. 147; also Geol. Rep. Ill., vol. iii. p. 325, pl. 4, figs. 1 a–c; also vol. vi, pl. 23, fig. 1. Hudson River Gr Oswego, Ill.

*1865. **Iocr. subcrassus** Meek & Worthen. (**Heterocr. subcrassus**), Proc. Acad. Nat. Sci. Phila., p. 148; also Geol. Rep. Ill., vol. iii. p. 325, pl. 4, figs. 5 a–d; also Meek, **Heterocr. (Iocrinus) subcrassus**, Geol. Surv. Ohio, Pal., vol. i. p. 15, pl. 1, figs. 9 a, b. Hudson River Gr. Cincinnati, Ohio.

Syn. **Heterocr. (?) Iocrinus polyxo** Hall, 1866. 24th Rep. N. Y. St. Cab. Nat. Hist., p. 210.

3. ANOMALOCRINUS Meek and Worthen.

(Diagram Pl. 16, Fig. 1.)

1865. *Heterocrinus* (?) (*Anomalocrinus*) Meek & Worth. Proc. Acad. Nat. Sci. Phila., p. 148.

1868. *Hybocrinus?* (*Anomalocrinus*) Meek & Worth. Geol. Rep. Ill., vol. iii. p. 327.

1869. *Ataxocrinus* Lyon. Am. Philos. Soc., vol. xiii. p. 464.

1873. *Anomalocrinus* Meek. Geol. Surv. Ohio, Pal., vol. i. p. 17.

Generic Diagnosis.—General form of the crinoid depressed, calyx comparatively large, depressed subglobose; its form extremely irregular, scarcely two plates being of the same shape.

Underbasals unknown, and perhaps undeveloped. Basals five, small, subequal, pentagonal, wider than high, partly hidden by the column. Radials very large, of diverse forms, simple or compound, the latter divided either horizontally or vertically. Of the com-

[1] It was to this peculiar structure that we alluded in our remarks on this family, and the similarity in the appearance of the ventral sac and the arms and pinnulæ is indeed most striking. If there is in nature any such thing as a transmutation of one organ into another, it would seem that such was the case here, and this may lead to a better understanding of the functions of the ventral sac.

pound plates, those that are divided by horizontal sutures, occur in similar rays as in *Heterocrinus*, being always found in the right posterior and either in the left lateral, or in the anterior ray. The radials of the remaining rays are either simple or bisected vertically, the two halves taken together being similar in form to the simple plates. The lower segment of the former compound plates is subquadrangular, the upper one axillary and pentagonal, its lower edge slightly concave to fit the convexity of the abutting margin below. The rays with simple radials have generally fewer brachials than those with compound plates, and this gives to the Crinoid that abnormal, irregular appearance which is the most characteristic feature of the genus.

Arms divergent at their origin; long, slender, bifurcating irregularly several times above, the divisions being often of unequal size; rounded, and composed each of a single range of pieces. Pinnulæ strong. First anal plate resting transversely between the upper sloping sides of the posterior radials; succeeding plates smaller and longitudinally arranged.

Column stout, round, composed of very thin discs or segments, and having near the base a large pentagonal opening. The segments have the appearance of being composed of numerous little anchylosed spicula of irregular size and form (Meek).

Anomalocrinus has its closest affinities with *Heterocrinus*, to which it was referred in 1865 by Meek and Worthen as a subgenus. Not so apparent are its relations to *Hybocrinus*, with which the same authors afterwards similarly combined it. It certainly differs from them both very distinctly in the shallow and depressed form of the body, in the form and arrangement of the radial plates, and in the arms.

Geological position.—Lower Silurian, so far as known.

Two species have been described :—

1869. **Anomalocrinus caponiformis** Lyon. (**Ataxocrinus caponiformis**), Trans. Am. Philos. Soc., vol. xiii. p. 464, pl. 27, figs. 0, 01, 02, 03. Hudson River Gr. Cincinnati, Ohio, and Kentucky.

1865. **Anomalocr. incurvus** Meek & Worth. (**Heterocrinus ? (Anomalocr.) incurvus**), Proc. Acad. Nat. Sci. Phil., p. 148, 1868, Meek & Worth. **Hybocrinus ? (Anomalocr.) incurvus**, Geol. Rep. Ill., vol. iii. p. 327, pl 4, fig. 3 a, b. Hudson River Gr. Cincinnati, O. The latter is probably a new species.

4. **HYBOCRINUS** Billings.

(Diagram Pl. 16, Fig. 4.)

1856. Geol. Surv. Canada, p. 274, and Dec. IV. p. 23.

(*Apiocrinites* Leuchtenberg, *Haplocrinus* Grewingh, *Homocrinus*, p. p. Eichw., *Bærocrinus* Volborth, are synonymous. See Zittel's Handb. d. Petrefactenkunde, p. 350.)

Calyx globular or pyriform, one side protuberant; composed of 5 basals, 5 radials, and 2 anal plates.

Underbasals not observed, and probably rudimentary. Basals of equal size, pentagonal. The next ring of plates consists of a large anal and four of the radials, all nearly equal in size, and alternating regularly with the basals. The anal plate is hexagonal, its two upper sides equal, the sloping right side supporting a small radial, the left a second anal plate. Both of these plates are wider than high, of about the same size, which is about one-third that of the plates below. They are separated by a vertical suture, and rest by their outer edges against the upper portion of the adjoining radials which are octagonal, while the other two are heptagonal.

Arms five, simple throughout, composed of rather heavy quadrangular joints, about as wide as high, decreasing in size slightly upward. Pinnulæ wanting. The ambulacral furrow is covered by small alternating pieces, about five to each arm-joint.

Column round, small.

The unsymmetrical form of the calyx, produced by the protuberance of the posterior side; the peculiar position and small size of the right posterior radial, and the large anal plate in line with the four larger radials, are the most remarkable features of this genus, and those by which it is easily recognized. The small radial evidently corresponds to the upper half of the compound plate in *Dendrocrinus*, while the lower half, which is here apparently absent, is perhaps represented in a portion of the large undivided anal plate.

Geological position.—Lower Silurian, and so far found only in America.

The following species have been discovered:—

1856. **Hybocrinus conicus** Billings (type of the genus), Geol. Surv. Canada, p. 274; also Decade IV. p. 29, pl. 2, fig. 2 a, b. Trenton limestone. Ottawa, Canada.

1856. **Hybocr. tumidus** Billings. Geol. Surv. Canada, p. 275; also Decade IV. p. 28, pl. 2, figs. 1 a–e. Trenton limestone. Ottawa, Canada.

1859. **Hybocr. pristinus** Billings. Geol. Surv. Canada, Decade IV. p. 23, pl. 1, fig. 2 a. Chazy limestone. Montreal, Canada.

5. DENDROCRINUS Hall.

Diagram Pl. 16, Fig. 5.)

1852. *Dendrocrinus* Hall. Geol. Rep. N. Y., vol. ii. p. 193.

1859. *Dendrocrinus* Billings. Geol. Surv. Canada. Decade IV. p. 35.

1873. *Dendrocrinus* (subgenus of *Poteriocrinus*) Meek. Geol. Surv. Ohio, Pal., vol. i. p. 20.

A. Typical form.

General form of the crinoid elongate and slender. Calyx obconical, higher than wide, unsymmetrical.

Underbasals five, similar in form, scarcely of medium size, but extending beyond the column. Basals five, the largest plates in the calyx; four of them equal, hexagonal, the fifth or posterior one heptagonal, truncate above for the support of a large anal plate. Radials alternating with the basals all around, simple in four of the rays, pentagonal and of about equal size. The right posterior radial is compound, divided by a horizontal suture into two halves, which, taken together, have about the form of the simple plates, only slightly longer. Brachials two to five, some long and narrow, and others short and wide. Anals one, subquadrangular.

Arms long, branching; ambulacral furrow deep. Pinnulæ wanting.

Dome unknown. Ventral sac strongly developed, composed of numerous small, hexagonal, alternately interlocking plates of equal size, strengthened by little transverse or slightly oblique costæ, and so arranged as to present an ascending zigzag appearance.

Column pentagonal, or exceptionally round.

The compound plate in the right posterior ray is one of the best characters of *Dendrocrinus*, and distinguishes it readily from *Cyathocrinus* with which it is most likely to be confounded. The lower half of the radial has nearly the same position and form as the first oblique anal plate in *Poteriocrinus*, and both these plates rest against the sloping side of the posterior basal, with an anal plate on the left; but while this plate in *Dendrocrinus* is succeeded by the upper segment—a radial plate—separated by a horizontal suture (which becomes oblique in *Homocrinus*), in *Poteriocrinus* it supports a third anal plate, and by pushing the right radial to one side assumes its oblique position which it maintains throughout all genera of the *Poteriocrinus* group; while in the *Cyathocrinus* group the compound radial becomes modified into a single plate.

Geological position.—Lower Silurian with the exception of a single species from the Niagara group.

The following species are known :—

1856. **Dendrocrinus acutidactylus** Billings. Geol. Surv. Can., p. 266; also Dec. iv. p. 37, pl. 3, fig. 2 a, b. Trenton limest. Montreal, Canada.

*1843. **Dendrocr. alternatus** Hall. (**Poteriocr. alternatus.**) Geol. Rep. N. Y., vol. i. p. 83, pl. 28, figs. 1 a–f. Trenton limest. Middleville, New York.

*1870. **Dendrocr. angustatus** Meek & Worth. (**Homocr. angustatus.**) Proc. Acad. Nat. Sci. Phil., p. 30; also Geol. Rep. Ill., vol. vi. p. 492, pl. 23, fig. 8. Hudson River Gr. Illinois.

1866. **Dendrocr. caduceus** Hall. (**Poteriocr. (Dendrocr.) caduceus.**) Descr. New sp. Crin. etc., p. 3; also 24th Rep. N. Y. St. Cab. Nat. Hist. 1872, p. 208, pl. 5, figs. 7, 8; also Geol. Surv. Ohio, Pal., vol. i. p. 26, pl. 3, figs. 1 a, b, c. Hudson River Gr. Lebanon, Ohio.

1871. **Dendrocr. Casei** Meek. (**Poteriocr. (Dendrocr.) Casei.**) Am. Jour. Sci., vol. ii. (3d ser.) p. 295; also Geol. Rep. Ohio, Pal., vol. i. p. 28, pl. 3, figs. 2 a, b. c. Hudson River Gr. Richmond, Ind.

1872. **Dendrocr. Cincinnatiensis** Meek. (**Poteriocr. (Dendrocr.) Cincinnatiensis.**) Proc. Acad. Nat. Sci. Phil., p. 312; also Geol. Surv. Ohio, Pal., vol. i. p. 20, pl. 3, figs. 5 a, b. Hudson River Gr. Cincinnati, O.

1856. **Dendrocr. conjugans** Billings. Geol. Surv. Can., p. 268; also Decade iv. p. 41, pl. 4, figs. 1 a, b, and 2 a, b. Trenton limest. Ottawa, Canada.

1859. **Dendrocr. cylindricus** Billings. Geol. Surv. Can., Dec. iv. p. 44, pl. 3, figs. 8 a, b. Trenton limest. Montreal, Canada.

1872. **Dendrocr. Dyeri** Meek. (**Poteriocr. (Dendrocr.) Dyeri.**) Proc. Acad. Nat. Sci. Phil., p. 314; Geol. Surv. Ohio, Pal., vol. i. p. 24, pl. 3, figs. 3 a, b. Hudson Riv. Gr. Cincinnati, O.

1843. **Dendrocr. gracilis** Hall. (**Poteriocr. gracilis** Hall, not McCoy.) Geol. Rep. N. Y., vol. i. p. 84, pl. 28, figs. 2 a–d. Trenton limest. Middleville, N. Y. Syn. **Poteriocr. subgracilis** d'Orbigny.

1856. **Dendrocr. gregarius** Billings. Geol. Surv. Can., p. 265; also Dec. iv. p. 36, pl. 3, figs. 1 a, b, c. Trenton limest. Ottawa, Canada.

1856. **Dendrocr. Jewetti** Billings. Geol. Surv. Can., Dec. iv. p. 43. Trenton limest. Bay of Quinte, Canada.

1856. **Dendrocr. humilis** Billings. Geol. Surv. Can., p. 270; Dec. iv. p. 39, pl. 3, fig. 4. Trenton limest. Ottawa, Can.

1856. **Dendrocr. latibrachiatus** Billings. Geol. Surv. Can., p. 270; also Dec. iv. p. 39, pl. 3, figs. 5 a, b, c. Hudson River Gr. Charleston Point, Anticosti.

1852. **Dendrocr. longidactylus** Hall (Type of the genus). Geol. Rep. N. Y., vol. ii. p. 193, pl. 43, figs. 1 a–k; also pl. 42, figs. 7, a, b. Niagara Gr. Lockport, N. Y.

1868. (?) **Dendrocr. Oswegoensis** Meek & Worth. Geol. Rep. Ill., vol. iii. pl. 4, fig. 4. (The specimen is too imperfect for identification.) Hudson River Gr. Oswego, Ill.

*1867. **Dendrocr. polydactylus** Shumand. (**Homocrinus polydactylus**) Trans. Acad. Sci. St. Louis, vol. i. p. 78, pl. 1, fig. 6; also Geol Surv. Ohio Pal., vol. i. p. 22, pl. 3, fig. 9. Hudson River Gr. Richmond, Ind.

*1872. **Dendrocr. posticus** Hall (**Poteriocr. posticus.**) 24th Rep. N. Y. St. Cab. Nat. Hist., p. 209, pl. 5, figs. 5 and 6. *Poteriocr.* (*Dendrocr.*) *posticus*, Meek. Geol. Surv. Ohio, Pal., vol. i. p. 22, pl. 3, figs. 4 a, b, c. Hudson Riv. Gr. Cincinnati, O.

1856. **Dendrocr. proboscidiatus** Billings Geol. Surv. Can., p. 267; also Dec. iv. p. 38, pl. 3, figs. 3 a–c. Trenton limest. Montreal, Can.

1856. **Dendrocr. rusticus** Billings. Geol. Surv. Can., p. 270; also Dec. iv. p. 41, pl. 3, figs. 7 a, b. Trenton limest. Ottawa, Can.

1856. **Dendrocr. similis** Billings. Geol. Surv. Can., p. 267; also Dec. iv. p. 40. Trenton limest. Ottawa, Canada.

1866. **Dendrocr. tener** Billings. Catalogue Foss. of Anticosti Hudson Riv. Gr. Anticosti. Miller's Cat. (We have no means of comparison.)

B. Subgenus **HOMOCRINUS** Hall.

(Diagram Pl. 15, Fig. 6.)

1852. Geol. Rep. N. Y., vol. ii. p. 185.

The following is Hall's generic description of *Homocrinus*: "Crinoidea having the calyces composed of three series of simple plates, each series consisting of five plates, sometimes one or more irregular plates intercalated between the scapular or third series of plates on one side; arms proceeding from the summit of the third series of plates, without tentacles." And he says further: "The Crinoids constituting this genus have been referred to *Poteriocrinus* and *Cyathocrinus*, the structure of which genera are somewhat different. The two species given as *Poteriocrinus* in vol. i., Palæontology of New York, should be placed under this genus, having the same simple structure and arrangement of plates, arms, etc."

The above description is so indefinite, that it includes almost every genus of the Cyathocrinidæ; the only character mentioned of generic value is the absence of pinnulæ, in which it agrees, however, with *Cyathocrinus* and *Dendrocrinus*. The typical specimens which Hall used for description were most unsatisfactory, that of *H. parvus* being evidently a very young individual, while those of *H. cylindricus* are very imperfectly preserved. In Hall's corrected list of the New York fossils he seems to have given up both *Dendrocrinus* and *Homocrinus*, as he groups the species of both under *Poteriocrinus.* In 1861, however, he described two new species under *Homocrinus*, from good specimens. They are not *Poteriocrinus*, for they have no pinnulæ, nor *Cyathocrinus*, for they have an extra intercalated plate above the basals; nor *Dendrocrinus* for that plate is not radial; but their affinities are the closest with the latter, with which they agree in all principal characters. We therefore regard *Homocrinus* as a subgenus under *Dendrocrinus*, and propose the following description, with *Homocrinus scoparius* Hall as type:—

General form and arrangement of plates like in the typical *Dendrocrinus*, except at the posterior side where the lower portion of the compound plate is pushed slightly to the rear, thereby becoming a regular anal plate or support for the ventral sac. Hence in *Homocrinus* only the upper portion of the compound plate is a radial, and there are two anal plates, one subquadrangular, between the posterior radials, and supported on the truncated basal; and a smaller one resting obliquely between two basals, the right radial and the other anal plate.

The underbasals are perhaps proportionally larger than in *Dendrocrinus.* The arms have no pinnulæ, and this, together with the different arrangement of the anal plates forms the best distinction from *Poteriocrinus.* The ventral sac is without mesial ridge or lateral costæ. Column, so far as observed, round.

Geological position, etc.—Upper Silurian in America. In Europe it has been found in the Devonian.

Six species are known:—

1852. ?**Homocrinus cylindricus** Hall. Geol. Rep. N. Y., vol. ii. p. 186, pl. 41, figs. 2 a, b; Hall, 1859, **Poteriocr. cylindricus.** Correct. List of N. Y. Foss. Niagara Gr. Lockport, N. Y.

(The specimens are too imperfect for identification.)

*1844. **Homocr. fusiformis** Roemer. Rhein. Ueberganzsgeb., p. 61, pl. 3, fig. 2. Schnur, **Bactocrinitis fusiformis**, Steininger's Geogr, Beschr. der Eifel, p. 38. Müller, **Poteriocrinus fusiformis**, Neue Echin. d. Eifl. Kalk., p. 250, pl. 2, fig. 2; also Schultze, Echinod. Eifl. Kalk., p. 45, pl. 5, fig. 1 a–g; Devonian. Eifel, Germany.

*1868. **Homocr. nanus** Roemer. (**Poteriocrinus nanus.**) Palæontographia, by Wm. Dunker, p. 151, pl. 29, figs. 2, 3. Devonian. Bundenbach, Germany.

1852. **Homocr. parvus** Hall. Geol. Rep. N. Y., vol. ii. p. 185, pl. 41, figs. 1 a, b, c. **Poteriocrinus parvus** Hall, 1859. Corr. List N. Y. Foss. Niagara limest. Lockport, N. Y.

(Probably a very young individual of some other species.)

1861. **Homocr. proboscidialis** Hall. Geol. Rep. N. Y., vol. iii. p. 38, pl. 82, figs. 24, 25. Oriskany sandstone. Cumberland, Md.

1861. **Homocr. scoparius** Hall. (Type of the genus) Geol. Rep. N. Y., vol. iii. p. 102 pl. i. figs. 1–9. Lower Helderberg. Litchfield, N. Y.

6. CYATHOCRINUS Miller.

(Diagram Pl. 16, Fig. 8.)

1821. Miller. A History of the Crinoidea, p. 85.
1834. Agassiz. Mém. de la Soc. de Neuch., vol. i.
1843. Austin. Monogr. Rec. and Foss. Crin., p. 59.
1853. De Koninck and Lehon. Rech. s. les Crin. Carb. Belgique, p. 81.
1858. Hall. Geol. Surv. Iowa, vol. i. pt. ii. p. 622.
1866. Meek and Worthen. Geol. Rep. Ill., vol. ii. p. 175.
1873. Meek and Worthen. Geol. Rep. Ill., vol. v. p. 400.
1877. Wachsmuth. Am. Journ. Sci. (August No.), p. 120.
1878. Wachsm. and Springer. Proc. Acad. Nat. Sci. Phila., p. 256.
Syn. 1859. *Palæocrinus* Billings. Geol. Rep. Can., Decade IV. p. 24.
Syn. *Sphærocrinus* Roemer. 1851. Beiträge, z. foss. fauna a. Rhein, p. 13.

In the Thesaurus Devonico-Carboniferus, Dr. Bigsby calls *Cyathocrinus* very appropriately "a genus full of errors." This unfortunate condition is largely due to the confusion existing among Miller's typical species, which embrace an assemblage of very distinct types. It seems even doubtful whether any of his species can be properly ranked within the genus, and this would naturally suggest the question whether *Cyathocrinus*, as Roemer has suggested, ought not to be given up altogether. We are of opinion, however, that the genus ought to stand, and that it can be so amended as to include certain forms of Crinoids which have been referred to it by later palæontologists, and which cannot be included in any other established genus.

Miller describes the genus substantially as follows: "Column round or pentangular; calyx composed of a saucer-shaped pelvis consisting of five plates, on which are in successive series five costal plates, five scapulæ, and one intervening plate, with an arm proceeding from each scapula having two hands and several fingers." A comparison will show that this description differs from *Poteriocrinus* in but a single point, viz., *Cyathocrinus* has but one intervening or anal plate, *Poteriocrinus* two or more.

Miller refers to *Cyathocrinus* the following four species: 1. *C. planus*, which ought to be the type of the genus. 2. *C. tuberculatus*, which has since been referred to *Taxocrinus*. 3. *C. rugosus* which Goldfuss made the type of *Crotalocrinus*. 4. *C. quinquangularis*, which has been conceded to be a *Poteriocrinus*. As a proof how indefinite was Miller's conception of the genus, it may be noted that three of the four species are of distinct families, while he himself places *Poteriocrinus* among the Semiarticulata, and *Cyathocrinus* among the Inarticulata.

C. planus is, therefore, the only species that need be considered with reference to *Cyathocrinus*. The "pelvis" has the typical saucer shape, with a subpentangular perforation. There are five "costals," four of them hexagonal, the fifth with a truncated superior margin; "scapulæ" of similar form to those in *Poteriocrinus*, having also a horseshoe-like impression, with a transverse perforated ridge for the reception of the first arm joint (brachial), and which is succeeded by a cuneiform bifurcating plate. The arms (or hands of Miller) bifurcate several times, and there are six fingers to each division of the ray, which *are all tentaculated on alternate sides*. Here again is mentioned a single (anal) plate interposed between the radials or "scapulæ," and this plate is placed upon the truncate costal (basal). The description applies well generically to a large number of species which have been referred to *Cyathocrinus*, differing, however, in the pinnulate (tentaculated) arms. *Not one* of those species has ever been found with pinnulæ, though we have examined with reference to this point a large number of species, and some most perfect specimens, in which the covering of the ambulacral furrow is beautifully exposed all along the arm, and in which it seems certain that if they had been provided with pinnulæ, these organs would have been preserved. A similar covering has been found, with slight modification, in three or four other genera of the Cyathocrinidæ, but never in species with pinnulæ, and this suggests the idea that they may not exist in those genera. We therefore consider the presence or absence of pinnulæ of generic importance, and do not hesitate to say that if Miller's *Cyathocrinus planus* had pinnulæ, it cannot be classified with species in which these organs are wanting; and we also feel assured, from analogy, that if this was the case in *C. planus*, it will be found to possess more than one anal plate in the calyx, and prove to be a true *Poteriocrinus*.

Miller figures three specimens of this species. Fig. 1 represents an entire specimen, with a piece of column and perfect arms; the arms branch off from the second brachial, and are long, composed of wedge-form plates, which give off on alternate sides a row of strong pinnulæ, such as are found in *Poteriocrinus*. The specimen shows one side and partly the anterior of the body, for the ray at the extreme right has apparently more brachials than the other four, which is a very common occurrence in *Poteriocrinus*. Anal plates are not visible in the specimen, being probably imbedded in the rock. The second specimen, Fig. 28, is not sufficiently intelligible. The posterior side is shown, but the arrangement of the anal portion is so obscure that it gives no information whatever. The form of the calyx is like *Poteriocrinus*, subconical, and resembling Fig. 1.

The third specimen, Figs. 29 and 30, from the Ashmolean collection of Oxford, gives only the calyx, but this is sufficient to show that it is an entirely different form from that represented by Figs. 1 and 28. The position of the plates, the form of the calyx with strongly convex sides, the peculiar articulating facet of the first radials, their proportions, and the arrangement of the anal area, agree in every respect with Miller's generic diagram,[1] and with those species which we have mentioned as having no pinnulæ. On the other hand, the first two figures in the subconical form of the calyx, in the disposition and form of the plates, in having two additional brachials in the anterior ray, in the presence of pinnulæ, closely resemble *Poteriocrinus*. This has induced us to consider the Ashmolean specimen alone[2] to be *Cyathocrinus planus* and the type of the genus, and we propose an amendment of the generic formula so as to admit only those species that are without pinnulæ, making the latter one of the best distinctions

[1] Miller's diagram of the Ashmolean specimen, Fig. 30, appears at first sight to be very different from the generic diagram of the preceding plate, but it must be understood that the four small plates, arranged in the figure in a half circle, are to represent the interradials (oral plates) in the dome, and not the plates of the ventral sac, as might be expected.

[2] We were not aware, when the above was written, that Austin, who examined most of Miller's original specimens, came to almost the same conclusion in regard to *C. planus* (Rec. & Foss. Crin., p. 2). He remarks that Miller in some cases has taken "parts of different animals and jumbled them together" to render his figures as perfect as possible, and on page 59 he says: "Miller's principal figure of the *C. planus* cannot be depended on, as he appears to have taken the rays of *Taxocrinus longidactylus* and placed them on the body of *C. planus*." In supposing these to be the arms of *Taxocrinus*, Austin is certainly mistaken.

between this genus and *Poteriocrinus*. The truncated posterior basal, the number and disposition of the anal plates, and the regular alternate arrangement of basals and radials are also excellent characters by which the two genera may be easily distinguished; but not the construction of the vault, nor the presence or absence of a separate buccal aperture, as Austin and De Koninck suggested; for both genera have a similar low vault with a single aperture, and in both types the ventral sac is lateral, strong, and upright, instead of extending from the entire summit like an enormous proboscis, as it has been described by several authors. De Koninck and Lehon give the number of anal plates at two to six, but there is really but one plate that can be regarded as such, all succeeding ones forming a part of the ventral sac.

Hall, in order to admit into *Cyathocrinus* such types as were afterwards separated under *Barycrinus*, mentions in the Iowa Report that there sometimes occurs in the anal area a rather small intercalated plate; but this, though having a similar position, cannot be considered identical with the lower anal plate of *Poteriocrinus*. *Barycrinus* has been very generally accepted as a genus, and as the plate in question has only been observed in species of that type, it need no longer be considered in this connection.

Angelin, in the Iconographia Crinoideorum, p. 22, mentions the presence in *Cyathocrinus* of small pinnulæ. We have already noticed this point in the introductory remarks, and think we have proved that the two alternate rows of plates, there called pinnulæ, are merely plates which cover the ambulacral groove in the arms, and though they are, in our opinion, the homologues of the pinnulæ, they are too rudimentary to be ranked as such. The covering in *Cyathocrinus longimanus* Angl., from the Silurian, consists of two rows of five successive plates each, one row being given off from the right, the other from the left side of the furrow and perfectly covering it. In *Cyathocr. Iowensis* O. & Shum., from the Subcarboniferous, there have been observed only two successive plates arranged in the same manner. If it could be shown that this structure were constant in all Silurian species of *Cyathocrinus*, we should feel disposed to separate them from their subcarboniferous representatives, at least subgenerically, since in the former the arm-joints are comparatively shorter, the ventral tube stronger, and there is besides a peculiar difference in the general habitus of the two which is not easily expressed.

Sphærocrinus Roemer is founded upon *Cyathocrinus geometricus* Goldfuss, and it has all the characters of *Cyathocrinus*, not only in the construction of the calyx, but also of the vault, and we find a contraction of the body in the arm regions in the majority of its species.

Palæocrinus Billings is not distinct from *Cyathocrinus*. The construction of the calyx is identical, and the five calycinal grooves radiating from the centre of the abdominal surface, which, according to Billings, form the principal distinction, are identical with the ambulacral grooves passing here as there over the sutures of the oral plates. *Cyathocrinus*, especially in its Lower Silurian form, and when deprived of the arms, bears the closest relation to some forms of the Blastoids on one side, and the Pentacrinoid larva on the other. We propose the following:—

Revised Generic Diagnosis: General form of the body with arms, elongate; calyx cyathiform, usually with convex sides, incurving toward the upper margin, and, therefore, subglobose in general outline; symmetry bilateral.

Underbasals five, moderately large, of equal size, either spread out horizontally or with a slight upward curvature. Basals large, regularly alternating with the radials, with acute upper angles, except the posterior one which is truncate for the support of a single anal plate. Radials one by five, as large or larger than the basals, incurving toward the vault. Articulating facet rarely occupying more than one-half the width of the plate—often less than one-third —and one fourth to one-third its height. It is on the exterior of the plate, circular or elliptic in form, and provided either with a small perforation, or more frequently with a deep notch which connects with the arm groove. The brachials are similar in construction to the arm joints, and their number, as a rule, is very irregular, varying sometimes from two to seven in the same specimen, and even in arms of the same relative position, scarcely two rays having an equal number.

Arms long, branching, each branch bifurcating several times, and as they gradually taper toward the tips they become very slender above. The arm joints, as well as the brachials in Silurian species, are shorter, and comparatively heavier than in species from the Subcarboniferous. In the former they are about as wide as high, in their later representatives generally three or four times higher than wide. Both, however, agree in the absence of the pinnulæ and in the structure of the ambulacral groove, which, instead of those appendages, is provided with two rows of from two to five successive movable plates, alternately arranged on opposite sides, by means of which the furrow could be opened to the surrounding element, or shut off from it.

Anal plate one, resting upon the superior edge of the truncated basal and between two radials. None of the succeeding plates in the series are embraced in the calyx; they are much smaller and form a part of the ventral sac.

The vault is composed of five large oral plates, joining laterally, which fit in between the inflected margins of the two radial plates, leaving in the oral centre an open space, which in perfect specimens is completely covered by the apical dome plates. The food groove and ambulacral canal are also arched over solidly by two rows of alternate plates which connect with the movable covering of the arm furrow. The ventral sac extends to about one-half the height of the arms, and is composed of a large number of small plates not so regularly arranged as in *Poteriocrinus*. Its communication with the main body internally is maintained by means of a passage pierced through the posterior oral plate. The sac is stronger in the Silurian species, and in them only have pores and slits been observed.

Column round, with alternate larger and smaller joints in its upper portion; central passage scarcely of medium size.

Geological position, etc.—The genus existed in the Lower Silurian, was well represented in the Upper Silurian, and attained its greatest abundance in the Subcarboniferous. Beyond the age of the Keokuk limestone no trace of it has been discovered, and toward the close of that epoch the general aspect of the species underwent a marked change, the later species being large, and the arms, which before were delicate, became very robust at the bases. (See Wachsm. & Spr., Proc. Acad. Nat. Sci. Phila., 1878, p. 257.) According to Murchison and others, *Cyathocrinus* is represented in the Permian, but nothing has been discovered upon which to base this opinion beyond the fragments of columns, which afford no reliable proof. So far as ascertained there are 4 species from the Lower, 19 from the Upper Silurian; a single one from the Devonian; 28 from the Subcarboniferous, making in all 53 species, of which 27 have been found in Europe, and 26 in America.

1878. **Cyathocrinus acinotubus** Angelin. Iconogr. Crin. Suec., p. 23, pl. 20, fig. 5. Upper Silur. Gotland, Sweden.

1856. **Cyathocr.** angulatus, Billings. (**Palæocrinus angulatus.**) Geol. Surv. Can., p. 269; also Dec. iv. pl. 3, figs. 6 a, b. Trenton limest. Ottawa, Canada.

1878. **Cyathocr. alutaceus** Angelin. Iconogr. Crin. Suec., p. 23, pl. 4, fig. 6, and pl. 23, figs. 10, 11. Upper Silur. Gotland, Sweden.

1865. **Cyathocr. arboreus,** Meek & Worth. Proc. Acad. Nat. Sci. Phil., p. 160; also Geol. Rep. Ill., vol. iii. p. 520. Keokuk limest. Subcarb. Crawfordsville, Indiana.

*1861. **Cyathocr. Barrisi** Hall. (**Poteriocr. Barrisi.**) Desc. New Pal. Crin., p. 5; also Bost. Jour. Nat. Hist., p. 303. Lower Burlington limest. Subcarb. Burlington, Iowa.

1878. **Cyathocr. barydactylus** Wachsmuth & Springer. Proc. Acad. Nat. Sci. Phil., p. 257, pl. 2, fig. 5. Upper Burlington Fishbed. Subcarb. Burlington, Iowa.

1836. **Cyathocr. bursa** Phillips Geol. Yorksh., vol. ii. p. 206, pl. 3, fig. 29; 1843, Austin, Mon. Rec. & Foss. Crin., p. 63, pl. 7, fig. 7 a. Subcarboniferous. Bolland, England.

1836. **Cyathocr. calcaratus** Phillips. Geol. Yorksh., p. 206, pl. 3, fig. 35; also Austin, 1843, Rec. & Foss. Crin., p. 63, pl. 8, fig. 2 a–c. Subcarbon. England.

1839. **Cyathocr. capillaris** Phillips. Murch. Silur. Syst., p. 671, pl. 17, fig. 2. Upper Silur. Dudley, England.

1836. **Cyathocr. conicus** Phillips. Geol. Yorksh, vol. ii. pt. ii. p. 206, pl. 3, fig. 27; also Austin, 1843, Rec. & Foss. Crin., p. 64, pl. 8, figs. 1 a, b. Subcarb. Bolland, England.

1868. **Cyathocr. cora** Hall. 18th Rep. N. Y St. Cab. Nat. Hist., p. 324, pl. 11, figs. 13, 14. Niag. group, U. Silur. Racine, Wisconsin.

1836. **Cyathocr. distortus** Gilbert. Phillips' Geol. Yorksh., vol. ii. p. 206, pl. 3, fig. 34. Subcarb. Bolland, England.

1878. **Cyathocr. distensus** Angl. Iconogr. Crin. Suec., p. 23, pl. 3, figs. 6, 6 a. Upper Silur. Gotland, Sweden.

*1843. **Cyathocr. Dudleyensis** Austin. (**Poteriocr. Dudleyensis.**) Upper Silur. Dudley, England.

1865. **Cyathocr. enormis** Meek & Worthen. (**Poteriocr. (?) enormis.**) Proc. Acad. Nat. Sci. Phil., p. 137; also Geol Rep. Ill, vol. iii. p. 481, pl. 16, figs. 3 a, b. Lower Burl. limest. Subcarb. Burlington, Iowa.

1866. **Cyathocr. Farleyi** Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 252; Geol. Rep. Ill., vol. iii. pp. 5, 17, pl. 20, figs. 1 a, b. Keokuk limest. Subcarb Warsaw, Illinois.

1876. **Cyathocr. fasciatus** Hall. 28th Rep. N. Y. St. Cab. Nat. Hist., pl. 13, figs. 5, 6. (No description.) Niag. limest. U. Sil. Waldron, Indiana.

1868. **Cyathocr. fragilis** Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 237; Geol. Rep. Ill., vol. v, p. 401, pl. 4, fig 5. Lower Burl. limest. Subcarb. Burlington, Iowa.

1826. **Cyathocr. geometricus** Goldfuss. Petref Germ., i. p. 189, pl. 58, fig. 5; Phillips, Pal. Foss., p. 135, pl. 60, fig. 41; Austin, Rec. & Foss. Crin., p. 61, pl. 7, figs. 5 a–e. F. Roemer. *Spœrocrinus geometricus,* Verh. d. nat. Vereins f. Rheinl., viii. p. 366, pl. 8, fig. 1; Sandberger, Verst. Nassaus,

p. 390, pl. 25, fig. 14; Müller, *Poteriocr. geometricus*, Neue Echinod, d. Eifl. Kalkes, p. 250, pl. 2, figs. 4–7, and pl. 4, figs. 1–3. Schultze, Mon. Echinod, Eifl. Kalkes. p. 51, pl. 5, fig. 6 a to l. Schultze recognizes the following varieties: var., *typus*, pl, 5, fig. 6 a, b; var., *reticularis*, pl. 5, fig. 6 f, i; var., *ornata*, fig. 6 l; var., *ornata tuberculata*, fig. 6 k; var., *concentrica*. Devonian. Eifel, Germany.

Syn. *Poteriocrinus hemisphæricus*, Müller. Monatsber. d. Berl Acad. d. Wissensch. 1856, p. 354.

Syn. *Sphærocr. stellatus*, Schnur. Steininger's geognost. Beschr. d. Eifel. p. 38.

1878. **Cyathocr. Gilesi** Wachsmuth & Springer. Proc. Acad. Nat. Sci. Phil., p. 259. Fishbed, Upper Burl. limest. Subcarb. Burlington, Iowa.

1878. **Cyathocr. glaber** Angelin. Iconogr. Crin. Suec., p. 23, pl. 23, figs. 12, 13. Upper Silur. Gotland, Sweden.

1839. **Cyathocr. goniodactylus** Phillips. Murch. Silur Syst., p. 671, pl. 17, fig. 1. Upper Silur. Dudley, England.

*1879. **Cyathocr. Harrodi** n. sp. (For description see note below.)

1861. **Cyathocr. incipiens** Hall. Desc. New Pal. Crin., p. 5; Bost. Jour. Nat. Hist. 1861, p. 296. Upper Burl. limest. Subcarb. Burlington, Iowa.

1878. **Cyathocr. incurvatus** Angl. Iconogr. Crin. Suec., p. 23, pl. 24, fig. 1. Upper Silur. Gotland.

1850. **Cyathocr. Iowensis** Owen & Shumard. Journ. Acad. Nat. Sci. Phil. (2d ser.) vol. ii.; Geol. Surv. Wisc. Iowa and Minn., p. 591, pl. 5 A, figs. 11 a, b, c. Upper and Lower Burl. limest. Subcarb. Burlington, Iowa.

Syn. *C. divaricatus* Hall, 1858. Geol. Rep. Iowa, vol. i. pt ii. p. 554, pl. 9, fig. 5. (Young specimen.)

Syn. *C. malvaceus* Hall, 1858. Geol. Rep. Iowa, vol. i. pt. ii. p. 554, pl. 9, fig. 4 a, b. (Depressed specimen.)

Syn. *C. viminalis* Hall, 1861. Desc. New Pal. Crin., p. 5; Bost. Jour. Nat. Hist., p. 299. (See Wachsm. & Spr., Proc. Acad. Nat. Sci. Phil. 1877, p. 256.)

1863. **Cyathocr. lamellosus** White. Bost. Journ. Nat Hist., p. 504. Upper Burl. limest. Subcarb. Burlington, Iowa.

1878. **Cyathocr. lævis** Angelin. Iconogr. Crin. Suec., p. 23, pl. 26, figs. 2, 3. Upper Silur. Gotland, Sweden.

1878. **Cyathocr. longimanus** Angelin. Iconogr. Crin. Suec., p. 22, pl. 20, figs. 4, 6, 7, pl. 26, figs. 4, 5. Upper Silur. Gotland, Sweden.

1836. (?) **Cyathocr. mammillaris** Phillips. Geol. Yorksh., vol. ii. p. 206, pl. 3, fig. 28; Austin, 1843, Rec. & Foss, Crin. p. 64, pl. 7, fig. 8 a, b; De Koninck & Lehon, 1863, Recherches s. l. Crin. Carb. Belg., p. 82, pl. 1, fig. 4. Subcarboniferous. Bolland, England, and Visé, Belgium.

1878. **Cyathocr. monilifer** Angelin. Iconogr. Crin. Suec., p. 23, pl. 21, figs. 15, 15 a. Upper Silur. Gotland, Sweden.

1859. **Cyathocr. multibrachiatus** Lyon & Cassiday. Am. Jour. Sci., vol. 28. Keokuk limest. Subcarb. Crawfordsville, Indiana.

1878. **Cyathocr. muticus** Angelin. Iconogr. Crin. Suec., p. 23, pl. 21, figs. 22, 23. Upper Silur. Gotland, Sweden.

1836. (?) **Cyathocr. ornatus** Phillips. Geol. Yorksh., pt. ii. p. 206, pl. 4, figs. 36, 37. Subcarboniferous. Bolland, England.

1861. **Cyathocr. parvibrachiatus** Hall. Desc. New. Pal. Crin., p. 6; Bost. Journ. Nat. Hist., p. 294. Keokuk limest. Subcarb. Keokuk, Iowa.

1821. **Cyathocr. planus** Miller. A History of the Crinoidea, p. 85, figs. 29, 30 (*not* figs. 1 and 28); Austin, 1843; Rec. & Foss, Crin. p. 59, pl. 7, figs. 4 a–e. Subcarboniferous. Near Bristol, England.

1863. (?) **Cyathocr. polyxo** Hall. New sp. foss. from Niagara Gr. p. 5; and figured without description, 28th Rep. N. Y. St. Cab. Nat. Hist., pl. 15, figs. 10–17. Niagara limest. Upper Silur. Waldron, Indiana. (This is evidently not *Cyathocrinus*, but its generic relations cannot be ascertained from the material which has been discovered.)

1870. **Cyathocr. poterium** Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 24; Geol. Rep. Ill., vol. v. p. 489, pl. 12, fig. 4. Keokuk limest. Subcarb. Crawfordsville, Indiana.

*1859. **Cyathocr. pulchellus** Billings. (**Palæocr. pulchellus.**) Geol. Surv. Can., Dec. iv. p. 46. Trenton limest. L. Silur. Ottawa, Can.

1878. **Cyathocr. ramosus** Angelin. Iconogr. Crin. Suec., p. 22, pl. 20, figs. 1–3. Upper Silur. Gotland, Sweden.

1856. (?) **Cyathocr. radiatus** Eichwald. (**Apiocrinus radiatus.**) Bull. Soc. des Nat. de Moscou, p. 115; Lethæa Rossica, p 592, pl. 31, figs. 50 a–f. Carboniferous. Near Moscow, Russia. (Perhaps *Poteriocrinus*—the figures not sufficiently intelligible.)

*1859. **Cyathocr. rhombiferus** Billings. (**Palæocrinus rhombiferus.**) Geol. Surv. Can., Dec. iv. p. 45. Trenton limest. L. Silur. Ottawa, Can.

1862. **Cyathocr. rigidus** White. Proc. Bost Soc. Nat. Hist., p. 8. Lower Burlington limest. Subcarb. Burlington, Iowa

1858. **Cyathocr. rotundatus** Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 555, pl. 9, figs. 7 a, b. Upper Burlington limest. Subcarb. Burlington, Iowa.

1826. **Cyathocr. rugosus** Goldfuss. Subcarboniferous. Saxony.

1860. **Cyathocr. saffordi** Meek & Worthen. Proc. Acad. Nat Sci. Phil., p. 371; Geol. Rep. Ill., vol. ii. p 236, pl. 17, figs. 5 a, b. Keokuk limest. Subcarb. Tennessee.

*1859. **Cyathocr. striatus** Billings. (**Palæocr. striatus.**) Geol. Surv. Can , Dec. iv. p. 25, pl. i. fig 5 a, b Chazy limest. Montreal, Can.

1878. **Cyathocr. striolatus** Angelin. Iconogr. Crin. Suec., p. 23, pl. 19, fig. 9. Upper Silur. Gotland, Sweden.

1868. **Cyathocr. tenuidactylus** Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 238; Geol. Rep. Ill., vol. v. p. 403, pl. 2, fig. 15. Lower Burlington limest. Subcarb. Burlington, Iowa.

1868. **Cyathocr. waukoma** Hall. 17th Rep. N. Y. St. Cab. Nat. Hist., p. 324, pl. 11, figs. 13, 14. Niagra Gr. Upper Silur. Racine, Wisconsin.

1878. **Cyathocr. zonatus** Angelin. Iconog. Crin. Suec., p. 22, pl. 6, fig. 5. Upper Silur. Gotland, Sweden.

Note.—*Cyathocrinus Harrodi*, n. sp. Form of calyx shallow, cup-shaped, the lower portion truncate and slightly excavated.

Underbasals very small, subquadrangular, spread out horizontally, and forming a five-rayed star. Basals large, a little wider than high, bending abruptly toward the underbasals in such a manner that the lower half of the plate stands on a level with the latter. The radials are of the size of the basals—perhaps a trifle smaller—once and a half as wide as high, subpentangular, the two lower sides making about a right angle. Articulating scar occupying about one-third the width of the plate, somewhat concave, and facing obliquely outward. Brachials varying from two to four or more in the rays, wider than high, rounded on the exterior, the upper one giving rise to two main arms, each of which branches three times.

Arms long, decreasing in width at each bifurcation, very delicate at the tips, the arm-joints increasing in length upward. Ventral furrow covered by two alternating rows of from two to three pieces. Anal plate small.

Surface of plates ornamented by strong radiating ridges, two to each radial, which connect with those of the two adjacent basals. They are most prominent on the latter, where they converge toward the middle into a node which points downward. These nodes, and their downward direction, give to the specimen an appearance very like *Ollacrinus*. Underbasals smooth.

Column small, round, composed of thin smooth joints, alternating in size; central perforation round.

This species is most nearly related to *C. lamellosus* White, of the Upper Burlington limestone, from which it differs in the number and form of the arms, which in our species are rounded, instead of sharply ridged on the back; in the surface markings of the calyx, and in the smooth column—that of *C. lamellosus* being beautifully sculptured.

The specific name is in honor of Dr. Harrod, of Canton, Ind., to whom we are indebted for the discovery and use of specimens.

Position and Locality. Keokuk limestone (Crawfordsville Division), Canton, Indiana, Collections of C. Wachsmuth and Dr. Harrod.

7. LECYTHOCRINUS Zittel (not Joh. Müller).

1858. *Lecythocrinus* Müller. Monatsber. der Berl. Akad., p. 196 (based upon an anomalous specimen).

1866. *Taxocrinus* Schultze. Echinod. d. Eifl. Kalkes, p. 30.

1879. *Lecythocrinus* Zittel. Handb. d. Petrefactenkunde (now in press).

Under this generic name, Johannes Müller described a species which, according to Schultze, was an abnormal specimen of his *Taxocrinus briareus*. In the original specimen, which is figured by Schultze, Mon. Echinod. d. Eifl. Kalkes, pl. 4, figs. 1 a–e, there are six radials and seven main arms, besides other irregularities in the calyx, plainly indicating some disturbance in the natural growth of the animal.

In the Am. Journ. Sci., Sept. 1877, one of us expressed a doubt as to *T. briareus* being a *Taxocrinus*, and we have since become convinced that its nearest affinities are with *Cyathocrinus* and *Gissocrinus*, from both of which it differs in the construction of the column, and in the small size of its underbasals. If the species possesses five underbasals, as we believe, it ought to be placed subgenerically under *Cyathocrinus;* if it has but three, as Schultze supposed (they have not been observed), it should be similarly ranked under *Gissocrinus*, but at all events under the Cyathocrinidæ.

Generic Diagnosis.—General form of the calyx cyathiform; symmetry bilateral.

Underbasals very small, entirely covered by the column, their number not ascertained. Basals five, four of them equal, the fifth or posterior one with the upper side truncate. Radials large, alternating with the basals; articulating faces concave, occupying one-half to two-thirds the width of the plate. Brachials two to four or more, their number varying in the different rays, as well as in different individuals. They are very short, the upper one supporting on each sloping side two main arms, which divide on the second or third plate, each division branching several times again.

Arms long, composed of simple joints, and provided with a dorsal canal[1] and a deep ambulacral furrow. No pinnulæ.

Anal plate one, constructed as in *Cyathocrinus* and resting upon the truncate posterior basal. Ventral sac in form of a long tube, constructed of numerous very regular hexagonal plates of equal height, longitudinally arranged in alternately wider and narrower rows.

The column, which forms the best generic distinction, is obtusely quadrangular, with slightly concave sides, and is composed of very narrow joints of equal size, which are penetrated by a large central and four smaller accessory canals, situated within the joints of the four angles.

The only known species is:—

*1866. **Lecythocrinus briareus** Schultze. Echinod. Eifl. Kalk., p. 36, pl. 4, fig. 1 (1858. **Locythocr. Eifelianus** Müller.); 1879. Zittel. *Lecythocrinus Eifelianus*, Handbuch d. Petrefactenkunde. 3te Liefer. (Now in press.) Devonian, Eifel, Germany.

8. **GISSOCRINUS** Angelin.

1878. Iconog. Crin. Suec., p. 10.

General form of body—including arms—elongate, slightly ven-

[1] By "dorsal canal" we understand the longitudinal passage, which occurs in some forms through the calcareous joints of the arms, next to the dorsal side, and in connection with the nervous centre in the calyx.

tricose above the arm bases. Calyx low, neatly ornamented by radiating striæ; symmetry bilateral.

Underbasals three instead of five, two of them equal and twice as large as the third; the smaller one placed anteriorly, the sutures of the two larger directed to the rear. The plates are so arranged that a bisection of the latter two produces five equal pieces regularly alternating with the succeeding ring of basals. Basals large, four of them pentagonal or hexagonal with sharp upper angles, the fifth longer, hexagonal, truncate above. Radials semi-lunate, larger than the basals, wider than long; articulating facet concave and occupying about one-half the width of the plate. The brachials consist either of a single bifurcating plate, which is wider than long, pentangular; or in some species of two smaller plates which combined have about the form and proportions of the single one.

Arms long, bifurcating, branches very numerous and of almost uniform thickness throughout their length. The divisions take place at regular intervals, but only toward the inner side of the ray, the outer or main arms remaining straight; the inner arms or branches remain simple or in some cases subdivide once or twice. The first bifurcation of the main arms takes place upon the first or second plate above the brachials, the next and all succeeding bifurcations from each first, second, or fourth plate, according to species. Arm-joints distinctly rounded on the exterior, with parallel sutures, rather higher than wide, the upper margin generally projecting into a band inclosing the lower part of the next plate. The axillary or bifurcating plates the largest, with a sharp angular process at their sides toward the upper margin. No pinnulæ. Arm furrows covered by two rows of alternate plates which stand out prominently forming an elevated arch.

Anal plate one, which is large, resting upon the truncate basal and supporting the ventral sac, which has the form of a tube. The tube is long, sometimes extending beyond the tips of the arms, rather strong; cylindrical except at its junction with the main body, where it becomes much contracted toward one side; the inner passage elliptic, almost linear in its cross section. It is composed of quadrangular plates longitudinally arranged, leaving a deep furrow between the rows lined with fissures which penetrate the test.

The construction of the summit closely resembles that of *Cya-*

thocrinus, except that the arms are recumbent upon the vault. There are five oral plates, upon the sutures between which, and raised above the general level, the arm-joints are imbedded, being covered by small alternating plates like the free arms.

Column round, composed of joints of alternating thickness.

Gissocrinus approaches nearest the Silurian form of *Cyathocrinus;* indeed the form of the calyx and the general aspect are strikingly similar. But they differ in the number of underbasals, which in this genus are reduced to three. Angelin places *Gissocrinus* with *Forbesiocrinus* and both under the Taxocrinidæ, which is certainly not a natural group. The long slender proboscis, the single ring of radials within the calyx, show clearly that this genus belongs to the Cyathocrinidæ.

Geological position, etc.—Upper Silurian of England and Sweden, so far as known.

The following species have been referred to it:—

1839. **Gissocrinus arthriticus** Phillips. (**Actinocr. arthriticus**), Murchison. Silur. Syst., p. 674, pl. 17, fig. 8, and Morris, Cat. Brit. Foss., Ed. 2, 1854, p. 70.—Salter, 1859. Murch. Siluria, Ed. 3, p. 535, pl. 14, fig. 7, and ibid. Ed. 4; p. 512; Salter, 1873, **Cyathocr. arthriticus,** Cat. Camb. and Silur. Foss. in Univ. of Cambridge, p. 124. Angelin. **Gissocr. arthriticus,** Iconogr. Crin. Suec., p. 10, pl. 3, figs. 1–3. Upper Silur. Gotland, Sweden, and Dudley, Eng.

1878. **Gissocr. elegans** Angelin. Iconogr. Crin. Suec., p. 10, pl. 3, fig. 5. Upper Silur. Gotland, Sweden.

1878. (?) **Gissocr. macrodactylus** Angelin. Iconogr. Crin. Suec., p. 10, pl. 18, fig. 1. Upper Silur. Gotland, Sweden.

This species differs from all others referred to this genus by Angelin in the brachials, which are represented in a greater number and variable as in *Cyathocrinus;* in the branching of the arms, and in having a more elongate calyx. The underbasals are said to be three, but this is not certain.

1878. **Gissocr. nudus** Angelin. Iconogr. Crin. Suec., p. 10, pl. 20, fig. 20. Upper Silur. Gotland, Sweden.

1878. **Gissocr. punctuosus** Angelin. Iconogr. Crin. Suec., p. 10, pl. 27, figs. 1 a–g; pl. 29, figs. 73–76. Upper Silur. Gotland, Sweden.

1878. **Gissocr. tubulatus** Angelin. Iconogr. Crin. Suec., p. 10, pl. 3, fig. 4. Upper Silur. Gotland, Sweden.

1878. **Gissocr. umbilicatus** Angelin. Iconogr. Crin. Suec., p. 10, pl. 21, figs. 8–10; pl. 29, figs. 75 a, b. Upper Silur. Gotland, Sweden.

9. **ARACHNOCRINUS** Meek & Worthen.

1866. Geol. Rep. Illinois, vol. ii. p. 177.

The above name, with *Cyathocrinus? bulbosus* Hall as type, was proposed by Meek and Worthen for a little group of Crinoids which are distinguished by their spider-like appearance. The calyx in these species, as compared with the long and robust arms, is extremely small, hemispherical, and forms a bulb-like protuberance, from which the arms spread horizontally. These characters distinguish this form readily from *Cyathocrinus*, with which it otherwise agrees, and they are so remarkable that we feel constrained to consider *Arachnocrinus* a distinct genus, and not a subgenus, as suggested by its authors.

We had lately the pleasure of examining the splendid collections of Dr. Knapp in Louisville, where we found two exceedingly interesting specimens, representing different species of this genus, both new. In one, the arms are almost closed, in the other spread out horizontally, thus demonstrating clearly that this Crinoid was capable of folding up its arms, and bringing them to an erect position, which has been doubted by Meek and Worthen, who could not conceive how an animal with so small a visceral cavity could have sufficient muscular power to move such ponderous arms. Dr. Knapp kindly permits us to describe the two species, which will be known as *A. Knappi* and *A. extensus*. Roemer's *Poteriocrinus pisiformis*, which Meek and Worthen refer to this genus, is but imperfectly known, but we do not doubt that the reference is correct. We also place in this genus *Cyathocrinus granulatus* Angelin, though it differs from the other species in the brachials, which are restricted to one to each ray. We propose the following:—

Generic Diagnosis.—Calyx very small, resembling *Cyathocrinus* in the arrangement of the plates, but more depressed; basal portion rounded. Arms exceedingly robust, generally stretched out horizontally, and arranged around the body, as the arms in *Astrophyton* around the disc.

Underbasals five, small, apparently of equal size. Basals five, the posterior one truncate. Radials wider than high, articulating scar occupying almost the entire width of the plate, and more or less concave. The number of brachials differs in the rays, as many as fourteen having been observed; they are cylindrical, wider than high, and resemble in form and construction the joints of the heavy arms.

Arms long, ramifying several times towards the inner part of the ray, the main arms and branches scarcely diminishing in size; in fact the joints near the tips of the arms are almost as large as the brachials. Both are generally short, quadrangular, except the bifurcating plates, which are comparatively longer. Ambulacral furrow deep. Pinnulæ wanting.

Anal plate one, small, resting upon the truncate basal, and supporting a lateral tube which is in line with the arm bases. The ventral tube was evidently small. In *A. Knappi* it apparently rests directly upon the basal, or probably the anal plate forms a part of the ventral sac. The vault is surmounted by five large oral plates—all other plates in the dome unknown.

Column round, of alternately larger and smaller joints.

Geological Position, etc.—Confined to the Upper Silurian and Devonian so far as known, and found both in Europe and America.

The following species may be referred to this genus:—

1860. **Arachnocrinus bulbosus** Hall. (*Cyathocr.* (?) *bulbosus*), 15th Rep. N. Y. St. Cab. Nat. Hist., p. 123, pl. 1, figs. 19–22. Upper Helderberg, Devon. Livingston Co., Kentucky.

*1879. **Arachnocr. extensus** Wachsm. and Spr. (See description below.[1])

*1878. (?) **Arachnocr. granulatus** Angelin. (*Cyathocr. granulatus*), Iconogr. Crin. Suec., p. 23, pl. 16, figs. 1–3 Upper Silur. Gotland, Sweden.

*1879. **Arachnocr. Knappi** Wachm. & Spr. (See description below.[2])

---

[1] *Arachnocrinus extensus*, n. sp. The body of the only known specimen is not in a condition to exhibit satisfactorily the arrangement and proportions of all the plates, but enough is visible to show that the calyx closely resembles that of *Arachnocr. bulbosus*. Its plates are smooth, the underbasals small, and projecting but little beyond the column. Arms massive, bifurcating on the second brachial, except in the anterior ray which divides on the 14th or 15th plate, and branches further up four times; the two lateral rays branch five, the two posterior rays six times. The arms are long and stretched out horizontally to their full length. Arm joints almost as large as the brachials and like them cylindrical, much wider than long—except the bifurcating plates which are always comparatively longer, with a thickened rim both at their upper and lower margins.

This species differs from *A. bulbosus* in the proportions of its arm joints, from *A. Knappi* in the number of brachials, and from both in the bifurcation of the arms, ——. Hamilton Gr. below Hydraulic Beds (Encrinal limestone, Hall). Devonian, Falls of the Ohio.

[2] *Arachnocrinus Knappi*, n. sp. Calyx one and a half wider than high, basal portion concave. Underbasals small, not extending beyond the col-

*1860. **Arachnocr. pisiformis** Roemer. (*Posteriocr. pisiformis*), Sil. Fauna of West Tenn., p. 54, pl. 4, figs. 7 a–d; Meek & Worthen, *Arachnocr. pisiformis.* Geol. Rep. Ill., vol. ii. p. 177. Upper Silur. Tenn.

The arms are unknown in this species.

10. VASOCRINUS Lyon.

(Rectified by W. & Spr.)

1857. Geol. Surv. Kentucky, vol. 3, p. 485.

Hall—Advance Sheets Pal. New York, Vol. V., Part II., p. 6, containing a list of the Devonian fossils occurring at the falls of the Ohio—placed both species of Lyon's *Vasocrinus* under *Cyathocrinus*, in which he was apparently justified; for Lyon in describing the genus failed to point out any characters by which it might be distinguished from *Cyathocrinus*, except perhaps the peculiar form of the body. In his generic description Lyon mentions the presence of only a single anal plate, but at the same time describes his second species with two anals. On examining the original specimens, both of *V. valens* and *V. sculptus*, in the collection of Dr. Knapp, we arrived at the conclusion that Lyon was correct in separating these species from *Cyathocrinus*, and furthermore, that they are intimately related to certain other species

umn. Basals large, larger than the radials, and partly included within the concavity. Radials of unequal size—the posterior ones smaller—semilunulate; articulating facet strongly excavated, facing outward and almost circular in outline. Brachials very heavy, their number varying in the rays. In the original specimen the left posterior ray has fourteen brachials; the right posterior—evidently recuperated and hence perhaps not showing its normal condition—has eight; the lateral rays twelve to fourteen, and the anterior ray fourteen. The first and only bifurcation visible in the specimen takes place on the second, third, or fourth plate. Arms erect, being otherwise built upon the same plan as in *A. extensus*. Arm joints as heavy as the brachials, cylindrical, much wider than high, with parallel sutures, and without pinnulæ. All these plates appear as if constricted in the middle, on account of the thickening of the plates toward the sutures. Anal arrangement not clearly disclosed in the specimen, but there appears to be a rather large lateral opening directly above the posterior basal and between two adjoining radials. We can observe no special anal plate, and if it were present it was evidently small, and perhaps formed a part of the ventral tube, which toward the dome is supported by an elongate lozenge-shaped oral plate. Four additional oral plates of a similar form cover the ventral side. Apical dome plates, and the covering of the ambulacral furrow, not preserved. Hamilton Group. Devonian. Near Charleston, Indiana.

which have been referred to various genera and always with difficulty.

In reconstructing the genus, we prefer to make *Vasocrinus Lyoni* (*Cyathocrinus Lyoni* Hall), from Crawfordsville, the type, because it is found more perfectly preserved in the arm portion; but we scarcely doubt, to judge from the brachials, as far as they are preserved, that the arms in the Devonian species were constructed in a like manner.

Revised Generic Diagnosis.—Calyx shaped like a low vase; plates thin. Underbasals five, rather small, forming a regular pentagon. Basals large, almost as high as wide, generally depressed toward their angles, four pentagonal or hexagonal, the fifth with an additional side. Radials always wider than high, the upper portion strongly inflected toward the dome. Articulating facet, concave occupying about one-third of the plates, almost circular, deeply notched for the ambulacral groove. Brachials resembling the arm plates, but slightly wider. In *Vasocr. Lyoni*, the only species in which their number is perfectly known, there are two by five (*V. valens* had at least as many), with two arms to the ray.

Arms long, moderately heavy, tapering gradually to the tips. They are simple throughout, so far as observed, but in place of branching they throw off armlets alternately from each side, and these branch once or twice, as in *Botryocrinus* and *Barycrinus*, though they are less robust.

Anal area wide; anal plates generally two, rarely one, arranged as in *Barycrinus*. There is one large plate situated between two radials, and a smaller one placed obliquely toward the right side of the specimen, and between two basals, the right posterior radial and the larger anal. The ventral sac, as observed in *V. Lyoni*, extends to more than half the length of the arms. It is rather heavy, with a series of large quandrangular plates at the base,[1] the lower ones as wide, but much higher than the radials. All the other plates of the sac are much smaller, decreasing in size upward. Construction of the vault unknown.

[1] These plates, which are much heavier and larger than any other plates of the tube, in their longitudinal arrangement and rounded exterior, strongly resemble an arm, and were taken by Lyon and Casseday, who described this species as *Cyathocr. hexadactylus*, for arm plates of a sixth ray, and the large anal plate upon which they rest, for a radial.

Column round, undivided longitudinally (except in *V. dilatatus*); central perforation scarcely of medium size.

This genus occupies a position systematically between *Cyathocrinus* on the one side and *Botryocrinus* and *Barycrinus* on the other. It differs from *Barycrinus* in the delicacy of its body plates, in having two brachials instead of one, in the less robust arms, and in having a round column with a comparatively small and simply constructed passage, in contrast to the pentagonal, divided column, and wide and complicated central canal of that genus. From *Botryocrinus* it differs in the form of the ventral sac and the construction of the arms.

Geological Position, etc.—Devonian and Subcarboniferous; only found in America, save one doubtful species from the Eifel.

The following species are considered as belonging here:—

*1866. (?) **Vasocrinus dilatatus** Schultze. (**Potericr. dilatatus,** not Hall = **Coeliocr. dilatatus.**) Mon. Echinod. Eifl. Kalk., p. 49, pl. 5, figs. 3, 3 a. Devonian. Eifel, Germany.

This species has the column divided longitudinally, and therein approaches *Barycrinus*, from which it differs in having thin body plates, and a form exactly as in Lyon's typical species *V. valens*.

*1861. **Vasocr. Lyoni** Hall. (**Cyathocrinus Lyoni.**) Type of the genus. Desc. New. Pal. Crin., p. 5; Bost. Journ. Nat. Hist., p. 298. 1868. Meek & Worthen. **Barycrinus Lyoni.** Proc Acad. Nat. Sci. Phila., p. 340. Keokuk limest. Subcarb. Crawfordsville, Indiana.

Syn. *Cyathocrinus hexadactylus*, Lyon & Casseday. 1859. Amer. Journ. Sci., p. 74.

Lyon's name has precedence, but being specifically as well as generically incorrect (see note above), we adopt Prof. Hall's later name.

*1861. **Vasocr. macropleurus** Hall. (**Cyathocr. macropleurus.**) Desc. New. Pal. Crin., p. 5; Bost. Journ. Nat. Hist., p. 295. Meek & Worthen, *Scaphiocr. macropleurus.* Geol. Rep. Ill., vol. v. p. 412. Lower Burl. limest. Subcarb. Burlington, Iowa.

1857. **Vasocr. sculptus** Lyon. Geol. Rep. Ky., vol. iii. p. 486, pl. 4, figs. 3 b–e.; Hall, 1877. *Cyathocr. sculptus.* Pal. N. Y., vol. v. (advance sheet No. 2) p. 6. Hamilton Gr., Devonian, above Hydraulic Bed. Jefferson Co., Ky.

1857. **Vasocr. valens** Lyon. Geol. Rep. Ky., vol. iii. p. 485, pl. 4, figs. 3, 3 a. Hall, 1877. *Cyathocr. valens.* Pal. N. Y., vol. v. (advance sheet No. 2) p. 6. Hamilton Gr. Devonian, above the Hydraulic Bed. Near Greenville, Ky.

11. OPHIOCRINUS Angelin.

1878. Iconogr. Crin. Suec., p. 24.

In the form and structure of the calyx this type resembles *Cyathocrinus*, but in the position of the arms it is like *Arachnocrinus*, from which it is perhaps only subgenerically distinct.

Underbasals five, four of medium size, equal, thin, upper edges meeting at right angles, except the fifth is truncated above. Radials five, lunulate; articulating surface deeply concave, and occupying almost the entire width of the plate. Brachials spreading out horizontally, varying in number from one to four in the different rays; very short but heavy. Only one anal plate.

Arms directed downward; composed of joints similar to the brachials, being, however, slightly narrower and longer. Total length of arms unknown. *O. crotalurus* had apparently only ten arms; in the original specimen some eight or nine arm joints are preserved without any signs of bifurcation. The arm grooves are rather narrow, covered by two rows of plates; with short lateral grooves given off from each side of the main furrow, within the arm joints, similarly covered, and which are evidently recumbent pinnulæ.

The condition of the ventral sac is the most remarkable feature of the genus. Instead of going straight upward, it bends close to the base, and coils upon itself spirally twice, decreasing in thickness toward the upper end. It is composed of regular rows of hexagonal plates alternately arranged, with a rather deep longitudinal ridge bordered with fissures on each side.

Column round, of alternate larger and smaller joints; central perforation of medium size.

This genus resembles *Cyathocrinus*, but is easily distinguished by its peculiar pendent arms, recumbent pinnulæ, and remarkable proboscis.

Geological position, etc.—Upper Silurian. Sweden.

The only known species is—

1878. **Ophiocrinus crotalurus** Angelin. Iconogr. Crin. Suec., p. 24, pl. 4, figs. 8 a–c. Upper Silur. Gotland, Sweden.

12. BOTRYOCRINUS Angelin.

1878. Iconogr. Crin. Suec., p. 24.

A. Typical form.

The crinoids of this type resemble in general form a tree with many branches and branchlets. Calyx small, cyathiform, unsymmetrical.

Underbasals five, slightly protuberant. Basals five, three of them equal, the other two of somewhat different form, due to their abutting against the anal plates. Radials large, articulating surface concave, occupying more than three-fourths of the width of the plate. Brachials less than one-half the size of the radials, wider than high, their number varying in the rays from two to five.

Each ray is composed of two main arms from which, throughout their entire length, spring two rows of branches, given off on alternate sides from every second or third joint, and which extend to the very top of the specimen. The secondary arms branch again, throwing off branchlets right and left, which themselves ramify, thus producing branches of a third and fourth order. The main arms are heavy, almost as wide at the base as the brachials, and decreasing in size very gradually toward the tips. The secondary branches are about two-thirds the size of the former, and those of the succeeding orders are slender, short, not reaching to the top of the specimen. The plates of arms and branches of corresponding position, throughout the specimen, are of equal width and height, those of the branches being relatively shorter. Articulating face of arm joints and brachials circular.

Anal plates two, arranged as in *Homocrinus;* the lower one rhomboidal, situated between two basals, the right posterior radial and the second anal. The latter is larger, similar in form to the radials, almost as large, and in line with them. Ventral sac of medium width, composed of very regular hexagonal plates, alternately arranged in rows. It is in form of a tube, and ascends almost vertically to about one-fourth the length of the arm, where it bends abruptly towards the posterior side and coils upon itself like a snail. Anal aperture apparently located anteriorly at the very base of the tube.

Vault composed of a large number of small plates the exact arrangement of which has not been ascertained.

Column round, composed of thin joints.

Botryocrinus agrees closest with *Barycrinus*, to the description of which we refer for comparison.

Geological position, etc.—Known only in the Upper Silurian of Sweden, where it is represented by the two following species:—

1878. **Botryocrinus ramosissimus** Angelin. Iconogr. Crin. Suec , p. 24, pl. 20, fig. 8 and Pl. 23, fig. 14. Upper Silur. Gotland, Sweden

1878. **Botryocr. corallum** Angelin. Iconogr. Crin. Suec., p. 24, pl. 15, fig. 9, and pl. 23, figs. 15, 16, and pl. 24, fig. 4. Upper Silur. Gotland, Sweden.

B. Subgenus **SICYOCRINUS** Angelin.

1878. Iconogr. Crin. Suec., p. 23.

Sicyocrinus cucurbitaceus Angelin, the only known species of this type, is so closely related to *Botryocrinus* that we think it should be placed thereunder as a subgenus. The calyx, in form and arrangement of plates, is alike in both, and even the arms and ventral sac are constructed upon the same plan, but which is differently executed.

In *Sicyocrinus* there are five single arms, in place of five pairs, which give off branches from one side only, and not alternately from both sides as in the typical form. The branches, which are represented up to the fourth order, diverge from the arm at a less angle, and those of the third and fourth orders are comparatively longer. The brachials, as well as the arm joints throughout the branches, are from two to three and even four times longer than wide, and have a deep ambulacral furrow. The ventral sac, as in *Botryocrinus*, first ascends, then turns abruptly toward the posterior side, and bends until its extremity points downwards. It is now very remarkable that the portion of the tube which is bent over is not only firmly attached exteriorly to the lower part by a growth of plates, but it appears that its inner passage followed the curvature of the tube, for on each lateral surface there are two rows of fissures which follow exactly the line of deflection. Column obscurely pentagonal.

1878. **Sicyocrinus cucurbitaceus** Angelin. Iconogr. Crin. Suec., p. 24, pl. 4, fig. 9, and pl. 16, fig. 5. Upper Silur. Gotland, Sweden.

13 **BARYCRINUS** Wachsmuth.

(Diagram Pl. 1, Fig. 3.)

1868. Proc. Acad. Nat. Sci. Phil,. p. 338.

This genus was founded upon a group of Crinoids which had formerly been referred by Hall and Meek & Worthen to *Cyathocrinus*, differing, however, from it in several strongly marked features. In the first place the species are more robust, having thicker and more ponderous plates which form a more shallow cup. They also differ in having generally an extra quadrangular anal piece, which is inserted toward the right lower margin of the other anal, and although it is often very small, and in some rare cases entirely wanting, it is characteristic as a rule, while such a plate never occurs in *Cyathocrinus*. A more constant difference is observable in the brachials, which are proportionally shorter and wider, particularly the first one, which often presents an almost linear appearance. In *Cyathocrinus* the number of brachials is very irregular, but in *Barycrinus*, without exception, it is fixed at two. The best means of distinction, however, is afforded by the arms, which in *Barycrinus* are composed of rather short, heavy, rounded pieces, with very narrow ambulacral grooves, while *Cyathocrinus* has rather slender arms and wide, deep furrows. The arms also instead of regularly dichotomizing, so as to form equal divisions, are simple in *Barycrinus* and give off armlets at regular intervals. The column in this genus is almost unique in its construction, and very distinct from that of *Cyathocrinus*. It is not only stouter and subpentagonal, but is divided longitudinally into five sections, and has a large, highly organized central canal.

Barycrinus has its closest affinities with *Botryocrinus* Angl., with which it agrees in the general construction of the arms and in the anal arrangement, but from which it is easily distinguished by its massive body plates, the number and proportion of its brachials, and by the column.

Generic Diagnosis.—General form of the calyx basin or low cup-shaped; often attaining a gigantic size; plates massive, more or less gibbous or protuberant. Surface coarsely corrugated, granulated, or striated, with frequently a depression at each angle between the plates.

Underbasals five, of less than medium size, fully one-half extending beyond the column, their points in form of little triangles bent upward.

Basals large, three of them—sometimes four—hexagonal, the other two heptagonal. Radials five, very unequal in size, the right posterior and often the anterior one much the lowest, all of them wider than high, pentagonal in outline; articulating scar facing outward, concave, occupying from one-half to fully two-thirds the width of the plate. Brachials, two to each ray, wide and short, articulating face circular; the first one extremely short in the middle, one fourth as high as wide, and becoming still thinner or wedge-shaped at each side; the second is a little longer in proportion and presents a subtrigonal outline, supporting on its sloping upper sides two arms.

Arms moderately long, robust, scarcely decreasing in size, and generally simple throughout, though sometimes they branch once on the third or fourth plate in some of the rays—but never in the anterior one—and only in one arm to a ray, the other arm always remaining simple. In one species, probably *B. tumidus* Hall, from the Keokuk limestone, the antero-lateral rays are entirely simple, the arm plates and brachials forming a continuous series. All the main arms, instead of bifurcating, give off at regular intervals, alternately on opposite sides, and from the inner margins of the plates, short, rounded, simple armlets, which in most species throw off secondary branches as in *Botryocrinus*, and these armlets, here as there, probably performed the office of pinnulæ. The arm joints are simple, round, mostly shorter than wide, with a narrow, almost linear ambulacral furrow.

Anal plates generally two, never more. The lower plate which is often very small is wanting in some few species, and in very young specimens is frequently undeveloped, but when present, it is located against the posterior basal and beneath the right radial; the larger, which stands in line with the radial, is generally of about their height and half their width, quadrangular in outline. Ventral sac and vault unknown, but both were evidently of a delicate structure, as we have never seen a trace of them in any of our specimens.

Column short, obtusely pentagonal, divided longitudinally into five sections, which are in a radial position. The sutures are interradial, the opposite of *Heterocrinus* in which they are radial; they are bordered by little pores which apparently communicated with the large pentangular central canal at its five angles. These sutures extend throughout the entire length of the stem and partly to the radicular cyrrhi, which are strong, ramifying, and radially situated. The genus had evidently no cyrrhi along the column, for we have examined with reference to this point a number of specimens showing several feet of stem from near the body to, and including the root, without discovering any trace of them. The radicular cirrhi, which are long and strong, are given off radially.

The inner canal is large throughout and increases in size toward the root.

Geological position, etc.—The genus has a very limited range. It occurs so far as known only in the Subcarboniferous, and in America, where it first appears in the Lower Burlington limestone. It is found in the greatest profusion and size in the Keokuk, and has only two representatives in the Warsaw, where it becomes extinct.

We recognize 23 species, 2 of them being doubtful.

1860. **Barycrinus angulatus** Meek & Worthen. (**Cyathocr. angulatus.**) Proc. Acad. Nat. Sci. Phil., p. 391; Geol. Rep. Ill., vol. ii. p. 234, pl. 17, fig. 4; *Barycr. angulatus*, 1868, Proc. Acad. Nat. Sci. Phil., p. 340. Burlington and Keokuk transition bed. Subcarb. Nauvoo, Illinois (probably *syn.* of *B. sculptilis* Hall).

1858. **Barycr. bullatus** Hall. (**Cyathocr. bullatus.**) Geol. Rep. Iowa, vol. i. pt. ii. p. 624, pl. 18, fig. 1. *Barycr. bullatus* M. & W. 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Keokuk limest. Subcarb. Keokuk, Iowa.

Syn. Cyathocr. protuberans Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 626, pl. 18, fig. 9.

1850. **Barycr. cornutus** Owen & Shumard. (**Cyathocr. cornutus.**) Jour. Acad. Nat. Sci. Phil. (2d ser.), vol. ii.; U. S. Geol. Surv. Wisc, Iowa, and Minn., p. 591, pl. 5, fig. 8 a, b; *Barycr. cornutus*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Lower Burl. limest. Subcarb. Burlington, Iowa.

1860. **Barycr. crassibrachiatus** Hall. (**Cyathocr. crassibrachiatus.**) Supp. Geol. Rep. Iowa, p. 60; *Barycr. crassibrachiatus*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Keokuk limest. Subcarb. Warsaw, Ill.

1873. (?) **Barycr. geometricus** Meek & Worthen. (**Cyathocr. ? undetermined.**) Geol. Rep. Ill., vol. iii. pl. 20, fig. 5 a–c; vol. v. pl. 12, fig. 3. Keokuk limest. Subcarb. Warsaw, Ill.

The original specimen is very imperfect, possibly *Niptero-crinus*.

*1868. **Barycr. herculeus** Meek & Worthen. (**B. Hoveyi var. herculeus.**) Proc. Acad. Nat. Sci. Phil., p. 341; Geol Rep. Ill., vol. v. p. 485, pl. 13, fig. 2. Keokuk limest. Subcarb. Crawfordsville, Ind.

This is a good species, and not a variety.

1861. **Barycr. Hoveyi** Hall. (**Cyathocr. Hoveyi.**) Desc. New. Pal. Crin., p. 5; Bost. Jour. Nat. Hist., p. 293: Meek & Worthen, 1873. *B Hoveyi*, Geol. Rep. Ill. vol. v. p. 486, pl. 13, fig. 1. Keokuk limest. Subcarb. Crawfordsville, Ind.

*1862. **Barycr. Kelloggi** White. (**Cyathocr. Kelloggi.**) Proc. Bost. Soc. Nat. Hist., p. 8. Keokuk limest Subcarb. Biggsville, Ill.

1858 **Barycr. magister** Hall. (**Cyathocr. magister.**) Geol. Rep. Iowa, vol. i. pt. ii. pl. 18, figs. 2, 3; *B. magister*, 1868, Proc Acad. Nat. Sci. Phil., p. 340. Keokuk limest. Subcarb. Keokuk, Iowa.

1868. **Barycr. magnificus** Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 340. Geol Rep. Ill , vol. v. p. 483, pl. 12, fig. 2. Keokuk limest. Subcarb. Biggsville, Ill.

1873. **Barycr. mammatus**[1] Worthen. Geol. Rep. Ill., vol v p. 486, pl. 15, fig. 4. Keokuk limest. Subcarb. Otter Creek, Ill.

1873. **Barycr. pentagonus** Worthen. Geol. Rep. Ill., vol. v. p 487, pl. 15, fig 3. Keokuk limest. Subcarb. Jersey Co., Ill.

*1850. **Barycr. rhombiferus** Owen & Shumard. (**Poteriocr. rhombiferus.**) Jour. Acad. Nat. Sci. Phil., new ser., vol. ii. U S. Geol. Surv. of Wisc., Iowa, and Min., p 595, pl. 5 B, figs. 2 a, b, c. Lower Burl. limest. Subcarb. Burlington, Iowa.

1860 **Barycr. sculptilis** Hall. (**Cyathocr. sculptilis.**) Supp. Geol. Rep. Iowa, p. 59; *B. sculptilis*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Upper Burl. limest. Subcarb. Burlington, Iowa.

Syn. Cyathocr. latus Hall, 1861. Desc. New. Pal. Foss., p. 5; and Bost. Jour., p. 292.

Syn. Cyathocr. scitulus Meek & Worthen, 1863. Proc. Acad. Nat. Sci. Phil., p. 393.

1861. **Barycr. solidus** Hall. (**Cyathocr. solidus.**) Desc. New Pal. Crin., p. 5. Bost. Jour. Nat. Hist., p. 293; *B. solidus*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Upper Burl. limest. Subcarb. Burlington, Iowa.

1869. **Barycr. spectabilis** Meek & Worthen. Proc. Acad. Nat. Sci. Phil.; Geol. Rep. Ill., vol. v. p. 530, pl. 20, fig. 8. Warsaw limest. Subcarb. Jersey Co., Ill.

1858. **Barycr. spurius** Hall. (**Cyathocr. spurius.**) Geol. Rep. Iowa, vol. i. pt. ii. p. 625, pl. 18, figs. 7, 8; *B. spurius*, 1868. Proc. Acad. Nat. Sci. Phil , p. 340. Keokuk limest. Subcarb. Keokuk, Iowa.

*1858. **Barycr. stellatus** Hall. (**Cyathocr. stellatus.**) Geol. Rep. Iowa, vol. i. pt. ii. p. 623, pl. 16, figs. 3, 8. Keokuk limest. Subcarb. Keokuk, Iowa.

Syn. Cyathocr. quinquelobus Meek & Worthen, 1865. Proc. Acad. Nat. Sci. Phil., p. 150. Geol. Rep. Ill., vol. iii. p. 519, pl. 20, figs. 6 a, b.

1875. (?) **Barycr. striatus** Worthen. Geol. Rep. Ill., vol. vi. p. 515, pl. 29, fig. 5. Keokuk limest. Subcarb. Jersey Co., Ill.

This is certainly *not Barycrinus*. The lines of the sutures in the figure are drawn incorrectly, as, according to it, the basals are radial in position. It is most probably a *Dichocrinus*.

1865. **Barycr. subtumidus** Meek & Worthen. (**Cyathocr. subtumidus.**) Proc. Acad. Nat. Sci. Phil., p. 151, Geol. Rep. Ill., vol. v. p. 487, pl. 13, fig. 3; *B. subtumidus*, 1868. Proc. Acad. Phil. p. 340. Keokuk limest. Subcarb. Greene Co., Ill.

1860. **Barycr. Thomæ** Hall. (**Cyathocr. Thomæ.**) Supp. Geol. Rep. Iowa, p. 61; *B. Thomæ*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Warsaw limest. Subcarb. Warsaw, Ill.

---

[1] We are well aware that a number of these Keokuk species of *Barycrinus* are mere variations of earlier types, but as our material is too limited for comparison, we give them as they were described.

1858. **Barycr. tumidus** Hall. (**Cyathocr. tumidus.**) Geol. Rep. Iowa, vol. i. pt. ii. p. 624, pl. 18, figs. 1 b, c. *B. tumidus*, 1868. Proc. Acad. Nat. Sci. Phil., p. 340. Keokuk limest. Subcarb. Keokuk, Iowa.

1861. **Barycr. Wachsmuthi** Meek & Worthen. (**Cyathocr. Wachsmuthi.**) Proc. Acad. Nat. Sci. Phil , p. 136, Geol. Rep. Ill., vol. iii. p 482, pl. 16, fig 5; *B. Wachsmuthi*, 1868. Proc. Acad. Phil., p. 340. Lower Burl. limest. Subcarb. Burlington, Iowa.

14. **POTERIOCRINUS**, Miller.

1821. *Poteriocrinites* Miller. A History of the Crinoidea, p. 65.
1835. *Poteriocrinus* Agassiz. Mem. de la Soc. de Neuch., vol. i.
1836. *Poteriocrinus* Phillips. Geology of Yorkshire, p. 205.
1843. *Poteriocrinus* Austin. Rec. and Foss. Crin., p. 68.
1853. *Poteriocrinus* de Koninck & Lehon. Recher. s. l. Crin. Belg., p. 84.
1849. *Cupressocrinus* McCoy. Ann. & Mag. Nat. Hist., ser. ii. vol. ii. (not Goldf.).
1858. *Scaphiocrinus* Hall. (Subgenus of *Poteriocr.*) Geol. Rep. Iowa, p. 550. (Not *Graphiocrinus* de Koninck & Lehon.)
1866. *Poteriocrinites* Meek & Worthen. Geol. Rep. Ill., vol. ii. p. 179.
1866. *Scaphiocrinus* Meek & Worthen. (Subgenus of *Poteriocr.*) Ibid. vol. ii. p. 237.
1866. *Poteriocrinus* Schultze. Mon. Echinod. Eifl. Kalk. p. 42.
1867. *Hydriocrinus* Trautschold. Bull. de la Soc. Imp. des Naturalists de Moscou, p. 16.

(Diagram Pl. 2, No. 7.)

In no other genus of the Crinoids is there found so much confusion as in the one now under consideration. This is partly due to the imperfect preservation of the specimens from which the earlier descriptions were made, and also, no doubt, to the species themselves upon which Miller founded the genus. Neither of his two species of *Poteriocrinus* can be considered characteristic types of the genus, and unfortunately among his four species of *Cyathocrinus*—the genus with which *Poteriocrinus* was afterwards so often confounded—only one can be properly claimed for that genus, two of them having been later referred to very distinct groups, and the fourth is a *Poteriocrinus*.

According to Miller, the pelvis of *Poteriocrinus* is composed of five pentagonal plate-like joints, supporting five hexagonal intercostal plate-like joints, and five plate-like scapulæ with an intercostal and an interscapulary plate interposed; an arm proceeds from each scapula; column round, composed of narrow joints with a central perforation. This embraces everything in Miller's description which might be deemed of generic importance, but it is fully sufficient for identification, as it affords the means of separating this form from the only other genus of this family then known. It gives us unquestionable evidence of the existence of at least two anal plates within the calyx, which are plainly shown in the diagrams; while in Miller's typical species of *Cyathocrinus* only a single anal plate is mentioned or figured, which is wedged in between the scapulæ or first radial plates.

In the description of *P. crassus*, which is Miller's first species, and ought to be the type of the genus, he gives additional information regarding the scapulæ or radials. They are described as thin plates, obliquely truncated at the upper margins, excavated with a horseshoe-like impression occupying scarcely more than one-third the width of the plates. Miller's second species agrees well with the preceding. It has only one brachial, which is a bifurcating plate, narrow, four to five times longer than wide, supporting an arm on each side. Only one arm is preserved which has the same dimensions as the brachial, and a deep ambulacral furrow. Miller also found minute plates indicating that the abdominal cavity and perhaps also the excavated sulci in the arms were protected by a plated integument.

It thus appears that the calyx of *Poteriocrinus*, acccording to Miller, is composed of three rings of plates, 5 underbasals, 5 basals, and 5 radials; that there are not less than two anal plates, one alternating with the basals (intercostals) and another between the radials; that the radials in the two then known species are excavated for the attachment of the brachials, the articulating scar occupying only one-third the width of the plate; that in *P. tenuis*, the only species in which any part above the calyx was known, there is only a single brachial which is a very long, slender plate, and that the arm joints, so far as known, were found to be long and proportioned like the brachials. The calyx of both species is subconical, and both came from the Subcarboniferous of England. Miller describes the basals as being hexagonal, which is not quite correct. It was shown by de Koninck and Lehon that three of the subradials (basals) are hexagonal or heptagonal and of a similar form, while the other two—those in contact with the anal plates—have one or two additional sides, and are slightly larger. The same authors also point out the fact, that four of the radials are of equal size, pentagonal, regularly alternating with the basals, but that the right posterior one, which is rather smaller and elevated above the line of the others, is less regular in form and rests upon the truncated upper side of the basal and against the two anal pieces, differing therein from *Cyathocrinus*, in which basals and radials alternate all around. They consider the latter a very important distinction between the two genera, but they further assert that the best character for separation is to be found in the presence of a single aperture in the dome of *Poteriocrinus*, and of a separate oral and anal opening in *Cyathocrinus*. This unfortunate and altogether incorrect statement on the part of de Koninck has caused the utmost confusion, and when it was shown by Meek & Worthen that the supposed oral aperture is closed in perfect specimens in the one as well as in the other, some of the leading authorities in Europe, who had previously expressed their doubts as to the genus *Cyathocrinus*, wished to abandon it altogether. We, for our part, cannot endorse this proposition, for we think that the two genera are nicely defined by good generic characters; and that has been the opinion of the American Palæontologists generally, which has probably arisen from the fact that this country has produced far better specimens.

But while American authors agree thus far, they differ in regard to the proper limits of the genera. When in the course of recent years a great variety of forms of *Poteriocrinus* were discovered, Hall undertook to divide them subgenerically, but in this he was not very successful. In establishing his subgenus *Scaphiocrinus*, he selected *Scaphiocr.* (?) *simplex* as type, a species which in its anal arrangement and arm structure, though clearly distinct from *Poteriocrinus*, agrees exactly with *Graphiocrinus* de Koninck & Lehon. The majority of species, however, which were described under *Scaphiocrinus*, agree substantially, both in the arms and anal area, with *Poteriocrinus*, and we see no possibility of separating them. This may appear strange, for, on looking over a large collection of *Poteriocrinus*, it seems to embrace a number of very different groups; but an attempt to separate them will invariably result in finding but few species agreeing in the same points.

Hall defines *Scaphiocrinus* as follows: radials 2×5, both pentagonal, the first with the upper side straight or obliquely concave, the second with the lower side straight, often much elongated, and the plates contracted or concave on each side; anals four or more; arms double from their origin, or rarely simple in the anterior ray; arm plates simple, often wedge-shaped, with pinnulæ originating on the longer side of the plate; the line of articulation between first and second radials more or less gaping exteriorly, and the edge of the plate rounded. Among the species referred to *Scaphiocrinus* there are some with two brachials (three radials, Hall), others with but one; some with long slender brachials, others with short ones; some in which the brachials occupy the entire width of the upper margin of the radials, others scarcely one-third, and with a horseshoe-like articulating scar; some with a shallow almost concave calyx, others with a nearly cylindrical one; in some species the arms are simple, with short joints, in others branching, with long joints, or *vice versa;* in some the pinnulæ are strong, and the arms zigzag, in others thin and short, and the arms straight; but all agree, with the exception of the few species which we refer to *Graphiocrinus* (and among the latter Hall's *Scaphiocr. simplex*), in the construction of the anal area, which is exactly as described in *Poteriocrinus*, and in having a strong cylindrical or slightly club-shaped ventral sac.

Our own attempt to subdivide *Poteriocrinus* subgenerically met with but little better success, though we had the advantage of subsequent discoveries. A division based upon the number of free radials—or brachials as they are now called—cannot be carried out practically. Species with two brachials are not otherwise distinct from those with but one, and Hall himself, who founded *Scaphiocrinus* upon the presence of a single brachial, and likewise, Meek and Worthen, included therein several species with an additional brachial. In this they were evidently justified, for the additional plate, according to our views, is only a supplementary piece, which facilitates the motion of the arms, but has no effect upon the general structure of the animal. The two brachials combined have the form and size of the single one—in fact it is a compound plate, and this term properly expresses its relations.

Nor can the gaping sutures be regarded as of generic importance. We look upon this structure merely as another mode of articulation—taking place upon a straight hinge line instead of a sloping semicircular scar—and the gradations from one form to another are so close, that it is impossible to separate groups thereby. Nevertheless, to facilitate the identification of species, which is always difficult when there is a large number in a single group, we have separated *Poteriocrinus*, as well as could be ascertained from the descriptions and figures, with the aid of our own extensive collections, into six divisions, for which we propose distinct names. In doing so, however, we wish to have it understood that we scarcely deem the characters upon which they are based sufficiently important even for subgeneric separation. Still better distinctions may be discovered hereafter, and in the mean time this arrangement will prove very convenient for comparative study.

The genus *Poteriocrinus*, of which there are now over a hundred species known and described, was thought by Miller to be represented altogether by two, and of these the material at his command was very limited and imperfect, so that probably in order to make the most of what he had—to render his descriptions as perfect as possible and to prove some of his theories more effectually—he in some cases reconstructed the specimens from fragmentary pieces, which he supposed to be parts of the same species, but which, as we now know, belonged, at least in some instances, to different genera. The fact that Miller's figures cannot be relied upon, and that his best original specimens can nowhere be found (Austin), has produced continual trouble. Some of his species have been badly defined by subsequent writers. This is evidently the case with his typical species *P. crassus*. It is true Miller's figures are not so intelligible as might be wished, yet they prove plainly that the plates of the calyx in that species are thin, with elevations radiating from a point near the centre of the plates and meeting at the sutures those from adjoining plates. Such costæ—as these elevations have often been called—are found very prominent in several species of *Poteriocrinus* from the Burlington limestone, and in these they are not mere external markings, but are produced by a flexure of the plate itself. That the structure was similar in *P. crassus* is plainly indicated by Fig. 7 G, which represents folds on the inner surface of a radial—not intercostal, as Miller makes it. In the figures of de Koninck's so-called *P. crassus*, the plates, on the contrary, are massive, without plications, the surface simply granulose, and the articulating scar, which in Miller's specimens scarcely fills one-third the width of the radials, extends almost the entire breadth of the plate. Strange as it may appear, it seems as if de Koninck took the plications—which in Miller's principal figures somewhat indistinctly resemble the parasitic excrescences of one of his own specimens—to be the work of parasites; and in no other way can we account for his supposing such distinct forms to belong to the same species. The same difficulty exists in regard to Austin's figures, who has represented under *P. crassus* two or more distinct species.

The identification of *P. tenuis*, Miller's second species, is equally doubtful, and in our opinion altogether unreliable. The arms as there figured certainly do not belong to that calyx nor that column, and we are confident that the two latter pertain to *Poteriocrinus* and the former to *Cyathocrinus*. We may here remark that while we have experienced scarcely any difficulty in referring the known species to *Poteriocrinus* and *Cyathocrinus* respectively, we find in all of Miller's species, in one way or another, characters altogether at variance with the rules we have laid down for distinguishing the two genera. Under these circumstances the question arises whether it is not in the interest of science to adopt a new or at least an additional type for the genus. This may somewhat conflict with the rules and practices of naturalists, but in this case we consider it the only adequate remedy. We accordingly propose for this purpose *Poteriocrinus notabilis* Meek & Worthen, from the Burlington limestone, the original of which, formerly in the collection of C. W. and now in the Museum of Comp. Zool. of Cambridge, Mass., is figured in the Geol. Rep. Ill., vol. v., pl. 1, fig. 9. We have selected this species because it is found in very perfect preservation, and because it agrees most closely with Miller's typical species, and certainly belongs to the same division.

Making this the typical form, we further propose as sections under it *Scaphiocrinus* Hall, with *S. dichotomus* Hall's second species (the first being referred to *Graphiocrinus*) for type; *Parisocrinus* W. & Spr., with *Poteriocr. perplexus* M. & W.; *Pachylocrinus* W. & Spr., with *Poteriocr. subæqualis* W. & Spr. (Hall's *Poteriocr. æqualis*); *Scytalocrinus* W. & Spr., with *Poteriocr. robustus* Hall, *Decadocrinus*, with *Scaphiocr. scalaris* M. & W., respectively as types; and as we regard these sections rather as variations of the genus, which hardly rise to the dignity of subgenera, we shall for the present write the names with that of the parent genus prefixed. There are some other species, only known from the calyx which could not be satisfactorily arranged under the above groups, and these will be found in a list by themselves.

Generic Diagnosis.—General form of body with arms, elongate, subcylindrical, expanding uniformly upward. Calyx very variable in shape, subconical or subturbinate, sometimes bell, cup, or almost saucer-shaped; arrangement of plates unsymmetrical.

Underbasals five, equal in form and size, forming a more or less depressed pentagonal cup. Basals five, three of them hexagonal or heptagonal, and of the same size, the two others—those adjacent to the anals—slightly larger, and with one or two additional sides. Radials wider than high, four of a similar pentagonal form, and alternating regularly with the basals; the fifth slightly smaller, elevated above the level of the others, less regular in form, resting upon the truncated upper side of one basal and against two anal pieces. Articulating surface very variable, the scar for the attachment of the brachials occupying in the typical species scarcely one-third of the upper edge, but in some species it extends across the entire margin of the radials with a hinge-like apparatus for articulation. Brachials one to two or more, their number the same in four of the rays, the anterior having often a few additional plates. In species with only one brachial it is generally long and laterally constricted; in those with two brachials, the first is quadrangular and short, and both combined are equivalent in form and size to the single plate of the other type.

Arms simple or branching; the anterior ray, frequently less developed than the others, is sometimes simple throughout; composed of single joints, generally at least as high as wide, often much higher, more or less wedge-shaped, and throwing off pinnulæ alternately. In species whose pinnules have a decidedly zigzag arrangement they are remarkably strong.

Anals three (rarely four) within the calyx, in two rows alternately arranged; the lower one pentagonal, resting against the sloping upper side of the posterior basal and the radial to the right; the second supported by the upper truncated side of the posterior basal, having on the left a radial, on the right the first and third anal plates, the third being sometimes partly above the level of the calyx. Succeeding plates hexagonal, decreasing in size upwards, forming a part of the ventral sac. Ventral sac upright, strong, cylindrical, sometimes club-shaped, either extending up to the top of the arms or more than half way, frequently crowned with a set of long spines. Plates of the sac hexagonal, and pierced at the sutures with pores or fissures, which penetrate the lateral margins of the plates. Anal opening rarely observed, but in all cases, so far as known, low down and situated laterally, not posteriorly.

Dome constructed like that of *Cyathocrinus*. Apical dome plates frequently pushed toward the front by the large ventral sac.

Column round or pentagonal, composed of thin joints with a small central aperture.

Geological position, etc.—*Poteriocrinus* has not been found in the Silurian, neither in this country nor in Europe; the few species which were recorded from that age having since been referred to *Dendrocrinus*, *Homocrinus*, etc. It flourished to some extent in the Devonian, but reached its climax both in variety of form and number of individuals in the Subcarboniferous. There are known 17 species from the Devonian and 99 from the Subcarboniferous, of which 27 are from Europe and 89 from America. The species are arranged under the respective sections as follows:—

A. Typical form.

Calyx obconical, plates delicate, with elevated wrinkles or radiating plications. Radials with a semicircular scar facing outward, and deeply notched, not filling the full width of the plate. Brachials one by five, long, laterally constricted in the middle. Sutures somewhat gaping. Arms long and branching. Ventral sac very long and heavy. Column round.

1866. **Poteriocrinus angulosus** Schultze. Echinod. Eifl. Kalk., p. 50, pl. 5, figs. 3, 3 a. Devonian. Eifel, Germany.

1821. **Poteriocr. crassus** Miller. (Miller's type of the genus.) Nat. Hist. Crin., p. 68, with figures; Schlottlein, 1822. Nachtr. Petrefactenkunde, vol. i. p. 82; *Id.*, vol. ii. p. 93, pl. 25, fig. 2; Blainville, 1834. Mon. de Actin., p. 260, pl. 29, fig. 1; L. Agassiz, 1835. Mem. de la Soc. de Neuch., vol. i. p. 197; Milne Edwards, 1836. Lamarck's Anim. s. vert., 2d ed., vol. ii. p. 664; DeKoninck, 1842. Desc. des Anim. Foss. du Terr. Carb., p. 46, pl. F. fig. 4; Austin, 1843. Rec. and Foss. Crin., p. 69, pl. 8, figs. 3 a–k, and pl. 9, fig. 1; De Koninck and Lehon, 1853. Recherch. s. les Crin. Belg., p. 97, pl. 1, fig. 10 a–d. Subcarb. Yorkshire, England, and Visé, Belgium.

It is very doubtful whether specimens figured by these various authors represent the same species. De Koninck refers Austin's figures, pl. 8, fig. a–f and pl. 9, fig. 1, to *Pot. spissus*, while he himself figures a specimen which very probably belongs to *Barycrinus*. See our remarks on the genus.

*1861. **Poteriocr. doris** Hall. (**Scaphiocr. doris.**) Desc. New. Pal. Crin., p. 7, Bost. Journ. Nat. Hist., p. 310. Upper Burl. limest. Subcarb. Burlington, Iowa.

*1869. **Poteriocr. notabilis** Meek and Worthen. (**Scaphiocr. notabilis.**) Proposed type of the genus. Proc. Acad. Nat. Sci. Phila., p. 148. Geol. Rep. Ill., vol. v. p. 410, pl. 1, fig. 9. Lower Burl. limest. Subcarb. Burlington, Iowa.

1862. **Poteriocr. obuncus** White. Proc. Bost. Soc. Nat. Hist., p. 11. Lower Burl. limest. Subcarb. Burlington, Iowa.

1842. **Poteriocr. plicatus** Austin. Ann. and Mag. Nat. Hist. (ser. 1), vol. x. p. 108; *Id.*, vol. xi. p. 196. Mon. Rec. and Foss. Crin., p. 79, pl. 9, figs. 4 a–f; DeKoninck and Lehon, Recherch. Crin. Belg., p. 100, pl. 1, fig. 11. Subcarb. Bristol, England, and Tournay, Belgium.

1854. **Poteriocr. spissus** DeKon. and Lehon. Recherd. s. les Crin. Belg., p. 100, pl. i. figs. 9 a, b. Subcarb. Avon, England.

1866. **Poteriocr. stellaris** Schultze. Mon. Echinod. Eifl. Kalk., p. 49, pl. 5, fig. 2. Devonian. Eifel, Germany.

*1861. **Poteriocr. Whitei** Hall. (**Scaphiocr. Whitei.**) Desc. New. Pal. Crin., p. 7, Bost. Journ. Nat. Hist., p. 306. Lower Burl. limest. Subcarb. Burlington, Iowa.

B. SCAPHIOCRINUS Hall (modified by W. & Spr.).

1858. *Scaphiocrinus* Hall (subgenus of *Poteriocr.*). Geol. Rep. Iowa, vol. i. pl. ii. p. 550.

1867. *Hydriocrinus* Trautschold, Bull. de. Moscou, p. 16.

Calyx obconical to semiovoid. Radials truncate above; brachials simple or compound, and similar in form to the radials, but truncate below; line of articulation straight, occupying the full width of the plate; sutures gaping. Column round, obscurely pentagonal, or even pentalobate.

a. Species with a Simple Brachial.

*1859. **Pot. (Scaphiocrinus) æqualis** Hall (not **Scaphiocr. æqualis** Hall, 1861, Bost. Journ. Nat. Hist., p. 316 = *Pot.* (*Pachylocrinus*) *irregularis*, W. & Spr.). Supp. Geol. Rep. Iowa, p. 63. Lower Burl. limest. Subcarb. Burlington, Iowa.

Syn. Scaphiocr. solidus M. & W. 1861. Proc. Acad. Nat. Sci. Phila., p. 60.

Syn. Scaphiocr. tenuidactylus M. & W. 1865. Proc. Acad. Nat. Sci. Phila., p. 156. Geol. Rep. Ill., vol. iii. pl. 18, fig. 10.

*1864. **Pot. (Scaphiocr.) corycea** Hall. (**Pot. corycea**) 17th Rep. N. Y. St. Cab., p. 57. Geol. Sur. Ohio, Pal., vol. ii. p. 173, pl. 12, fig. 9. Waverly Gr. Subcarb. Richfield, Ohio.

1869. **Pot. (Scaphiocr.) coreyi** Meek & Worthen (not **Pot. coreyi**, Worthen. Geol. Rep. Ill., vol. vi. p. 514 = *Pot. Scytalocrinus grandis*, W. & Sp.). Proc. Acad. Nat. Sci. Phila., p. 148. Geol. Rep. Ill., vol. v. pl. 15, fig. 1. Keokuk limest. Subcarb. Crawfordsville, Ind.

1864. **Pot. (Scaphiocr.) crineus** Hall. 17th Rep. N. Y. St. Cab., p. 56. Geol. Surv. Ohio, Pal., vol. ii. p. 172 pl. 12, figs. 6, 7. Waverly Gr. Subcarb. Richfield, Ohio.

1858. **Pot. (Scaphiocr.) dactyliformis** Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 670, pl. 17, fig. 6. St. Louis limest. Subcarb. St. Louis, Mo.

1869. **Pot.** (**Scaphiocr.**) **delicatus** Meek & Worthen. Proc. Acad. Nat. Sci. Phila., p. 144; Geol. Rep. Ill., vol. v. p. 407, pl. 1, fig. 10. Upper Burl. limest. Subcarb. Burlington, Iowa.

1860. **Pot.** (**Scaphiocr.**) **divaricatus** Hall. Supp. Geol. Rep. Iowa, p. 65. Warsaw limest. Subcarb. Illinois and Indiana.

1858. **Pot.** (**Scaphiocr.**) **dichotomus** Hall. (Type of **Scaphiocrinus**, as proposed by us.) Geol. Rep. Iowa, vol. i. pt. ii. p. 553. Upper Burl. limest. Subcarb. Burlington, Iowa.

1873. **Pot.** (**Scaphiocr.**) **Huntsvillæ** Worthen. Geol. Rep. Ill., vol. v. p. 534, pl. 20, fig. 1. St. Louis limest. Subcarb. Huntsville, Ala.

*1860. **Pot.** (**Scaphiocr.**) **Keokuk** Hall. (**Poteriocr. Keokuk.**) Supp Geol. Rep. Iowa, p. 64. Keokuk limest. Subcarb. Keokuk, Iowa.

1858. **Pot.** (**Scaphiocr.**) **internodius** Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 679, pl. 25, fig. 2. Chester limest. Subcarb. Chester, Ill.

*1843. **Pot.** (**Scaphiocr.**) **isacobus** Austin. (**Poteriocr. isacobus.**) Ann. and Mag. Nat. Hist., vol. ii. p 195. Mon. Rec. and Foss. Crin., p. 74, pl. 8, fig. 4 a, b. Subcarb. England and Ireland.

1869. **Pot.** (**Scaphiocr.**) **nanus** Meek & Worthen (not **Poteriocr. nanus**, Ad. Roemer, 1868 = *Homocrinus nanus*). Proc. Acad. Nat. Sci. Phila., p. 141; Geol. Rep. Ill., vol. v. p. 423, pl. 1, fig. 8. Lower Burl. limest. Subcarb. Burlington, Iowa.

1869. **Pot.** (**Scaphiocr.**) **penicillus** Meek & Worth. Proc. Acad. Nat. Sci. Phila., p. 142. Geol. Rep. Ill., vol. v. p. 414, pl. 2, fig. 7. Upper Burl. limest. Subcarb. Burlington, Iowa.

*1867. **Pot.** (**Scaphiocr.**) **pusillus** Trautschold (**Hydriocrinus pusillus**). Bull. de la Soc. Imp. des Naturalists de Moscou, p. 16, pl. ii. fig. 9; Quenstedt. Petrefact. Deutschlands, iv. p. 527, pl. 108, fig. 47. Trautschold, 1879, Kalkbrüche von Mjatschkowa, p. 116, pl. 14, fig. 4, and pl. 15, fig. 2. Upper Subcarb. Near Moscow, Russia.

1861. **Pot.** (**Scaphiocr.**) **ramulosus** Hall. Bost. Journ. Nat. Hist., p. 307. Upper Burl. limest. Subcarb. Burlington, Iowa.

1873. **Pot.** (**Scaphiocr.**) **Randolphensis** Worthen. Geol. Rep. Ill., vol. v. p. 551, pl. 21, fig. 14. Chester limest. Subcarb. Chester, Ill.

1863. **Pot.** (**Scaphiocr.**) **rusticellus** White. Bost. Journ. Nat. Hist., p. 505. Upper Burl. limest. Subcarb. Burlington, Iowa.

1858. **Pot.** (**Scaphiocr.**) **scoparius** Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 680, pl. 25, fig. 3. Chester limest. Subcarb. Chester, Ill.

*1852. (?)**Pot.** (**Scaphiocr.**) **spinosus** Owen & Shumard (**Poteriocr. spinosus**). U. S. Geol. Surv. Wis., Iowa, and Min., p. 596, pl. v B, fig. 4. Chester limest. Subcarb. Grayson Co., Ky.

It is possible that this species belongs to *Hydreionocrinus*—the figure is very imperfect.

1864. **Pot.** (**Scaphiocr.**) **subcarinatus** Hall. 17th Rep. N. Y. St. Cab., p. 58; Geol. Surv. Ohio, Pal., vol. ii. p. 176, pl. 12, figs. 13, 14. Waverly Gr. Subcarb. Richfield, Ohio.

*1861. **Pot.** (**Scaphiocr.**) **subimpressus** Meek & Worthen (**Poteriocr. subimpressus**). Proc. Acad. Nat. Sci. Phila., p. 138. Geol. Rep. Ill., vol. iii. p. 485 pl. 18, fig. 1 a, b. Lower Burl. limest. Subcarb. Burlington, Iowa.

1869. **Pot. (Scaphiocr.) thetys** Meek & Worthen. Proc. Acad. Nat. Sci. Phila., p. 143. Geol. Rep. Ill., vol. v. p. 419, pl. 2, fig. 13. Upper Burl. limest. Subcarb. Burlington, Iowa.

1861. **Pot. (Scaphiocr.) unicus** Hall. Desc. New Pal. Crin., p. 8. Bost. Journ. Nat. Hist., p. 313. Geol. Rep. Ill., vol. v. pl. 15, fig. 5. Keokuk limest. Subcarb. Crawfordsville, Ind.

1861. **Pot. (Scaphiocr.) verticellus** Hall. 15th Rep. N. Y. St. Cab., p. 122. Hamilton Gr. Devonian. Ontario Co., N. Y.

b. Species with Compound Brachials.

*1861. **Pot. (Scaphiocr.) carinatus** Hall (not **Poteriocr. carinatus** M. & W. = **Pot. (Pachylocr.) liliiformis** M. & W.). Desc. New Pal. Crin., p. 8, Bost. Journ. Nat. Hist., p. 310. Upper and Lower Burl. limest. Subcarb. Burlington, Iowa.

1869. **Pot. (Scaphiocr.) clio** Meek & Worthen. Proc. Acad. Nat. Sci. Phila., p. 144. Geol. Rep. Ill., vol. v. pl. 1, fig. 10. Upper Burl. limest. Subcarb. Burlington, Iowa.

*1860 **Pot. (Scaphiocr.) cultidactylus** Hall (**Poteriocr. cultidactylus**). Supp. Geol. Rep. Iowa, p. 62. Lower Burl. limest. Subcarb. Burlington, Iowa.

*1843. **Pot. (Scaphiocr.) longidactylus** Austin (**Poteriocr. londactylus**) (not Shumard, 1855, nor McChesney, 1859). Mon. Rec. and Foss. Crin., p. 88; pl. 11. fig. 3 a. Subcarb. England.

1878. **Pot. (Scaphiocr.) Gibsoni** White. Proc. Acad. Nat. Sci. Phila., p. 31. Keokuk limest. Crawfordsville, Ind.

1878. **Pot. (Scaphiocr.) Gurleyi** White. Proc. Acad. Nat. Sci. Phila., p. 32. Keokuk limest. Crawfordsville, Ind.

*1857. **Pot. (Scaphiocr.) missouriensis** Shumard. First described as *Poteriocr. longidactylus* (Shumard, not Austin). Geol. Rep. Missouri, p. 188, pl. B, figs. a–c. St. Louis limest. Subcarb. St. Louis, Mo.

It differs from all other species in this group in having a single arm to each ray, the first bifurcation taking place at the tenth or twelfth plate.

*1867. **Pot. (Scaphiocr.) multiplex** Trautschold (**Poteriocr. multiplex**). Bull. de Moscou, No. 3, p. 6, pl. 2, figs. 1–8; also F. Roemer, Lethæa Geognost., pl. 40, fig. 11. Trautschold, 1879, Steinbrüche von Mjatschkowa, p. 112, pl. 14, fig. 2, and pl. 15, fig. 1. Upper Subcarb. Near Moscow, Russia.

1865. **Pot. (Scaphiocr.) Norwoodi** Meek & Worthen. Proc. Acad. Nat. Sci. Phila., p. 158. St. Louis limest. Subcarb. Hancock Co., Ill.

*1875. **Pot. (Scaphiocr.) proboscidialis** Worthen (**Poteriocr. proboscidialis**) Geol Rep. Ill., vol. vi. p. 518, pl. 31, fig. 1. St. Louis limest. Subcarb. St. Louis, Mo.

*1860. **Pot. (Scaphiocr.) Swallovi** Meek & Worthen (**Poteriocr. Swallovi**). Proc. Acad. Nat. Sci. Phila., p. 394. Geol. Rep. Ill., vol. ii. pl. 16, figs. 4 a, b. Upper Burl. limest. Subcarb. Burlington, Iowa.

C. PARISOCRINUS W. & Spr.

(πάρισος resembling, κρῖνον a lily.)

Calyx obconical. Differs from the last group in having two or more brachials, which are short and rest within a small semicircular scar. Mode of articulation and branching of arms almost as in *Cyathocrinus*. Column round, rarely pentangular.

1858. **Poteriocrinus (Parisocrinus) curtus** Müller. Verh. d. nat. Verein f. Rheinl., xii. p. 80, pl. 10, figs. 2, 3. Neue. Echin. Eifl. Kalk., p. 230, pl. 2, fig. 3; Schultze, 1866, Echin. Eifl. Kalk. p. 46, pl. 5, fig. 5. Devonian. Eifel, Germany.

*1858. **Pot. (Parisocr.) intermedius** Hall (**Cyathocr. intermedius**). Geol. Rep. Iowa, vol. i. pt. ii. p. 627, pl. 18, fig. 10. Keokuk limest. Subcarb. Warsaw, Ill.

1861. **Pot. (Parisocr.) nereus** Hall. 15th Rep. N. Y. St. Cab., p. 121. Hamilton Gr. Devonian. Ontario Co., New York.

1869. **Pot. (Parisocr.) perplexus** Meek & Worthen. Type of this group (*Poteriocr.(?) perplexus*). Proc. Acad. Nat. Sci Phila., p. 138. Geol. Rep. Ill., vol. v. p. 405, pl. 2, fig. 12. Lower Burl. limest. Subcarb. Burlington, Iowa.

1821. **Pot. (Parisocr.(?)) quinquangularis** Miller (**Cyathocr. quinquangularis**). A History of the Crinoidea, p. 92, with figures. *Poteriocrinus* Austin, 1843 Ann. and Mag. Nat Hist., vol. 10, p. 108, and vol. 11, p. 196. Rec. and Foss. Crin., pl. 10, figs. 2 a–e. Subcarb. England and Ireland.

1843. **Pot. (Parisocr.) radiatus** Austin. Ann. and Mag. Nat. Hist., vol. 10, p. 108, and vol. 11, p. 196. Rec. and Foss. Crin., p. 79, pl. 10, figs. 1 a, b. Subcarb. Ireland, England, and Belgium.

1862. **Pot. (Parisocr.) salignoideus** White. Proc. Bost. Soc. Nat. Hist., p. 10. Upper Burl. limest. Subcarb. Burlington, Iowa.

1861. **Pot. (Parisocr.) tenuibrachiatus** Meek & Worthen. Proc. Acad. Nat. Hist. Phila., p. 138. Geol. Rep. Ill., vol. iii. p. 485, pl. 16, fig. 1. Upper Burl. limest. Subcarb. Burlington, Iowa.

D. PACHYLOCRINUS W. & Spr.

(παχυλὸς thick, clumsy, κρῖνον a lily.)

Name given to designate the comparatively short (for *Poteriocrinus*), unusually stout aspect of the body. Calyx depressed; underbasals forming a concavity, and not extending beyond it; radials and brachials as in *Scaphiocrinus*, with straight hinge lines and gaping sutures; brachials generally compound. Arms short, and placed closely side by side, as in *Zeacrinus*, also dichotomizing in a very similar manner, but the arm joints are more cuneiform and angular on the exterior. Column round or obtusely pentagonal. *Pachylocrinus* is a kind of transition form toward *Zeacrinus* and *Cœliocrinus*, with which it agrees in the short and infolding arms and in the concavity of its basal portions; but it differs from both in the construction of the ventral sac, which in this group is almost cylindrical, with a tendency toward a balloon shape.

*1873. **Poteriocrinus (Pachylocrinus) arboreus** Worthen **(Zeacrinus arboreus).** Geol. Rep. Ill., vol. v. p. 534, pl. 20, fig. 5. St. Louis limest. Subcarb. Huntsville, Ala.

*1869. **Pot. (Pachylocr.) asper** Meek & Worthen. **(Zeacr. asper).** Proc. Acad. Nat. Sci. Phil., p. 150; Geol. Rep. Ill., vol. v. p. 430, pl. 1, fig. 7. Burl. limest. Subcarb. Burlington, Iowa.

1870. **Pot. (Pachylocr.) concinnus** Meek & Worthen. **(Pot. (Zeacr.) concinnus.)** Proc. Acad. Nat. Sci. Phil., p. 26; Geol. Rep. Ill., vol. v. p. 490, pl. 14, fig. 3. Keokuk limest. Subcarb. Crawfordsville, Ind.

1843. (?) **Pot. (Pachylocr.) latifrons** Austin. Rec. and Foss. Crin., p. 82, pl. 10, fig. 4. Subcarb. England (closely resembling *Zeacrinus*).

1869. **Pot. (Pachylocr.) liliiformis** Meek & Worthen. Described June, 1861, under *Pot. carinatus* M. & W. (not *Scaphiocr. carinatus* Hall, February, 1861), Proc. Acad. Nat. Sci. Phil., p. 139; *Scaphiocr. carinatus* M. & W., 1868, Geol. Rep. Ill., vol. iii. p 486, pl. 17, fig. 1; *Scaphiocr. liliiformis*, 1869, Proc. Acad. Nat. Sci. Phil., p. 138. Upper Burl. limest. Subcarb. Burlington, Iowa.

*1864. **Pot. (Pachylocr.) merope** Hall. **(Zeacr. merope.)** 17th Rep. N. Y. St. Cab., p. 60; Geol. Rep. Ohio, Pal, vol. ii. p. 178, pl. 12, fig. 18. Waverly Gr. Subcarb. Richfield, Ohio.

*1864. **Pot. (Pachylocr.) paternus** Hall. **(Zeacr. paternus.)** 17th Rep. N. Y. St. Cab., p. 59; Geol. Rep. Ohio, Pal., vol. ii. p. 177, pl. 12, fig. 17. Waverly Gr. Subcarb. Richfield, Ohio.

*1862. **Pot. (Pachylocr.) perangulatus** White. **(Zeacr. perangulatus.)** Proc. Bost. Soc. Nat. Hist., vol. ix. p. 11. Upper Burl. limest. Subcarb. Burlington, Iowa.

*1860. **Pot. (Pachylocr.) planobrachiatus** Meek & Worthen. **(Zeacr. planobrachiatus.)** Proc. Acad. Nat. Sci. Phil., p. 391; Geol. Rep. Ill., vol. ii. p. 240, pl. 18, fig. 5. Keokuk limest. Subcarb. Monroe Co., Ill.

*1879. **Pot. (Pachylocr.) subæqualis** Wachsm. & Springer. Type of the group. Described by Hall, 1861, as *Scaphiocr. æqualis* (not *Pot.* (*Scaphiocr.*) *æqualis* Hall, 1859). Desc. New Pal. Crin., p. 8; Bost. Jour. Nat. Hist., p. 316; Meek & Worthen, 1873, Geol. Rep. Ill., vol. v. pl. 15, fig. 6. Keokuk limest. Subcarb. Crawfordsville, Ind.

E. SCYTALOCRINUS W. & Spr.

(σκυτάλη a staff or club; κρῖνον a lily.)

General form of body, including arms, very slender and almost cylindrical. Calyx obconical or bell shaped. Underbasals well developed and bent upward; radials and brachials of nearly the same form, with straight hinge line occupying the entire width of the plates; brachials either single or compound, and supporting on each side an arm which remains simple throughout; the anterior ray sometimes has but one arm. Arms long, composed of quadrangular or slightly cuneiform joints; pinnulæ of moderate size. Column round or obtusely pentagonal.

a. Species with a Single Brachial.

*1875. **Poteriocrinus (Scytalocrinus) abnormis** Worthen. (**Scaphiocr. abnormis.**) Geol. Rep. Ill., vol. vi. p. 519, pl. 31, fig. 6. St. Louis limest. Subcarb. Monroe Co., Ill.

1873. **Pot. (Scytalocr.) Bisselli** Worthen. Geol. Rep. Ill., vol. v. p. 546, pl. 21, fig. 4. Chester limest. Subcarb. Chester, Ill.

1843. **Pot. (Scytalocr.) dactyloides** Austin. Ann. and Mag. Nat. Hist., vol. x., p. 108; vol. xi. p. 197; Rec. and Foss. Crin., p. 86, pl. 10, fig. 7, and pl. 11, figs. 1 a, b. Subcarb. Ireland.

*1860. **Pot. (Scytalocr.) dactylus** Hall. (**Graphiocr. dactylus.**) Supp. Geol. Rep. Iowa, p. 80. St. Louis limest. Subcarb. Missouri and Illinois.

1860. **Pot. (Scytalocr.) decadactylus** Meek & Worthen. (Not **Cyathocrinus.** = **Poteriocr. decadactylus** Lyon & Cass. = **Scaphiocr. Coreyi** Worthen. = **Pot. (Scytalocr.) grandis** Wachsm. & Spr) Trans. Acad. Nat. Sci. Phil., p. 394; Geol. Rep. Ill., vol. ii. p. 338, pl. 17, fig. 6. Keokuk limest. Subcarb. Illinois.

1858. **Pot. (Scytalocr.) decabrachiatus** Hall. Geol. Rep. Iowa, vol. i. pl. 2, p. 679, p. 25, fig. 1. Chester limest. Subcarb. Kaskaskia, Ill.
Syn. Scaphiocr. longidactylus McChesney, Dec. 1859, New Pal. Foss., p. 7; Trans. Chicago Acad. Sci., 1867, vol. i. pt. i. p. 4, pl. 4, fig. 4.

1865. **Pot. (Scytalocr.) Indianensis** Meek & Worthen. Proc. Acad. Nat. Sci. Phil., p. 155; Geol. Rep. Ill., vol. iii. p. 515, pl. 20, fig. 4. Keokuk limest. Subcarb. Crawfordsville, Ind.

This species, if not based upon an abnormal specimen of *P. robustus* Hall, differs from all the others in this section in having two brachials, and in having an additional arm in the posterior rays.

*1869. **Pot. (Scytalocr.) macrodactylus** Meek & Worthen. (**Scaphiocr. macrodactylus.**) Proc. Acad. Nat. Sci Phil., p. 140; Geol. Rep. Ill., vol. v. p. 415, pl. 2, fig. 9. Upper and Lower Burl. limest. Subcarb. Burlington, Iowa.

*1858. **Pot. (Scytalocr.) maniformis** Hall. (**Zeacrinus maniformis.**) Geol. Rep. Iowa, vol. i. pt. ii. p. 682, pl 25, fig. 8. Chester limest. Subcarb. Illinois. Kentucky and Tennessee.

This species shades into several genera, and cannot be satisfactorily brought under any of them. It agrees with *Graphiocrinus*, except in the anal area; the arm joints are like those of *Zeacrinus*, but the arms are simple instead of bifurcating; it agrees with *Eupachycrinus* in the form of the calyx and in the anal area.

1861. **Pot.** (**Scytalocr.**) **robustus** Hall. Descr. New Pal. Crin., p. 7. Bost. Jour. Nat. Hist., p. 315. Keokuk limest. Subcarb. Crawfordsville, Ind.

Syn. Poteriocr. Hoveyi Worthen. Geol. Rep. Ill., vol. vi. p. 516, pl. 29, fig. 6.

1843. **Pot.** (**Scytalocr.**) **rostratus** Austin. Ann. and Mag. Nat. Hist., vol. x. p. 108; vol. xi. p. 196; Rec. and Foss. Crin., p. 75, pl. 9, figs. 2 a–f. Mountain limest. Subcarb. England, Ireland.

1879. **Pot.** (**Scytalocr.**) **Wetherbeyi** Miller. Cincinnati Soc. Nat. Hist. (April number), p. 6, pl. 8, figs. 1, 1 a, b. Chester limest. Subcarb. Kentucky.

b. Species with a Compound Brachial.

1867. **Pot.** (**Scytalocr.**) **bijugus** Trautschold. Bull. Soc. Natur. de Moscou, p. 14, pl. 4, fig. 1–3. 1879. Kalkbrüche von Mjatschkowa, p. 114, pl. 14, fig. 3. Upper Subcarb. Moscow, Russia.

*1879. **Pot.** (**Scytalocr.**) **grandis** Wachsm. & Spr. Described as *Poteriocr. Coreyi* Worthen, 1875. Geol. Rep. Ill., vol. vi. p. 516, pl. 29, figs. 2, 3 (not *Pot.* (*Scaphiocr.*) *Coreyi* M. & W. 1869). Keokuk limest. Subcarb. Crawfordsville, Ind.

*1867. (?)**Pot.** (**Scytalocr.**) **originarius** Trautschold. Bull. Soc. Nat. de Moscou, p. 2, pl. 1, fig. 1. Kalkbrüche bei Mjatschkowa, p. 110, pl. 14, fig. 1. Upper Subcarb. Near Moscow, Russia.

We cannot believe that this species possesses only six arms as described by its author, as this would be too great a departure from the arm structure of Crinoids generally. It may possibly have had nine arms, with a single one in the anterior ray, but more probably ten. Thus far but a single specimen has been discovered, and in this only the right posterior ray is perfectly visible, which had two arms; the two adjoining rays are partly hidden from view, while the remaining two are entirely imbedded in the matrix. There are traces of but five arms in the slab. We judge from the photograph, Pl. 14, fig. 1, that the arrangement of the plates in the calyx has been somewhat disturbed, and this explains the fact that in the diagram, p. 110, the basals (subradials of Trautschold) and radials are incorrectly represented. It may, however, be possible that the original, like a specimen of *P. bijugus* in our possession, for which we are indebted to the kindness of Prof. Trautschold, is abnormal, and that some of the basals (subradials) are anchylosed with the adjoining radials, as in our specimen. Until better material is found we must consider *P. originarius* as a large and abnormal example of *P. bijugus*.

*1879. **Pot.** (**Scytalocr.**) **urna** Trautschold. (**Phialocr. urna**). Steinbrüche von Mjatschkowa, p. 123, pl. 15, fig. 5. Upper Subcarb. Near Moscow, Russia. (Compare with our remarks on *Phialocrinus*.)

1875. **Pot.** (**Scytalocr.**) **Van Hornei** Worthen. Geol. Rep. Ill., vol. vi. p. 517, pl. 31, figs. 2, 3. St. Louis limest. Subcarb. St. Louis, Mo.

F. DECADOCRINUS W. & Spr.

(δέκας number of ten ; κρῖνον a lily.)

Arms always ten in number. Calyx depressed. Shallow bowl or saucer-shaped. Underbasals small, frequently hidden from view in the concave base. Form of radials and brachials as in the preceding group, the latter plates simple or compound. Arms composed of angular wedge-form joints, zigzag, with the longer sides alternating and projecting so as to support short rounded pinnulæ, which have the appearance of armlets. Column more or less pentangular.

a. Species with a Single Brachial.

*1865. **Poteriocrinus (Decadocrinus) Bayensis** Meek & Worthen. (**Scaphiocr. Bayensis.**) Proc. Acad. Nat. Sci. Phil., p. 157; Geol. Rep. Ill., vol. v. p. 550, pl. 20, fig. 2. Chester limest. Subcarb. Illinois.

*1870. **Pot. (Decadocr.) depressus** Meek & Worthen. (**Scaphiocr. depressus.**) Proc. Acad. Nat. Sci. Phil., p. 27; Geol. Rep. Ill., vol. v. pl. 14, fig. 8. Keokuk limest. Subcarb Crawfordsville, Ind.

*1869. **Pot. (Decadocr.) fiscellus** Meek & Worthen. (**Scaphiocr. fiscellus.**) Proc. Acad. Nat. Sci. Phil., p. 141; Geol. Rep. Ill., vol. v. p. 423, pl. 1, fig. 3. Lower Burl. limest. Subcarb. Burlington, Iowa.

*1861. **Pot. (Decadocr.) Halli** Hall. (**Scaphiocr. Halli.**) Desc. New Pal. Crin., p. 7; Bost. Journ. Nat. Hist., p. 308. Upper Burl. limest. Subcarb. Burlington, Iowa.

*1864. **Pot. (Decadocr.) lyriope** Hall. (**Scaphiocr. lyriope.**) 17th Rep. N. Y. St. Cab., p. 58; Geol. Surv. Ohio, Pal., vol. ii. p. 175, pl. 12, fig. 10. Waverly Gr. Subcarb. Richfield, Ohio.

1864. **Pot. (Decadocr.) pleias** Hall. 17th Rep. N. Y. St. Col., p. 141; Geol. Surv. Ohio, Pal., vol. ii. p. 173. Waverly Gr. Subcarb. Richfield, Ohio.

*1869. **Por. (Decadocr.) Stimpsoni** Lyon. (**Zeacr. Stimpsoni.**) Trans. Am. Philos. Soc., Phil., p. 465, pl. 27, fig. m, m 1. Subcarb. Kentucky.

b. Species with More than one Brachial.

*1864. **Pot. (Decadocr.) ægina** Hall. (**Saphiocr. ægina.**) 17th Rep. N. Y. St. Cab., p. 57; Geol. Rep. Ohio, Pal., ii. p. 174, pl. 12, figs. 11, 12. Waverly Gr. Subcarb. Richfield, Ohio.

1861. **Pot. (Decadocr.) diffusus** Hall. 15th Rep. N. Y. St. Cab., p. 121. Hamilton Gr. Devonian. Ontario Co., New York.

*1863. **Pot. (Decadocr.) gracilior** F. Roemer. (**Cyathocr. gracilior.**) Dunker's Palæontologr., vol. ix. p. 149, pl. 29, fig. 1; pl. 25, figs. 8, 10. Dachschiefer. Grauwacke. Bundenbach, Germany.

*1869. **Pot. (Decadocr.) juvenis** Meek & Worthen. (**Scaphiocr. juvenis.**) Proc. Acad. Nat. Sci. Phil., p. 146; Geol. Rep. Ill., vol. v., p. 417, pl. 2, fig. 8. Lower Burl. limest. Subcarb. Burlington, Iowa.

1861. **Pot. (Decadocr.) nycteus** Hall. 15th Rep. N. Y. St. Cab., p. 120. Hamilton Gr. Devonian. Ontario Co., N. Y.

*1861. **Pot. (Decadocr.) scalaris** Meek & Worthen. Type of this group (*Scaphiocr. scalaris*). Proc. Acad. Nat. Sci. Phil., p. 145. Geol. Rep. Ill., vol. v. p. 421, pl. 2, fig. 10. Upper Burl. limest. Subcarb. Burlington, Iowa.

*1864. **Pot. (Decadoc.) subtortuosus** Hall. (**Scaphiocr. subtortuosus.**) 17th Rep. N. Y. St. Cab., p. 59. Geol. Surv. Ohio, Pal., vol. ii. p. 177, pl. 12, figs. 15, 16. Waverly Gr. Subcarb. Richfield, Ohio.

G. Species of Poteriocrinus, imperfectly known.

1858. **Poteriocr. calyculus** Hall. Geol. Rep. Iowa, vol. i. pl. 2, p. 553, pl. 9, figs. 6 a, 6 b. Lower Burl. limest. Subcarb. Burlington, Iowa.

1836. **Poteriocr. conicus** Phillips. Geol. Yorksh., ii. pl. 4, fig. 3. Portlock's Geol. Rep., pl. 16, fig. 12. De Koninck, 1842, Animaux Foss., p. 47, pl. F, fig. 3; Milne Edwards ap. Lamark, p. 664; Austin, 1843, Rec. and Foss. Crin., p. 82, pl. 10, figs. 3 a, b, c. Subcarb. England, Ireland, and Belgium.

1853. **Poteriocr. conoideus** De Koninck & Lehon. Recherch. Crin. Belg., p. 93, pl. 1, figs. 8 a, b. Subcarb. Visé, Belgium.

1869. (?)**Poteriocr. cylindricus** Lyon. (Not Hall=**Homocr. cylindricus**). Trans. Am. Philos. Soc., Philad., vol. xiii. p. 458, pl. 27, fig. 1. Encrinal limest. Subcarb. Falls of the Ohio. (Imperfect specimen.)

1842. **Poteriocr. gracilis** McCoy. (Not **Pot. gracilis** Hall = **Dendocr. gracilis.**) Carb. Foss. Ireland, p. 178, pl. 25, figs. 11–14. Subcarb. Ireland.

1873. **Poteriocr. Hardinensis** Worthen. Geol. Rep. Ill., vol. v. p. 533, pl. 20, fig. 10. St. Louis limest. Subcarb. Hardin Co., Ill.

1836. **Poteriocr. impressus** Phillips. Geol. Yorksh., ii. p. 205, pl. iv. fig. 1; Austin, 1843, Rec. and Foss. Crin., pl. 10, fig. 6. (Not *Pot. impressus* Richter & Unger. Geognost. Rossica, 1860, pl. 31, fig. 46.) Subcarb. England.

1861. **Poteriocr. indentus** Hall. 15th Rep. N. Y. St. Cab., p. 122. Hamilton Gr. Devonian. Ontario Co., N. Y.

*1861. **Poteriocr. læviculus** Lyon. (**Cyathocr. læviculus.**) Proc. Acad. Nat. Sci. Phil., p. 409. Encrinal limest. Subcarb. Jefferson Co., Ky.

1875. **Poteriocr. Lasallensis** Worthen. Geol. Rep. Ill., vol. vi. p. 526, pl. 32, fig. 3. Upper Coal Measures. Lasalle, Ill.

1861. **Poteriocr. lepidus** Hall. Desc. New Pal. Crin., p. 6; Bost. Journ. Nat. Hist. p. 304. Lower Burl. limest. Subcarb. Burlington, Iowa.

1873. **Poteriocr. macoupiensis** Worthen. Geol. Rep. Ill., vol. v. p. 561, pl. 24, fig. 3. Coal Measures, Ill.

1850. **Poteriocr. minutus** F. A. Roemer. Beitr. zur Kenntn. d. Harzgeb., p. 47, pl. 8, figs. 1 a–d. Posidonien Schiefer. Devonian. Lauthenthal. Germany.

1872. **Poteriocr. montanaensis** Meek. Hayden's Rep. U. S. Geol. Surv. Terr. Lower Carbon. Montana Territory.

1861. **Poteriocr. nassa** Hall. 15th Rep. N. Y. St. Cab., p. 120. Hamilton Gr. Devonian. Canandaigua, N. Y.

1861. **Poteriocr. nereus** Hall. 15th Rep. N. Y. St. Cab., p. 121. Hamilton Gr. Devonian. Ontario Co., N. Y.

1861. **Poteriocr. nodobrachiatus** Hall. Desc. New Pal. Crin., p. 8; Bost. Journ. Nat. Hist., p. 614. Keokuk limest. Subcarb. Crawfordsville, Ind.

1858. (?)**Poteriocr. pachydactylus** Müller. Monatsber. Berl. Acad., p. 192. Devonian. Germany. (No means of comparison.)

1858. (?)**Poteriocr. patulus** Müller. Monatsber. Berl. Acad. Devonian. Germany. (No means of comparison.)

1843. **Poteriocr. pentagonus** Austin. (**Cladocr. pentagonus.**) Ann. & Mag. Nat. Hist., vol. ii. p. 198; Rec. and Foss. Crin., p. 86, pl. 11. figs. 2 a–f. Subcarb. England.

1858. **Poteriocr. rugosus** Shumard. Trans. St. Louis Acad. Sci. Coal Measures. (No means of comparison.)

1869. **Poteriocr. simplex** Lyon. (Not **Pot. (Scaphiocr.) simplex** Hall=**Graphiocr. simplex.**) Trans. Am. Philos. Soc. Phil., p. 458, pl. 26, fig. f. Upper Helderberg, Devonian. Falls of the Ohio.

1821. **Poteriocr. tenuis** Miller. Hist. Crin., p. 71; Schlotheim, 1822; Nachtr. Petrefactenk., vol. ii. pl. 25, fig. 2; Austin, 1843, Rec. and Foss. Crin., p. 83, pl. 10, figs. 5 a, b. Mountain limest. Subcarb. England and Ireland.

*1861. **Poteriocr. Wortheni** Lyon. (**Cyathor. Wortheni.**) Proc. Acad. Nat. Sci. Phil., p. 410. Encrinal limest. Devon. Jefferson Co., Ky.

15. GRAPHIOCRINUS De Koninck & Lehon.

1853. *Graphiocrinus* De Kon. & Leh. Crin. Carb. Belg., p. 115.
1858. *Scaphiocrinus* (in part) Hall. Geol. Rep. Iowa, vol. i. pt. 2, p. 549.
1879. *Phialocrinus(?)* Trautschold. Kalkbrüche Mjatch., p. 122.

A. Typical form.

In general aspect *Graphiocrinus* closely agrees with a form of *Poteriocrinus* for which we have proposed the name *Scytalocrinus*, from which, however, it differs clearly in the anal area, which in *Graphiocrinus* has but a single plate, while in the other it has three. De Koninck, in his generic description, mentions only two orders of plates as constituting the calyx, in which he is evidently mistaken. We have before us several species from the Burlington limestone, which have heretofore been referred by their authors to *Scaphiocrinus*, but which agree in the clearest manner with the typical *Graphiocrinus encrinoides*. They all, like the typical species, have ten arms—except an undescribed species, which we think belongs to this type, and which has only five—constructed of simple joints with parallel sutures; they have one large brachial and a single anal plate, extending beyond the general limit of the calyx; and whenever the column is attached there is no trace of underbasals, yet these plates are found in every one of those species when seen with the column removed. We can no longer doubt, from the evidence of our specimens, that the underbasals, as suggested by Hall and Meek & Worthen, are also present in the Belgian species, but hidden from view by the column, and that all the above-mentioned species belong to the same genus. We therefore propose a revision of the generic formula, protesting, however, against the assertion of the authors last named, that the entire genus *Scaphiocrinus* as formulated by Hall, is identical with *Graphiocrinus. Scaphiocrinus simplex*, and a few other species like it with a single anal plate, are undoubtedly so, but all others, and by far the majority of species described under *Scaphiocrinus*, are generically distinct from *Graphiocrinus*, and must be classed with *Poteriocrinus*.

Closely related to *Graphiocrinus* are *Bursacrinus*, Meek & Worthen, and *Phialocrinus*, Trautschold. We can perceive slight structural differences by which the two might be distinguished from the first, but it can only be a subgeneric division, and it is somewhat questionable whether even this can be maintained as to *Phialocrinus*.

Revised Generic Diagnosis.—General form elongate, almost cylindrical. Calyx small, rather shallow, with bilateral symmetry. Underbasals five, minute, rarely extending beyond the column. Basals small; four at least, frequently all five of them, equal. The former is the case in all species in which the anal plate is disconnected from the basals, the latter when it rests directly upon one of them, in which case the posterior basal is considerably higher and truncate above. Radials large, their upper articulating margins straight. Brachials one by five, as large or larger than the radials, and of a similar form, but with the lower margin straight; sutures gaping, articulating facet occupying the entire width of the plate.

There are generally two arms to each brachial, or ten to the individual, which remain simple throughout; but in the above mentioned species the upper side of the brachials is truncate, and the Crinoid has only five arms. The arms are long and heavy, composed of short joints with almost parallel sutures. Pinnulæ long.

A single rather small anal plate is placed half-way between the radials and brachials, either resting on the posterior basal or separated from it, but in either case extending above the plane of the radials. Ventral sac, so far as observed, strong, composed of elongate hexagonal plates. Column round or obtusely pentagonal.

Geological position, etc.—Found so far only in the Subcarboniferous both of Europe and America. We recognize the following species:—

*1861. ? **Graphiocrinus carbonarius** Meek & Worthen. (**Scaphiocr. carbonarius.**) Proc. Acad. Nat. Sci. Phil., p. 140; Geol. Rep. Ill., vol. v. p. 562, pl. 24, fig. 2. Coal Measures. Springfield, Ill.

1853. **Graphiocr. encrinoides** De Koninck & Lehon. Type of the genus. Recherch. Crin. Belg., p. 117, pl. 4, fig. 15, 15 a, b. Mountain limest. Subcarb. Tournay, Belg., and Bristol, Eng.

*1873. **Graphiocr. McAdamsi** Worthen. (**Scaphiocr. McAdamsi.**) Geol. Rep. Ill., vol. v. p. 495, pl. 15, fig. 2. Keokuk limest. Subcarb. Jersey Co., Ill.

*1869. **Graphiocr. rudis** Meek & Worthen. (**Scaphiocr. rudis.**) Proc. Acad. Nat. Sci. Phil., p. 139; Geol. Rep. Ill., vol. v. p. 412, pl. 1, fig. 1. Upper Burlington limest. Subcarb. Burlington, Iowa.

*1858. **Graphiocr. simplex** Hall. (**Scaphiocr. simplex.**) Geol. Rep. Iowa, vol. i. pt. ii. p. 551, pl. 9, Fig. 10. Burlington limest. Subcarb. Burlington, Iowa.

*1861. **Graphiocr. spinobrachiatus** Hall. (**Scaphiocr. spinobrachiatus.**) New Pal. Crin., p. 8; Bost. Journ. Nat. Hist., p. 306. Lower Burlington limest. Subcarb. Burlington, Iowa.

*1869. **Graphiocr. striatus** Meek & Worthen. (**Scaphiocr. striatus.**) Proc. Acad. Nat. Sci. Phil., p. 142; Geol. Rep. Ill., vol. v. pl. 2, fig. 11. Lower Burlington limest. Subcarb. Burlington, Iowa.

*1861. **Graphiocr. tortuosus** Hall. (**Scaphiocr. tortuosus.**) Desc. New Pal. Crin., p. 7; Bost. Journ. Nat. Hist., p. 309. Upper and Lower Burlington limest. Subcarb. Burlington, Iowa.

*1861. **Graphiocr. Wachsmuthi** Meek & Worthen. (**Scaphiocr. Wachsmuthi.**) Proc. Acad. Nat. Sci. Phil., p. 141; Geol. Rep. Ill., vol. iii., p. 488, pl. 16, fig. 7, a, b. Lower Burl. limest. Subcarb. Burlington, Iowa.

B. Subgenus BURSACRINUS Meek & Worthen.

1861. *Bursacrinus* M. & W. Proc. Acad. Nat. Sci. Phil., p. 136.
1862. *Bursacrinus* White. Proc. Bost. Soc. Nat. Hist., vol. ix. p. 11.
1868. *Bursacrinus* M. & W. Geol. Rep. Ill., vol. iii. p. 478.

Body rapidly spreading to the top of the first division of the arms. Calyx, in the known species, small and turbinate, closely agreeing with *Graphiocrinus* in its general construction, but the basals comparatively larger, the posterior one much higher and truncated. Radials and brachials smaller, and the single anal plate, which here also reaches beyond the plane of the radials, extends—at least in the typical species—as far as to the lower portion of the first arm plates. The best distinction, however, and that by which *Bursacrinus* is easily recognized, is found in the arms, which are branching instead of simple, broad, flat, and in contact laterally. Between the first bifurcation of the rays on the brachial pieces and the next division above, the arms are very wide, flat, and composed of from six to eight short wedge-form pieces which are squarely truncated on each side. In the division above, the arm pieces are less than half the width of the last, and like all others composed of a single series of joints.

In the extraordinary width of the lower portion of the arms, the flatness of the arm pieces, and the fact that these lie side by side, abutting laterally, *Bursacrinus* somewhat resembles *Ichthyocrinus*, but the arms are comparatively longer and the general construction of the body otherwise is very distinct.

Only two species are known; both are from the Subcarboniferous.

1861. **Bursacrinus Wachsmuthi** Meek & Worthen. Type of the subgenus. Proc. Acad. Nat. Sci. Phil., p. 137; Geol. Rep. Ill., vol. iii. p. 479, pl. 17, fig. 6. Upper Burlington limest. Subcarb. Burlington, Iowa.

1862. **Bursacrinus confirmatus** White. Proc. Bost. Soc. Nat. Hist., vol. ix. p. 11. Lower Burlington limest. Subcarb. Burlington, Iowa.

C. Subgenus (?) **PHIALOCRINUS** Trautschold.[1] (Not Eichwald)

1879. Monogr. Kalkbrüche von Mjatschkowa, p. 122.

Prof. Trautschold proposed the above name in a full generic sense for two species of Crinoids from the Upper Subcarboniferous of Russia. The resemblance to *Graphiocrinus*, as already mentioned, is so close that we doubt whether the group can be upheld even subgenerically. So far as known, *Phialocrinus patens* differs from *Graphiocrinus*, as now revised, only in having two brachial pieces instead of one, and in the underbasals, which here project slightly beyond the column. The latter is unimportant, and a comparison will show that the two brachials combined have exactly the form of the single plate in *Graphiocrinus;* their division involves no structural change, but merely facilitates articulation. Trautschold's first species only can be placed here: his *P. urna* is certainly a *Poteriocrinus*, as indicated by its obconical form, the large underbasals, and especially by the arrangement of its anal plates.

1879. **Graphiocr. (Phialocrinus) patens** Trautschold. Monogr. d. Kalkbrüche von Mjatsch., p. 123, pl 15, fig. 4. Upper Subcarb. Near Moscow, Russia.

16. **WOODOCRINUS** De Koninck.

1854. Recherch. Crin. Belgique. Supplement, p. 4.

General form including arms short and robust; calyx depressed, arrangement of the plates in the anal area unsymmetrical.

Underbasals five; small, quadrangular, forming a pentagon

[1] Eichwald's genus *Phialocrinus* (Lethaea Rossica, i. p. 578, pl. 31, fig. 27) was not defined, being founded on fragmentary pieces of column.

with nearly straight sides, slightly concave in the middle. Basals about of equal size, hexagonal, wider than high. Radials pentagonal, wide, and short, broadly truncate above. Brachials one by five, similar in form to the radials, but truncate below instead of above; they support on each upper sloping side an arm which bifurcates on the fourth to the eighth plate above, the branches remaining simple throughout, thus giving four arms to each ray uniformly.

The arms are rather divergent, heavy, rounded on the outside, gently tapering to the tips and terminating in a sharp point. Arm pieces extremely short, their sutures parallel. Pinnulæ long and numerous, directed inward, composed of ten to twelve small joints.

The anal area is remarkable for its great number of pieces, being composed longitudinally of several rows of plates, alternately arranged. The lower and largest plate rests between two basals, one of the upper sides against the right posterior radial, the other against the first anal of the adjoining row. The second anal plate rests upon a basal, and abuts laterally against the left posterior radial. The third anal is placed upon the first, toward the right side of the second, and rests partly against the right posterior radial. The anal area is elliptic in outline, composed of twelve or more plates, only three of which are on a level with the radials. The form of the ventral sac is unknown, but from all appearances it is somewhat balloon-shaped, and does not extend to the top of the arms.

Column rather slender, composed of alternate wider and narrower joints, their diameter increasing from the root up, being largest next to the calyx; central perforation round.

The genus is from the Subcarboniferous, and the only known species is:—

1854. **Woodocrinus macrodactylus** De Koninck. Recherch. Crin. Belg. Supplement, p. 6, pl. 8, figs. 1 a–d. Upper part of Subcarb. Richmond, England.

17. ZEACRINUS Troost.

1850. *Zeacrinus* Troost. Subgenus of *Poteriocrinus*. Cat. Crin. Tenn., p. 62 (without description.)

1858. *Zeacrinus* Hall. Subgenus of *Poteriocrinus*. Geol. Rep. Iowa, vol. i. pl. 2, p. 544.

1860. *Zeacrinus* Meek & Worthen. Subgenus of *Poteriocrinus*. Geol. Rep. Ill., vol. ii. p. 186. (Not *Zeacrinus* Schultze. Monog. Echin. Eifel Kalk., p. 38.)

General form of body with arms closed, terete or subcylindrical, often contracted near the arm bases and spreading above; Calyx more or less depressed, low cup or basin-shaped, rarely turbinate, with the basal portion sunken in and forming a deep concavity. Arrangement of plates slightly unsymmetrical.

Underbasals five (abnormally six), small, generally hidden in the central concavity, and covered by the column. Basals five, sometimes nearly equal, but more frequently showing a tendency to irregularity on the posterior side. Radials five, pentagonal, the upper side truncate, with a single brachial plate in each of the four lateral rays; the anterior ray, however, as a rule has one, two, to six or more additional quadrangular brachials, and a bifurcating plate above, resembling in outline the single brachial of the other rays. The latter plate is wide, rather short, and of the form of the radials, but truncate below, and joining the entire upper margin of the radial.

Arms comparatively short, bifurcating, scarcely rounded on the exterior, rarely angular; the bifurcating plates comparatively larger and sometimes nodose. Ramifications only occur on the two outer arms of the rays, and these arms have straight outer margins throughout their length. The branches are given off at regular intervals toward the inner side of the ray, and remain single throughout. The arms are all of uniform thickness, and their sides are sharply defined, and when closed they join so neatly with each other that it appears as if they formed a solid body. Arm-joints much wider than long, with nearly parallel sutures. Pinnulæ short and slender, composed of six or more angular joints directed to the interior of the crinoid, not given off laterally. Arm furrows apparently covered by the infolding of the pinnulæ, not by alternating plates.

There are from five to seven anal plates, alternately arranged in two rows, the lower plate resting with one side against the sloping right side of the posterior basal, the other against the right posterior radial, in some species almost touching the underbasals. The arrangement of the succeeding plates is very similar to that of *Woodocrinus*, except that the portion of the anal area above the line of the radials has a sharp triangular outline instead of elliptic as in that genus. The whole protrudes and is almost even with the surface of the adjoining arms, which curve around it or rest upon its flanks. The ventral sac is broadly balloon-shaped, and extends, so far as observed, to about one-half the height of the arm. It is composed of a great number of small plates, is subpyramidal, sharply pointed at its upper end. It consists of five diverging spheromeres, the radial portions deeply depressed, the interradial extending outward in sharp edges, the edge at the posterior side connecting with the anal area, those of the other sides abruptly turned near the top of the calyx toward the posterior of the specimen, where the sac evidently connects with the main body, thus resembling a balloon. The sharp edges are wedged in for a short distance between the outer arms of two different rays, and the arms themselves with their pinnulæ rest within the radial excavations almost as in *Eucalyptocrinus*. The radial spaces are subdivided near their base by a short ridge, underneath which, and apparently independent of the sac, there is seen in every ray a little short tube representing the ambulacral passages. There is no sign of an anal opening, but we have observed two rows of respiratory pores along the median line of the radial depressions.

Column round, sometimes bordered by irregular lateral cirrhi; its diameter small, the central canal minute and apparently round.

The genus *Zeacrinus* is evidently closely related to *Woodocrinus*, and as we are inclined to believe that the ventral sac, which has not yet been discovered in the latter, is most probably similarly constructed, we have felt almost like placing *Zeacrinus* (which was defined as late as 1858 by Hall), under De Koninck's genus as a subgenus. We have noticed, however, a difference in the construction and habitus of the arms by which we think the two may be satisfactorily distinguished. Those of *Woodocrinus*, as observed in a large number of specimens, show a strong inclination to separate by being more or less irregularly bent to one side, particularly near the top; while in *Zeacrinus* they are closely folded up, very much as in *Ichthyocrinus*, and perfectly straight, with quite a different mode of bifurcation. In the former they are round, very robust, terminating in a sharp point; in the latter almost flat, very delicate, and of nearly uniform size throughout.

The identification of *Zeacrinus* has always been attended with difficulty, owing to the fact that it had not been sufficiently well defined. The ventral sac, which really presents the best generic characters, and by which it is easily recognized, was altogether unknown, and the difficulty was increased when several species were admitted which belong to other groups, and which were evidently not intended to be included by the authors of the genus. We have been obliged to throw out all species with long, angular, zigzag arm-joints; these have also a tubular ventral sac, and we have placed them under some of the varieties of *Poteriocrinus*, where they really belong.

Zeacrinus has by most authors been placed under *Poteriocrinus* as a subgenus, but in this we cannot concur. We look upon it rather as the type of an independent little group of Crinoids, including several genera, which culminates in *Hydreionocrinus* and *Cœliocrinus*, some of the last survivors of the Cyathocrinidæ.

Zeacrinus excavatus Schultze is evidently a *Taxocrinus*.

Geological position, etc.—The genus is confined to the Subcarboniferous, ranging through all the divisions of that epoch; and has only been discovered in America.

We recognize the following species:—

1869. **Zeacrinus asper** Meek and Worthen. Proc. Acad. Nat. Sci. Phila., p. 150. Geol. Rep. Ill., vol. v. p. 430, pl. 1, fig. 7. Lower Burlington limest. (not Upper Burlington l. as stated by M. and W.). Subcarb. Burlington, Iowa.

1859. **Zeacr. bifurcatus** McChesney. New Pal. Foss., p. 10. Trans. Chicago Acad., 1867, vol. i. p. 71, pl. 4, fig. 3. Chester limest. Subcarb. Chester, Ill.

*1862. **Zeacr. bursæformis** White. (**Poteriocr. bursæformis.**) Proc. Bost. Soc. Nat. Hist., p. 10. Lower Burlington limest. Subcarb. Burlington, Iowa.

1873. **Zeacr. compactilis** Worthen. Geol. Rep. Ill., vol. v. p. 536, pl. 21, fig. 5. Subcarb. Cumberland Co., Ky.

1858. **Zeacr. elegans** Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 547, pl. 9, figs. 1 and 2. Upper Burlington limest. Subcarb. Burlington, Iowa.

1847. (?) **Zeacr. florealis** Yandell and Shumard. (**Cyathocr. florealis.**) Cont. Geol. Kentucky, p. 24, pl. 1, fig. 1. Shumard, 1855. *Poteriocr. florealis*, Second Rep. Geol. Missouri, pl. ii. p. 217. Shumard, 1866. *Zeacr. florealis*, Cat. Pal. Foss., pt. i., Echinodermata, p. 399. Chester limest. Subcarb. Grayson Co., Ky.

We are not certain that this species belongs here, as we have never seen the description.

1858. **Zeacr. intermedius** Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 681, pl. 25, fig. 4. Chester limest. Subcarb. Chester, Ill.

1846. **Zeacr. magnoliaeformis** Owen and Norwood. Type of the genus. (**Cyathocr. magnoliaeformis.**) Research Pot. Carb. Rocks, Kentucky. Troost, 1850. *Zeacr. magnoliæformis*, Cat. Crin. Tenn. Hall, 1858, Geol. Rep. Iowa, vol. i. pt. ii. p. 543 and 684, pl. 25, fig. 4. Chester limest. Subcarb. Grayson Co., Ky.

1859. **Zeacr. ovalis** Lyon and Casseday. Am. Jour. Sci. (n. s.) vol. 29, p. 71. Chester limest. Subcarb. Ky.
1858. **Zeacr. ramosus** Hall. Geol. Rep. Iowa, vol. i, pt. ii. p. 548, pl. 9, fig. 3. Upper Burl. limest. Subcarb. Burlington, Iowa.
1869. **Zeacr. scobina** Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 149; Geol. Rep. Ill., vol. v. p. 426, pl. 1, fig. 2. Upper Burlington limest. Subcarb. Burlington, Iowa.
1869. **Zeacr. serratus** Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 151; Geol. Rep. Ill., vol. v. p. 428, pl. 1, fig. 6. Upper Burlington limest. Subcarb. Burlington, Iowa.
1860. (Sept.) **Zeacr. Troostanus** Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 390; Geol. Rep. Ill., vol. ii. p. 186, pl. 16, fig. 2. Upper and Lower Burlington limest. Subcarb. Burlington, Iowa.
(*Syn.*) **Zeacr. scoparius** Hall (Feb. 1861). Descr. New. Pal. Crin., p. 8; Bost. Jour. Nat. Hist., p. 305.
(*Syn.*) **Zeacr. sacculus** White (1862). Proc. Bost. Soc. Nat. Hist., p. 12.
1858. **Zeacr. wortheni** Hall. Geol. Rep. Iowa, vol. i. pt. ii. p. 683. Chester limest. Subcarb. Chester, Ill.

(Compare with *Z. magnoliæformis.*)

18. HYDREIONOCRINUS De Koninck.

1858. Bull. Acad. Royale Belgique, vol. viii. pt. ii. p. 13.

A. Typical form.

General form subcylindrical, short, slightly spreading toward the tips of the arms; with an enormous ventral sac extending beyond the limits of the arms, and covering them like a roof. Calyx short, rounded below, basal portion sometimes deeply concave.

Underbasals small, and, according to De Koninck, forming a five-rayed star or shallow cup. In all known American species the underbasals rest within a deep concavity, and are scarcely visible beyond the column; but they appear to be considerably larger on the interior of the calyx, sometimes almost exceeding the basals in size. Basals five, three of them of equal size, and hexagonal; the two in contact with the anal plates frequently larger. Radials five, large, much wider than high, four of them pentangular, that on the left posterior side quadrangular; the former resting each between two adjacent basals, and the latter abutting upon only one. Brachials one to the ray, or two in the anterior ray, pentangular, as large or larger than the radials, often produced into long spines; in species where the anterior ray has an additional brachial, the first is quadrangular, the second is pentangular and bears the spine. The brachials meet laterally, and support on their upper sloping sides two arms, which subdivide once, or oftener.

The arms ramify in the same manner as in *Zeacrinus*, by throwing off branches toward the inner side of the ray; they touch laterally, and are so arranged that the sutures between the rays, from the basals up, form straight lines, except on the posterior side where the arms curve slightly, following the margin of the anal area. The arms, before they become simple, are composed of short, strongly wedge-shaped joints alternately arranged, which in most species are by degrees turned into a double series of interlocking plates. Pinnulæ very small and short.

The arrangement of the anal plates is exactly as in *Zeacrinus* and *Woodocrinus*, but the anal area is less protuberant. The ventral sac, which is the most remarkable part of this Crinoid, and the best character for distinction, has the form of a mushroom, upright, cylindrical below, abruptly spreading beyond the tips of the arms and forming a rim composed of a row of 6, 11, 15 or more large, spiniferous or nodose plates, spread out horizonally and tending slightly downward. The upper part or roof is low hemispherical, and is formed either by the spiniferous plates themselves, which are in that case unusually large, or more frequently by a number of irregular plates within the centre. The tube, or cylindrical portion of the sac, is composed of small plates, horizontally arranged, and provided at the sutures with one or two rows of respiratory pores. No other aperture has as yet been observed, nor has the connection of the tube with the main body been ascertained.

Column small.

De Koninck, in his generic description, took the upper portion of the ventral sac to be a regular vault, and thereby distinguished this genus from *Poteriocrinus* with a large proboscis, while this organ, as he supposed, was absent in *Hydreionocrinus*. Some of the European species which De Koninck refers to his genus must be considered doubtful until better proof is given that they belong here. His *H. globularis* is, in our opinion, an *Eupachycrinus*.

Hydreionocrinus has the closest relations with *Zeacrinus*, with which it agrees in the construction of the calyx, and in the mode of bifurcation of the arms; but the enormous size of the ventral sac, its peculiar form and construction, seem to warrant a full generic separation.

Geological position, etc.—The genus is known only from the uppermost part of the Subcarboniferous and from the Coal measures, and occurs both in Europe and America.

We recognize the following species:—

*1870. **Hydreionocrinus acanthophorus** Meek and Worthen. (**Zeacr. Hydreionocr. acanthophorus.**) Proc. Acad. Nat. Sci. Phil., p. 28; Geol. Surv. Ill., vol. v. p. 563, pl. 24, fig. 11. Upper Coal Measures. Illinois and Iowa.

*1870. **Hydreionocr. armiger** Meek and Worthen. (**Zeacr. (?) armiger.**) Proc. Acad. Nat. Sci. Phil., p. 27; Geol. Rep. Ill., p. 547, pl. 21, fig. 3. Chester limest. Subcarb. Pope Co., Ill.

*1850. **Hydreionocr. depressus** Troost. (**Zeacr. depressus.**) Cat. Pal. Foss. Tenn.; Hall, 1858, Geol. Rep. Iowa, vol. i. pt. ii. p. 546. Chester limest. Subcarb. Kentucky and Alabama.

*1860. **Hydreionocr. discus** Meek and Worthen. (**Zeacr. discus.**) Proc. Acad. Nat. Sci. Phil., p. 390; Geol. Rep. Ill., vol. II. p. 312, pl. 26, figs. 3 a, b. Upper Coal Measures. Illinois.

(Compare with *Hydreionocr. acanthophorus.*)

*1859. **Hydreionocr. mucrospinus** McChesney. (**Zeacr. mucrospinus.**) Desc. New Pal. Foss. p. 10; Trans. Chic. Acad. Sci., 1867, vol. i. p. 7, pl. 4, fig. 7. Coal Measures. Illinois.

1858. **Hydreionocr. woodianus** De Koninck. Type of the genus. Bull. Acad. Royale Belgique, pt. ii. p. 17, pl. 2, figs. 5, 5 a. Subcarboniferous. Richmond, Yorkshire, England.

Doubtful Species, placed under the genus by De Koninck. Bull. Acad. Royale, Belg., vol. iii. pt. ii. p. 13.

1853. (?) **Hydreionocr. calyx** De Koninck and Lehon. (**Zeacr. calyx.**) Recherch. Crin. Carb. Belg., p. 90, pl. 1, fig. 6 a–d. Lower Carboniferous. England and Belgium.

1836. (?) **Hydreionocr. granulosus** Phillips. (**Poteriocr. granulosus.**) Geol. Yorksh., p. 205, pl. 4, fig. 2; Austin, 1843, Mon. Rec. and Foss. Crin., p. 77, pl. 9, figs. 3 a–f. Subcarboniferous. Bolland, England.

1853. (?) **Hydreionocr. McCoyanus** De Koninck and Lehon. (**Poteriocr. McCoyanus.**) Rech. Crin. Carb. Belg., p. 91, pl. 1, fig. 7. Lower Carboniferous. Visé, Belgium.

1853. (?) **Hydreionocr. Phillipsianus** De Koninck and Lehon. (**Poteriocr. Phillipsianus.**) Rech. Crin. Terr. Carb. Belg., p. 91, pl. 1, fig. 7. Lower Carboniferous. Visé, Belgium.

1858. (?) **Hydreionocr. scoticus** De Koninck. Bull. Acad. Royale Belg., vol. iii. pt. ii. p. 19, pl. 2, figs. 6, 7. Carboniferous. Glasgow, Scotland.

B. Subgenus **CŒLIOCRINUS** White.

1861. *Poteriocrinus* Hall (in part). Bost. Jour. Nat. Hist., p. 300.

1863. *Cœliocrinus* White. Bost. Jour. Nat. Hist., p. 497.

1869. *Cœliocrinus*, subgenus of *Poteriocrinus*, Meek and Worthen. Proc. Acad. Nat. Sci. Phila., p. 138.

When Dr. White proposed the genus *Cœliocrinus*, he had evidently overlooked De Koninck's genus *Hydreionocrinus*, with which it agrees in all essential points except in the form of the ventral sac, which is balloon-shaped in *Cœliocrinus*, instead of like a mushroom, and except also that in *Hydreionocrinus* the calyx is comparatively larger and the arms shorter. Whether these differences are of sufficient importance to justify even a subgeneric division, is to us somewhat doubtful. The two forms are certainly not generically distinct, for they shade into one another so closely that in some species it becomes difficult even to separate them on the above characters. We, for our part, are inclined to recognize in *Cœliocrinus*, which occurs in the lower Subcarboniferous, the earlier stage of *Hydreionocrinus;* the latter, which flourished during the later periods of the Carboniferous, both in Europe and America, representing the culmination of the form in maturity and extravagance, as developed in the course of time. Such extraordinary development in certain parts of the animal—as here in the ventral sac—frequently occurs when a genus is about to become extinct, and *Hydreionocrinus* is, in fact, one of the last survivors of this family. Bearing this in mind, it is of little consequence whether we place the species of this group under *Hydreionocrinus*, or subgenerically under *Cœliocrinus.*

The relations of this form with *Zeacrinus* are also very close and interesting, and the question may well be asked whether all three forms ought not to be placed under *Woodocrinus*, provided this genus possesses an inflated sac, which we consider the most characteristic feature of this little group; especially as they further agree in the shortness of the arms and their peculiar mode of bifurcation. Such a classification would certainly be more natural than to place them under *Poteriocrinus*, as was done by Hall, and subgenerically by Meek and Worthen. All *Poteriocrini* have long arms, and the ventral sac is prolonged into a slender tube. The arms in all species of *Cœliocrinus* are composed of strongly wedge-shaped plates, which almost interlock, as they do completely in most species of *Hydreionocrinus*, while the corresponding joints in *Zeacrinus* and *Woodocrinus* are regularly quadrangular, with parallel sutures.

Geological position, etc.—Found only in the lower part of the Subcarboniferous of America.

The following species may be arranged here, though we rather prefer their consolidation with *Hydreionocrinus*.

1861. **Cœliocrinus dilatatus** Hall. (**Poteriocr. dilatatus**), Descr. New Pal. Crin., p. 6; Bost. Journ. Nat. Hist., p. 300. White, 1863, *Cœliocr. dilatatus*, Bost. Journ. Nat. Hist., p. 501. Lower Burlington limest. Subcarb. Burlington, Iowa.

1873. **Cœliocr. cariniferus** Worthen. (**Zeacr. cariniferus**), Geol. Rep. Illinois, vol. v. p. 535, pl. 20, fig. 4. (?) St. Louis limest. Near Huntsville, Ala.

*1869. **Cœliocr. lyra** Meek and Worthen. (**Zeacr. lyra**), Proceed. Acad. Nat. Sci. Phila., p. 152; Geol. Rep. Illinois, vol. v. p. 432, pl. 1, fig. 11. Upper Burlington limest. Subcarb. Burlington, Iowa.

1863. **Cœliocr. subspinosus** White. Bost. Journ. Nat. Hist., p. 501. Upper Burlington limest. Subcarb. Burlington, Iowa.

1861. **Cœliocr. ventricosus** Hall. (**Poteriocr. ventricosus**), Descr. New Pal. Crin., p. 6; Bost. Journ. Nat. Hist., p. 301. White, 1863, *Cœliocr. ventricosus*, Bost. Journ. Nat. Hist., p. 501. Lower Burlington limest. Subcarb. Burlington, Iowa.

19. EUPACHYCRINUS Meek and Worthen.

1855. *Eupachycrinus*, Proc. Acad. Nat. Sci. Phila., p. 159.

1866. Geol. Rep. Ill., vol. ii., p. 177.

1867. *Cromyocrinus* Trautschold. Crin. jüng. Bergkalkes bei Moskau, p. 19.

1879. *Cromyocrinus*, Monogr. Kalkbrüche von Mjatschkowa, p. 117.

Meek and Worthen proposed the name *Eupachycrinus*, without generic description, for a small group of American Crinoids, which, by their massive, tumid plates, the double series of interlocking plates generally composing the arms, and their general physiognomy, are well distinguished from all other known genera. They made Lyon's *Graphiocrinus quatuor decimbrachialis* the type of the genus, including in it Hall's two species—*Cyathocrinus* (?) *pentalobus* and *Scaphiocrinus orbicularis*, and have since described several new species.

In 1867 Prof. Trautschold, not knowing that such a genus had been established, proposed the name *Cromyocrinus* for two species from the Upper Subcarboniferous of Russia,[1] which in many respects, if not altogether, agree with those upon which *Eupachycrinus* was founded. The species of both agree in the bowl-shaped, sometimes nearly globular form of the calyx, its comparatively very large size, its large and heavy plates, the

[1] We are under obligations to Dr. Trautschold for some excellent Crinoids from the Russian beds, and to Prof. Wetherby, of Cincinnati, for the loan of some rare and well-preserved specimens of *Eupachycrinus*.

massive and simple arms, and the exceedingly slender column. A comparison, however, of all the species that have been referred to the two genera discloses the peculiar fact, that some of them disagree in certain other characters which we have heretofore, in connection with other groups, and apparently with good reason, considered to be of generic value. Among these we may mention the variation in the size of the proximal or underbasal plates, in the number and arrangement of the anal pieces, and in the form and arrangement of the arm plates; but to separate them thereby, either under *Cromyocrinus* or otherwise, has so far proved utterly impossible. It is true that the underbasals in all Russian species referred to *Cromyocrinus* are exceptionally large, but only so in the adult stage. In the young specimens, as shown by Trautschold himself, they are so minute as not to extend beyond the column, so that in making the size of these plates a generic character we should be obliged to separate the young and adult.

There are, moreover, several American species which in all other respects agree with the typical forms of *Cromyocrinus*, but in which these plates, even in the adult, are exceedingly small. The same difficulty is met with in regard to the anal area. In two species—*Eupachycrinus Craigii* Meek and Worthen, and *E. Fayettensis* Worthen—the anal area is composed of a single plate, instead of three, and this even extends partly beyond the line of the radials. That this is not an abnormity, but a constant character in the species, is proved by a number of specimens. In every other group we should not hesitate to establish a new genus on this character alone; but in this case we are convinced that it is only of specific importance, since those species agree in all other respects with Meek and Worthen's typical *Eupachycrinus*. In one specimen of another species, in our collection, only the larger, lower anal plate is absent, but this may be considered as abnormal, for the adjacent basal and radial plates show a very irregular form.

Examining the arms, we find them in two of the Russian species of *Cromyocrinus* composed of narrow, transverse, quadrangular plates; in *C. ornatus*, however, they are of cuneiform pieces which by degrees become interlocking plates. The same diversity in the structure of the arm plates is found among American species, some interlocking almost from the base of the arm, others only at the tips, while still others are constructed of a single series of transverse plates, with parallel sutures, as in the two species of *Cromyocrinus* from Russia. We have an example in a specimen from Kentucky, which we owe to the kindness of Prof. Wetherby, evidently *Eupachycrinus formosus* (*Zeacrinus formosus* Worth.), which in every other respect is so closely allied to *Eupachycrinus spartarius* S. A. Miller (which has two rows of alternating arm-pieces), that the two cannot be separated unless the arms are preserved; while, on the other hand, it is almost identical with Trautschold's *Cromyocrinus geminatus*. This is sufficient to show the impracticability of subdividing *Eupachyocrinus*, and we are forced to consider *Cromyocrinus* as a synonym.

It is certainly pertinent to inquire how it is possible that the same differences in the structure of these Crinoids are in some cases of generic, and in others only of specific importance. We think the question can be answered without much speculating. In a paper, "Transition Forms in Crinoids," Proc. Acad. Nat. Sci. Phila., 1878, p. 224, we have endeavored to prove that extravagant forms are of short duration; that many genera, before they become extinct, attain extreme proportions or become extraordinarily developed in certain parts of the body. Such was the case with *Hydreionocrinus* with regard to the ventral sac, which was developed to its farthest extreme in size and proportions. In *Eupachycrinus* the opposite extreme is reached, the same organ being reduced to almost nothing, making it almost doubtful whether the genus ought to be placed with the *Cyathocrinidæ* at all; although we cannot, with our present knowledge, separate it from this family. This form was one of its very latest representatives, which evidently struggled through under great difficulties, and which by degrees accommodated itself to the great changes which took place about the close of the Carboniferous Age. All the peculiarities which are expressed in the genus, the differentiations which distinguish the species, point toward and foreshadow *Encrinus*. We observe this in the form and construction of the calyx; in the number, size, and arrangement of the arms; in the mode of articulation, and in the general aspect. The two mainly differ in the absence of anal plates in *Encrinus;* but here again we find in the species of *Eupachycrinus*, to which we alluded above and which are restricted to the Coal Measures, the forerunners of *Erisocrinus* and *Stemmatocrinus* of the same horizon, which are the prophetic types, if not congenera, of the

Encrinidæ. All this tends to explain the extraordinary modification of characters that took place within the limits of genera at the close of the Carboniferous Era.

Generic Diagnosis.—Calyx large, saucer or bowl-shaped to subglobose. Plates heavy, convex to tumid, sometimes ornamented, their arrangement unsymmetrical; sutures strongly defined.

Underbasals five, of equal size; generally small and forming a concavity; in European species comparatively larger and slightly convex. Basals large, fully as high as wide, bent upwards so that the lower half of the plates stands almost at right angles to the vertical axis, and forms a part of the basal plane, or is involved in the concavity. Three of the basals are equal, pentagonal in outline; the other two modified to accommodate the anal pieces. Radials scarcely as large as the basals, much wider than high, all pentagonal, the right posterior plate being, however, generally smaller and of a more irregular form. The upper articulating margin of the plate forms a straight line, perfectly filled by the brachials. Brachials one by five, always large, at least twice as wide as high, and frequently extended into a large spine, projecting laterally. Their outer form is almost quadrangular, although they are usually bifurcating plates. They abut laterally, closing the interradial spaces (except at the anal side) by which they appear as if a part of the calyx.

There are generally two arms to each ray or ten to the individual; sometimes only five, as in *Eupachycrinus simplex* Trautschold. They are strong, scarcely diminishing in size to the extremities, and rounded on the outside. They are variously constructed, either of a single or double series of plates, the former being either short, transverse with straight lines, or cuneiform, becoming by degrees alternately arranged and interlocking. Ambulacral groove wide and deep; Pinnules short and heavy.

Anal plates generally three, rarely one; succeeding plates forming part of the small ventral tube. The lower anal plate is largest, and sometimes attains, for a plate of this kind, unusual dimensions; it is quadrangular in outline, and rests obliquely between the posterior basal and right radial. The second plate, which is next in size and also large, is placed between the first anal and left radial, and above the basal. The third anal is much swollen, and only the lower half of it is included in the calyx. All succeeding plates, which are alternately arranged, decrease in size upward, and form so far as known a small ventral tube, which has been traced to the height of the fourth or fifth arm plate, where it is composed of small, very delicate, hexagonal plates. The anal plates and lower portion of the tube are slightly protuberant, and give to the calyx a somewhat unsymmetrical aspect. In species with a single anal plate in the calyx, which, so far as observed, are altogether confined to the upper Coal measures, the plate is comparatively small, and rests upon the posterior basal and between the adjoining radials. There can be no doubt that this plate is the homologue of the second anal of other species, with which it closely agrees in form and position; and that the first anal plate is here absent, while the third is included in the ventral tube.

Column round and small.

The upper margin of the radials is provided with a rather prominent, narrow, articulating process, occupying the full width of the plate, corresponding to a similar process opposite on the succeeding brachial. A slit-like opening occupies the middle of it to nearly one-third of its length, which penetrates the plates and evidently contained the muscular apparatus. A similar structure is observed between the brachial and the first arm plates. Such linear processes were well adapted to facilitate the opening and closing of the arms. We may further state that in all species the lower portions of the brachials are pushed inward and the plates incline outward, owing to the position of the hinge lines which are close to the inner edge of the margin of the radial, and at the outer edge of the brachial; the outer edge of the margin of the radial is bevelled. By this structure, which gives to the Crinoids of this genus their peculiar subglobose form, the ponderous arms obtained an important support; for when open, the tumid or spiniferous brachials rested firmly upon the protuberant radials, and this explains fully the office of the brachial spines in this and all similar genera. A similar articulation exists between the brachials and arm plates, and also here the sutures are widely gaping.

Geological position, etc.—The genus is known only from the uppermost part of the Subcarboniferous and the Coal measures, reaching its culmination in the latter. It is found both in Europe and America, from Utah to Central Russia.

We recognize the following species:—

1875. **Eupachycrinus Bassetti** Worthen. Geol. Rep. Ill., vol. vi. p. 528, pl. 32, fig. 2. Coal measures. Illinois.

1870. **Eupachycr. Boydii** Meek & Worthen. Proc. Acad. Nat. Sci. Phila., p. 30. Geol. Rep. Ill., vol. v. p. 554, pl. 21, fig. 6. Chester limest. Subcarb. Chester, Ill.

1875. **Eupachycr. Craigii** Worthen. Geol. Rep. Ill., vol. vi. p. 527, pl. 32, fig. 1. Upper Coal measures. Illinois and Iowa.

Syn. Poteriocr. hemisphæricus, Shumard. 1858. Trans. St. Louis Acad. Sci., vol. i. p. 221; also *Scaphiocr. (?) hemisphericus* Meek, 1872. Final Rep. on Nebraska, p. 147, pl. 5, fig. 1. Geol. Rep. Ill., p. 561, pl. 24, fig. 5.

*1870. **Eupachycr. crassus** Meek & Worthen (**Cyathocr. (?)crassus**). Proc. Acad. Nat. Sci. Phila., p. 392. *Zeacr. (?)crassus*, 1866. Geol. Rep. Ill., vol. ii. pl. 26, figs. 2 a, b. Lower Coal measures. Fulton Co., Ill.

1873. **Eupachycr. Fayettensis** Worthen. Geol. Rep. Ill., vol. v. p. 565, pl. 24, fig. 10. Upper Coal measures. Illinois.

*1873. **Eupachycr. formosus** Worthen (**Zeacr. formosus**). Geol. Rep. Ill., vol. v. p. 549, pl. 21, fig. 2. Chester limest. Subcarb. Chester, Ill.

*1867. **Eupachycr. geminatus** Trautschold (**Cromyocr. geminatus**). Crin. jüng. Bergkalkes, p. 25, pl. 4, fig. 6 (not 7 and 8); 1879, Kalkbrüche von Mjatschkowa, p. 120, pl. 14, figs. 5, 6. Upper Subcarboniferous. Near Moscow, Russia.

*1858. **Eupachycr. globularis** De Koninck (**Hydeionocr. (?)globularis**). Bull. Acad. Royale Belg., pt. ii. p. 21, pl. 2, figs. 1–4. Carboniferous. Near Glasgow, Scotland.

*1861. (?)**Eupachycr. orbicularis** Hall (**Scaphiocr. orbicularis**). Bost. Journ. Nat. Hist., p. 311. Keokuk limest. Subcarb. Keokuk, Iowa.

*1879. **Eupachycr. ornatus** Trautschold (**Cromyocr. ornatus**). Kalkbrüche von Mjatschkowa, p. 121, pl. 14, figs. 9, 10. Upper Subcarb. Near Moscow, Russia.

Figured in "Crin. jüng. Bergkalk., pl. 4, figs. 7 and 8," under *C. geminatus.*

1876. (?)**Eupachycr. platybasalis** White. Geol. Unita Mount., p. 108. Lower Aubrey Gr. Utah.

This species is imperfectly known, and very likely belongs to *Hydreionocrinus.*

1857. **Eupachycr. quatuor decimbrachialis** Lyon. Type of this genus. (**Graphiocr. quatuor decimbrachialis**) Geol. Rep. Kentucky, vol. iii. p. 477, pl. 1, figs. 2 a, b. Coal measures. Crittenden Co., Kentucky.

Syn. Cyathocrinus (?)pentalobus, Hall, 1858. Geol. Rep. Iowa, vol. i. pt. ii. p. 687, pl. 25, figs. 5 a, b.

*1861. **Eupachycr. Sangamonensis** Meek & Worthen. (**Cyathocr. (?) Sangamonensis**) Proc. Acad. Nat. Sci. Phila., p. 392. Geol. Rep. Ill., vol. ii. p. 310, pl. 26, fig. 1 a, b. Upper Coal measures. Sangamon Co., Ill.

This species agrees very well with *Eup. globularis*, and with Trautschold's Russian species in the higher and more globose form of the calyx, as in the large size of the underbasals, which are the only characters upon which a separation under *Cromyocrinus* might be based; but in that case what shall be done with *Eup. crassus*, which has the same form and very small underbasals?

*1867. **Eupachycr. simplex** Trautschold. (**Cromyocr. simplex**) Crin. jüng. Bergkalk, p. 19, pl. 3, figs. 1-4; also 1879. Kalkbrüche von Mjatschkowa, p. 117, pl. 14, figs. 6-8. *Cupressocr. nuciformis* Goldfuss. Oryctographia b. Fisher, p. 151, pl. 41, figs. 5, 6; Fisher, *Poteriocr. nuciformis* Lethaea Rossica i., p. 588; also Quenstadt. Petref. Deutschland, iv. p. 543, pl. 109, fig. 6. Upper Subcarb. Near Moscow, Russia.

The small specimens which Trautschold has figured, and considered to be the young of *Cromyocr. simplex*, represent a very distinct species. In a specimen which we recently obtained from Prof. Zittel, the brachials in two rays are preserved, and show plainly that they are bifurcating plates, while *Cr. simplex* has but five arms. The specimen was labelled *Zeacrinus new sp.* We agree with Prof. Zittel that the calyx resembles that genus closely, but we doubt if it has more than ten arms. The length of the brachials and their form point rather to *Poteriocrinus* (*Scytalocrinus*), from which it differs in the shortness of the calyx. It evidently must be arranged with *Pot.* (*Scytalocrinus*)? *maniformis*, or as a transition form of *Eupachycrinus*.

*1867. **Eupachycr. subtumidus** Worthen. (**Zeacr. subtumidus**). Geol. Rep. Ill., vol. v. p. 548, pl. 21, fig. 1. Chester limest. Subcarb. Pope Co., Ill.

1865. **Eupachycr. tuberculatus** Meek & Worthen. (**Erisocr. tuberculatus**) Proc. Acad. Nat. Sci. Phila., p. 150. Geol. Rep. Ill., vol. ii. p. 319. Upper Coal measures. Illinois and Iowa.

*1867. **Eupachycr. verrucosus** White. (**Hydreionocr. (?)verrucosus**). Trans. Chic. Acad. Sci., p. 117. Upper Coal measures. Western Iowa.

20. ERISOCRINUS Meek & Worthen.

1864. A Crinoid near *Encrinus moniliformis.* Marcou. Bull. Geol. Soc., France.

1865, March. *Erisocrinus* M. & W. Am. Journ. Sci., 2d ser. vol. xxix. p. 174.

1865, May. *Philocrinus* M. & W. *Ibid.* (not De Koninck, 1863).

1865, August. *Erisocrinus* M. & W. Proc. Acad. Nat. Sci. Phila., p. 149.

A. Typical form.

Comparing the Crinoidal fauna of our Western States and territories, as we find it toward the close of the Carboniferous, with that of the same geological age in Central Russia, it is surprising to find the same generic forms surviving in both countries.

This has been already seen as to *Poteriocrinus* and *Eupachycrinus*, and will be still further proved in *Stemmatocrinus*, which we consider to be the Russian representative of the American genus *Erisocrinus*, although we are obliged to separate them subgenerically. Trautschold describes his genus *Stemmatocrinus* with a single subbasal plate, while in *Erisocrinus* the pelvis is distinctly divided into five pieces. We also observe a difference in the construction of the arms, which in the former are composed of a double series of interlocking plates, while in the two species of *Erisocrinus*, in which the arms have been found, they are composed of single transverse plates. Both species, however, are from the Burlington limestone, and are very small, and it is extremely probable, from analogy with contemporaries, that the arms in the species from the Coal measures, where the genus flourished more abundantly, were, as in *Stemmatocrinus*, composed of interlocking pieces, and that the Burlington species represent the young form. This would make the difference in the underbasals the only visible distinction.

Meek & Worthen, after publishing the description of *Erisocrinus*, were led by its similarity to a genus described by De Koninck under the name *Philocrinus*, from the Subcarboniferous rocks of India, to believe it identical therewith, and ranged their species under it accordingly. Later comparisons, however, led them to reconsider this. They assert that if *Philocrinus* has no subradial plates, then the two genera are clearly distinct; but, if small plates should be discovered within the plates now called basals, they are probably identical. We have never seen specimens, nor even De Koninck's description of *Philocrinus*, and are unable to express any opinion in the matter.

Generic Diagnosis.—Calyx saucer- to cup-shaped; symmetry strictly equilateral. General aspect similar to that of the two preceding genera.

Underbasals very small, forming a pentagonal, flattened, or concave disc or low cup. Basals large, uniformly hexagonal. Radials considerably larger than the basals, pentagonal, much wider than high, upper sides straight. There being no anals, the plates of each order or of each successive ring are of equal size and like form, and alternate regularly with those of successive rows. Brachials one by five, similar in form to the radials, but the lower margins are straight and the upper obtusely angular for the support of the arms. The brachials abut laterally, leaving no space for interradial or anal plates; the hinge line constructed as in *Eupachycrinus*.

Arms two to each ray, strong, and, so far as yet observed, composed of a single series of transversely oblong pieces.

Column round or obscurely pentagonal.

Geological position, etc.—The typical form of this genus has been found only in America, where it is restricted to the Burlington limestone and Coal measures. The two Burlington species are among the rarest Crinoids of that locality, and in the Coal measures perfect calyces are rare, though fragmentary pieces have been found in some localities in great abundance.

The following species are known:—

1869. **Erisocrinus antiquus** Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 71; Geol. Rep. Ill., vol. v. p. 447, pl. 2, fig. 3. Lower Burlington limestone. Subcarb. Burlington, Iowa.

1865. **Erisocr. conoideus** Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 150; Geol. Rep. Ill., vol. ii. p. 318. Upper Coal Measures. Springfield, Ill.

1865. **Erisocr. typus** Meek and Worthen. Type of the genus. Am. Jour. Sci., 2d ser. vol. xxix p. 174; Geol. Rep. Ill., vol. ii. p. 319; *ibid.* vol. v. pl. 24, fig. 6. Upper Coal Measures. Springfield, Ill.

Syn. Philocrinus pelvis M. and W. Am. Jour. Sci., 1866, p. 350.

Syn. Erisocrinus Nebrascensis M. and W. Am. Jour. Sci. 1865, p. 174.

1869. **Erisocr. Whitei** Meek and Worthen. Proc. Acad. Nat. Sci. Phil., p. 72; Geol. Rep. Ill., vol. v. p. 448, pl. 2, fig. 2. Upper Burlington limestone. Burlington, Iowa.

B. Subgenus STEMMATOCRINUS Trautschold.

1867. Crin. d. jüngeren Bergkalkes b. Moskau, p. 28.

1879. Kalkbrüche von Mjatschkowa, p. 125.

Calyx low cup-shaped, truncate below; symmetry equilateral; all the plates of the calyx regularly alternating.

Underbasals represented by a flat disc, which is undivided, regularly pentagonal, and extending considerably beyond the periphery of the column. Basals pentagonal, abruptly bending upward, the lower portion included in the truncate surface, the upper almost vertical. Radials pentangular, twice as wide as high, articulating lines straight and extending the full width of the plate. Brachials one by five, pentagonal, of similar form with the radials; the upper margin obtusely angular, its sloping sides excavated to receive the arms.

First arm plate simple, comparatively large, lower face rounded.

It is succeeded by two rows of regular interlocking plates. The arms are very heavy, rounded on the outside, continuing of the same size to near the top, where they taper to a sharp point. The articulation between the radial and brachial plates is on the same principle as in *Eupachycrinus*. There is a narrow single line across the entire width of the plate, and the outer edges of both plates adjoining it are so strongly bevelled in the typical species, that if the arms were open, nearly one-half of the brachials would rest upon, and be supported by the sloping face of the radials. Column round.

The total absence of anal plates in this and the preceding section of the genus, distinguishes it readily from any other of this family, but at the same time raises a reasonable doubt whether *Erisocrinus* and *Stemmatocrinus* possessed a solid ventral appendage, and, therefore, whether they belong to the Cyathocrinidæ, or even to the Palæocrinoidea. We have, so far, no knowledge whatever of the construction of the actinal or oral side of the body; whether it had an open mouth or was firmly closed by plates or scaly integument; and if it had not been for their marked resemblance to *Eupachycrinus* in which a ventral tube has been observed, and that both were representatives of the same geological age, living under the very same conditions, we should have felt strongly disposed to place the whole genus with *Encrinus*, with which it has, indeed, both in body and arms, the closest affinities. That *Erisocrinus* and *Stemmatocrinus* have only one brachial, and *Encrinus* two, is not material, and is, at the most, only of generic importance; but in *Encrinus* the aboral side of the body, or the plates which in all Cyathocrinidæ constitute the calyx, form almost a flat disc—at least do not extend beyond the basal plane—and this is the only important distinction which can be discovered between the two forms in the fossil state. This, however, may involve important structural modification in the internal anatomy of the animal, and probably shut out *Encrinus* entirely from the Palæocrinoidea.

Geological Position, etc.—*Stemmatocrinus* is only known from the limestone beds of Mjatschkowa, where Prof. Trautschold discovered the only species.

1867. **Stemmatocrinus cernuus** Trautsch. Bulletin d. l. Soc. d. Nat. de Moscou, 1867; also Monogr. d. Kalkbr. v. Mjatschkowa, 1879, p. 125, pl. 14, fig. 12. Upper part of Subcarbon., near Moscow, Russia.

21. (?) EUSPIROCRINUS Angelin.

1878. Iconogr. Crinoid., Suec. p. 24.

General form, including arms, short subcylindrical. Calyx cyathiform, unsymmetrical.

Underbasals five, subequal. Basals five, four of them with acute upper angles; the fifth heptagonal, the upper angle being truncate to meet the second anal, its left upper side resting against the adjoining first radial, the oblique right side against the first anal plate. Radials large, sublunular. Brachials two, wide, very short.

Arms dichotomizing, and on becoming free coiled up spirally inward.

Anal area wide, plates large, alternately arranged as in *Poteriocrinus*. Ventral tube rather slender, and composed of but few exceedingly large plates.

Vault constructed of five large oral plates; the ambulacral furrows, which divide within the disc for the two main divisions of each ray, covered by alternating pieces; the median part of the dome closed by rather large apical dome plates.

Column short, composed of alternately larger and smaller joints; central canal moderately large.

We place the genus *Euspirocrinus* by itself, as it differs from all other Cyathocrinidæ in its peculiar arm structure, in which it somewhat resembles *Edriocrinus* Hall, and the recent genus *Holopus* D'Orb. It also differs in the construction of the ventral sac, which appears like the proboscis of the Actinocrinidæ, except that in *Euspiocrinus* the inner cavity is large. Pores have not been observed.

The only known species is,

1878. **Euspirocrinus spiralis** Angelin. Iconogr. Crin. Suec., p. 24, pl. 4, fig. 7 a–e. Upper Siluria. Gotland, Sweden.

22. CARABOCRINUS Billings.

1856. Geol. Surv. Canada, p. 275.
1859. Ibid., Decade iv. p. 30.

Carabocrinus and the three following genera are imperfectly known, and placed here with some doubt; better specimens must be discovered before it can be decided whether they are good genera.

Carabocrinus, in our opinion, is founded upon a malformed or recuperated *Cyathocrinus*. A comparison of the two genera will show that on the anterior side they are perfectly identical; they also agree most remarkably in the form of the calyx, the construction of the oral side, the delicacy of the arms, and their mode of branching. The only difference is said to be in the construction of the anal area, which, according to Billings, is composed of three plates, the lower one resting upon the underbasals, which is in itself an anomaly such as is found in no other genus. But, further, if Billings's interpretation of the plates in question be correct, the anal area in *Carabocrinus* would be directed toward the left side of the specimen, which would be the only exception among the Palæocrinoidea, and there exists in no other group of them a basal (subradial of Billings) which is neither radial nor interradial, and which is disconnected from the radials, as would be the case in this genus. (See Billings's Diagram, Dec. iv. p. 30, and pl. 2, fig. 3 c.) In this specimen, which is the only example in which the anal area has been observed, the small and abnormal so-called subradial and the two anal plates of Billings combined, have almost the form of one of the other basals (subradials) and are but slightly larger, and we think that in the specimen they originally formed a single plate, which was accidentally broken during the life of the animal and afterwards recuperated, leaving marks of fracture which Billings took to be sutures between the plates. Similar cases are frequently met with among fossil crinoids, plates being sometimes broken into a dozen or more pieces, which afterwards reunite, each piece retaining the appearance of a true plate.

Geological position, etc.—Billings recognizes the following species:—

1856. **Carabocrinus radiatus** Billings. Type of the genus, and the only species and specimen in which the anal area has been seen. Geol. Surv. Canada, p. 276; Decade iv. p. 31, pl. 2, fig. 3 a–c. Trenton Limestone, Lower Sil. Ottawa, Canada.

1859. **Carabocr. (?) tuberculatus** Billings. Geol. Surv. Can., Dec. iv. p. 33, pl. 10, figs. 2 a–c. Hudson River Gr. Lower Sil. Anticosti.

1859. **Carabocr. van cortlandti** Billings. Geol. Surv. Can., Dec. iv. p. 32, pl. 2, fig. 4. Trenton Limestone, Lower Sil. Township of McNab, Canada.

23. (?) CYRTIDOCRINUS Angelin.

1878. Iconogr. Crin. Suec., p. 20.

This genus is not only very imperfectly known—a single calyx only having been thus far discovered—but it also deviates so materially from all other Cyathocrinidæ, that we doubt whether it can be properly classed with that family. According to Angelin it has four underbasals, which are small and unequal in size. Basals five, pentagonal or hexagonal. A single anal plate is intercalated between two basals and two radials. Radials five-sided, oblique, clypeiform.

1878. **Cyrtidocrinus facietatus** Angelin. Iconogr. Crin. Suec., p. 20, pl. 21, figs. 13, 14, 14 a. Upper Silur. Gotland, Sweden.

24. (?) PACHYOCRINUS Billings.

1859. Geol. Surv. Canada, Dec. iv. p. 22. (Not *Pachycrinus* Eichwald.)

In the single specimen to which Billings applied the above name, there are five pentagonal plates concealed within the cavity for the attachment of the column, and above and alternating with them five very large, thick plates, which may be either basals or radials. The lower portions of these plates are bent under the body, so as to constitute a broad, rounded, or concave bottom to the cup, which has a width of nine lines at a height of two. At this level the cup is broken off in the specimen.

Billings refers to this genus:—

1859. **Pachyocrinus crassibrachialis** Billings. Geol. Surv. Can., Dec. iv. p. 22, pl. 1, figs. 1 a, b. Chazy Limest. Montreal, Canada.

25. (?) MYELODACTYLUS Hall.

1851. Geol. Rep. New York, Pal., vol. ii. p. 191.
1878. Angelin, Iconogr. Crin. Suec. p. 11.

(*Herpetocrinus* Salter, 1873, Cab. Mus. Camb., p. 118 is synonymous with *Myelodactylus*, according to Angelin.)

Hall proposed the above generic name to characterize some most remarkable fragments, apparently arm pieces of Crinoids, in which, according to his description, "the foramen or medullury canal penetrates the column of joints." No other portion of the animal was known to him.

Angelin, for reasons unknown to us, referred to this genus three species, and gave the following generic descriptions, "General form of the body narrow, elongate; calyx cup-shaped. Basals three; parabasals five, polygonal. Primary radials one, forming a single zone; secondary radials in two series, the upper ones triangular and arm bearing. Interradials (probably anals) two. Arms long, threadlike, dichotomizing several times, composed of single joints. Ventral tube distinct, articulated. Column strong, convoluted, composed of thin joints with numerous articulated cirrhi." He places this genus under his division "Trimera" (along with *Taxocrinus* and *Gissocrinus*), among the Taxocrinidæ.

Comparing Angelin's figures, we find that only his *M. heterocrinus* agrees with the description. His *M. gracilis* has five primary radials, or, as we should say, four brachials; his *M.* (?) *interradialis* three to four, and, contrary to the rule in all Cyathocrinidæ, a number of interradial plates. None of the species, however, exhibit the peculiar arm structure upon which Hall founded the genus; but, on the contrary, the two first-named species at least seem to be devoid of pinnulæ. Angelin figures—pl. 10, fig. 25—an isolated convoluted column with numerous cirrhi, which is said to belong to *M. gracilis*, and it seems that the superficial resemblance of this column to the so-called arms of *Myelodactylus* induced Angelin to adopt Hall's name for his species. We cannot see any propriety in founding genera or species upon mere fragments of arms or column, especially in a case like this, where we are by no means satisfied that Hall's figure represents the column, but rather believe, with him, that they are most probably portions of arms. We have here placed *Myelodactylus* provisionally under the Cyathocrinidæ, because Angelin's first two species undoubtedly belong to that family, though probably to different genera. His *M.* (?) *interradialis*, however, is a representative of an altogether different family. They all differ from the Ichthyocrinidæ in the large underbasals, in the free plates above the first radials, the threadlike arms, and the general physiognomy. So far as we know, the species agree with no established genus, but the figures without descriptions are not sufficient for us to found new genera upon.

Hall places here the following species:—

1851. **Myelodactylus brachiatus** Hall. Geol. Surv. N. Y., Pal., vol. ii. p. 232, pl. 45, fig. 7. Niagara Gr. Upper Sil. Near Lockport, N. Y.

1851. **Myelodactylus convolutus** . Geol. Surv., N. Y., Pal., vol. ii. p. 191, pl. 42, figs. 5 a, b, and 6 a–h. Niagara Gr. Upper Sil. Lockport, N. Y.

Angelin's species are the following:—

1878. **Myelodactylus gracilis** Angl. Iconogr. Crin. Suec., p. 11, pl. 10, figs. 28. Upper Silur. Gotland, Sweden.

1878. **Myelodactylus heterocrinus,** Angl. Iconogr. Crin. Suec., p. 11, pl. 10, figs. 24, 25. Upper Silur. Gotland, Sweden.

1878. **Myelodactylus** (?) **interradialis** Angl. Iconogr. Crin. Suec., p. 11, pl. 10, figs. 26, 27. Upper Silur. Gotland, Sweden.

LIST OF SYNONYMS, CORRECTIONS, AND IMPERFECTLY DEFINED SPECIES.

Actinocrinus Miller.

A. arthriticus, Phill., see *Gissocr. arthriticus.*

Adelocrinus Phillips, founded upon fragments of column.

A. hystrix Phill., founded upon fragments of column.

Ataxocrinus Lyon, syn. of *Anomalocr.* M. & W.

Bactocrinites fusiformis Schnur., see *Homocrin. fusiformis.*

Bærocrinus Volborth, syn. of *Hybocrinus* (Zittel).

Barycrinus Wachsmuth.

B. Lyoni (Hall's sp.), see *Vasocr. Lyoni.*

Cladocrinus Austin (not Agassiz), see *Taxocrinus.*

C. brevidactylus Aust. see *Taxocr. brevidactylus.*

C. pentagonus Aust., see *Poteriocr. pentagonus.*

Cleiocrinus Billings

C. grandis Bill., founded on fragments of column.

C. magnificus Bill., founded on fragments of column.

Clidochirus Angl., var. of *Calpiocrinus* Angl.

Cromyocrinus Trautschold, syn. of *Eupachycrinus* M. & W.

C. geminatus Trautsch., see *Eupachycr. geminatus.*

C. ornatus Trautsch., see *Eupachycr. ornatus.*

C. simplex Trautsch., see *Eupachycr. simplex.*

Cupulocrinus d'Orbigny, syn. of *Taxocrinus.*

Cupressocrinus, Goldf.

C. nuciformis Goldf., see *Eupachycr. simplex.*

Cyathocrinus Miller.

C. abbreviatus Miller, insufficiently defined.

C. angulatus M. & W., see *Barycr. angulatus.*

C. arthriticus Phill., see *Gissocr. arthriticus.*

C. bulbosus Hall, see *Arachnocr. bulbosus.*

C. bullatus Hall, see *Barycr. bullatus.*

C. conglobatus Troost. Catalogue name.

C. cornutus O. & Shum., see *Barycr. cornutus.*
C. corrugatus (?) Troost. Catalogue name.
C. crassibrachiatus Hall, see *Barycr. crassibrachiatus.*
C. crassus M. & W., see *Eupachycr. crassus.*
C. crateriformis ? Catalogue name.
C. decadactylus Lyon & C., *Pot. (Scytalocr.) grandis.*
C. decaphyllus Ad. Roemer, founded on fragments of column.
C. depressus Troost. Catalogue name.
C. distans Phill., founded on fragments of column.
C. divaricatus Hall, see *Cyathocr. Iowensis.*
C. dubius Münster, not distinctly defined.
C. ellipticus Phill., founded on fragments of column.
C. exilis Eichw., founded on fragments of column.
C. florealis O. & Shum., see *Zeacr. florealis.*
C. forcolatus, Eichw., founded on fragments of column.
C. globosus Troost. Catalogue name.
C. Gosæ Ad. Roemer, imperfect specimen.
C. gracilis Troost. Catalogue name.
C. gracilior F. Roemer, *Poteriocr. gracilior.*
C. granulatus Angl., see *Arachnocr. granulatus.*
C. granuliferus Shum. 1852. We have not seen the description.
C. hexadactylus Lyon, *see Vasocr. Lyoni.*
C. Hoveyi Hall, see *Barycr. Hoveyi.*
C. inequidactylus McCoy, see *Poteriocr. inequidactylus.*
C. inflatus Troost. Catalogue name.
C. interbrachiatus Angl., see *Gnorimocr. Loveni* W. & Spr.
C. intermedius Hall, see *Pot. (Parisocr.) intermedius.*
C. Kelloggi White, see *Barycr. Kelloggi.*
C. læviculus Lyon, see *Poteriocr. læviculus.*
C. latus Hall, see *Barycr. sculptilis.*
C. Lyoni Hall, see *Vasocr. Lyoni.*
C. macrocheirus McCoy, see *Poteriocr. macrocheirus.*
C. macrodactylus Phill., see *Taxocr. macrodactylus.*
C. macropleurus Hall, see *Vasocr. macropleurus.*
C. magister Hall, see *Barycr. magister.*
C. magnoliæformis Norw. & Ow., see *Zeacr. magnoliæformis.*
C. malvaceus Hall, see *Cyathocr. Iowensis.*
C. megastylus Phill. Fragments of column.
C. nodulosus Phill. Fragments of column.
C. ornatus Phill., perhaps *Platycrinus ?*
C. penniger De Vern. Not seen description.
C. pentalobus Hall, see *Eupachycr. quatuordecimbrachiatus.*
C. pinnatus Goldf. Cluster of arms of some other genus.
C. pinnatus Bronn. Not seen description.
C. protuberans Hall, see *Barycr. bullatus.*
C. pusillus Hall, see *Lecanocr. pusillus.*
C. pyriformis Phill., see *Ichthyocr. pyriformis.*
C. quinquangularis Miller, see *Pot. (Parisocr.) quinquangularis.*
C. quinquelobus M. & W., see *Barycr. stellatus.*
C. rarus Lyon. Too imperfect for identification.

C. *Rhenanus* F. Roemer, see *Taxocr. Rhenanus.*
C. *robustus* Troost. Catalogue name.
C. *Roemeri* Troost. Catalogue name.
C. *rugosus* Miller (not Goldf.), is *Crotalocr. rugosus.*
C. *Sangamonensis* M. & W., see *Eupachycr. Sangamonensis.*
C. *scitulus* M. & W., see *Barycr. sculptilis.*
C. *sculptilis* Hall, see *Barycr. sculptilis.*
C. *sculptus* Troost. Catalogue name.
C. *sculptus* Lyon, see *Vasocr. sculptus.*
C. *solidus* Hall see *Barycr. solidus.*
C. *spurius* Hall, see *Barycr. spurius.*
C. *stellatus* Hall, see *Barycr. stellatus.*
C. *subtumidus* M. & W., see *Barycr. subtumidus.*
C. *Tennesseeus* Troost. Catalogue name.
C. *tenuiradiatus* Lyon. Insufficiently defined.
C. *tesseracontadactylus* Salter, *Pionocr. tesseracontadactylus.*
C. *thomæ* Hall, see *Barycr. thomæ.*
C. *tricarinatus* Ad. Roemer. Fragments of column.
C. *tuberculatus* Miller, see *Taxocr. tuberculatus.*
C. *tumidus* Hall, see *Barycr. tumidus.*
C. *valens* Lyon, see *Vasocr. valens.*
C. *variabilis* Phill. Fragments of column.
C. *viminalis* Hall, syn. of *Cyathocr. Iowensis.*
C. *Wachsmuthi* M. & W., see *Barycr. Wachsmuthi.*
C. *Wortheni* Lyon, see *Poteriocr. Wortheni.*

E isocrinus Meek & Worthen.

E. *tuberculatus* M. & W., see *Eupachycr. tuberculatus.*

Euryalecrinus Austin, syn. of *Taxocrinus.*

Euryocrinus Phill., see *Ichthyocrinus.*

Forbesiocrinus De Kon. & Leh.

F. *asteriæformis* Hall, see *Onychocr. asteriæformis.*
F. *divaricatus* Angl., see *Lithocr. divaricatus.*
F. *Giddingei* Hall, see *Taxocr. Giddingei.*
F. *gracilis* Schultze, see *Rhopalocr. gracilis.*
F. *juvenis* Hall, see *Taxocr. juvenis.*
F. *Kelloggi* Hall, see *Taxocr. Kelloggi.*
F. *lobatus* Hall. see *Taxocr. lobatus.*
F. *lobatus* (var.) *tardus* see *Taxocr. lobatus* (var.) *tardus.*
F. *Meeki* Hall, see *Taxocr. Meeki.*
F *Milleri* Angl., see *Lithocr. Milleri.*
F. *Monroensis* M. & W , see *Onychocr. Monroensis.*
F. *multibrachiatus* Lyon & C., see *Taxocr. multibrachiatus.*
F. *Norwoodii* M. & W., syn. of *Onychocr. exsculptus*, L. & C.
F. *nuntius* Hall, see *Taxocr. nuntius.*
F. *obesus* Angl., see *Lithocr. obesus.*
F. *ramulosus* Lyon & C. (not Hall), see *Onychocr. ramulosus.*
F. *ramulosus* Hall (not L. & C.), see *Taxocr. ramulosus.*
F. *robustus* Angl., see *Lithocr. robustus.*
F. *spinifer* Hall, syn. for *Taxocr. Thiemei.*

F. Shumardianus Hall, see *Taxocr. Shumardianus.*
F. Thiemei Hall, see *Taxocr. Thiemei.*
F. Whitfieldi Hall, see *Taxocr. Whitfieldi.*

Grammocrinus Eichwald. Founded on fragments of column.

G. lineatus Eichw. Columns.
G. clathratus Eichw. Columns.

Graphiocrinus De Kon. & Leh.

G. dactylus Hall, see *Pot. (Scytalocr.) dactylus.*
G. quatuordecimbrachiatus Lyon, see *Eupachycr. quatuordecimbrachiatus.*

Herpetocrinus Salter, see *Myelodactylus.*

Heterocrinus Hall.

H. canadensis Bill., syn. of *Heterocr. simplex* Hall.
H. crassus M. & W., *Iocr. crassus.*
H. gracilis Hall. Pieces of column.
H. incurvus M. & W., see *Anomalocr. incurvus.*
H. polyxo Hall, syn. of *Iocr. subcrassus.*
H. subcrassus M. & W., *see Iocr. subcrassus.*

Homocrinus Hall.

H. angustatus M. & W., see *Dendrocr. angustatus.*
H. polydactylus Shum. *Dendrocr. polydactylus.*

Hybocrinus Billings.

H. incurvus M. & W., see *Anomalocr. incurvus.*

Hydreionocrinus De Koninck.

H. globularis De Kon., see *Eupachycr. globularis.*
H. verrucosus White, see *Eupachycr. verrucosus.*

Hydriocrinus Trautschold, syn. of *Scaphiocrinus.*

H. pusillus, see *Scaphiocr. pusillus.*

Ichthyocrinus Conrad.

I. lævis Angl. (not Conr.), see *Ichthyocr. Gotlandicus.*
I. tesseracontadactylus D'Orb., see *Pionocr. tesseracontadactylus.*

Isocrinus Phill. (not Von Meyer), see *Taxocrinus.*

Lecanocrinus Hall.

L. elegans Bill. Perhaps *Taxocrinus?*
L. lævis Bill. Too imperfect for identification.
L. macropetalus Angl. (not Hall), see *Anisocr. Angelini.*
L. simplex Hall, see *Ichthyocr. simplex.*

Lecythocrinus Joh. Müller, see *Lecythocrinus* Zittel.

L. eifelensis Müll., see *Lecythocr. briareus* Schultze.

Pachycrinus Eichwald. Fragments of column.

P. notatus Eichw. Fragments of column.

Palæocrinus Billings, syn. for *Cyathocrinus.*

P. angulatus Bill., see *Cyathocr. angulatus.*

P. pulchellus Bill., see *Cyathocr. pulchellus.*
P. rhombiferus Bill., see *Cyathocr. rhombiferus.*
P. striatus Bill., see *Cyathocr. striatus.*

Phialocrinus Eichw. (not Trautsch.). Fragments of column.

P. impressus Eichw. Fragments of column.

Phialocrinus Trautsch. (not Eichw.), subgenus of *Graphiocrinus.*

P. urna Trautsch., see *Poteriocr.* (*Scytalocr.*) *urna.*

Philocrinus De Kon.

P. pelvis M. & W., see *Erisocr. typus*, M. & W.

Poteriocrinus Miller.

P. abbreviatus Aust., see *Taxocr. brevidactylus.*
P. alternatus Hall, see *Dendrocr. alternatus.*
P. Barrisi Hall, see *Cyathocr. Barrisi.*
P. bursæformis White., see *Zeacr. bursæformis.*
P. caduceus Hall, see *Dendrocr. caduceus.*
P. calyx De Kon. & Leh., see *Hydreionocr. calyx.*
P. carinatus M. & W., see *Poteriocr.* (*Pachylocr.*) *liliiformis.*
P. casei Meek, see *Dendrocr. casei.*
P. Cincinnatiensis Meek, see *Dendrocr. Cincinnatiensis.*
P. concinnus M. & W.. see *Poteriocr.* (*Pachylocr.*) *concinnus.*
P. Coreyi Worthen, see *Poteriocr.* (*Scytalocr.*) *grandis.*
P. corycia Hall, see *Poteriocr.* (*Scaphiocr.*) *corycia.*
P. crassimanus Eichw. Fragments of column.
P. crateriformis Troost. Catalogue name.
P. cultidactylus Hall, see *Poteriocr.* (*Scaphiocr.*) *cultidactylus.*
P. cylindricus Hall, see *Homocr. cylindricus.*
P. dilatatus Hall (not Schultze), see *Cœliocr. dilatatus.*
P. dilatatus Schultze (not Hall), see *Vasocr. dilatatus.*
P. Dudleyensis Aust., see *Cyathocr. Dudleyensis.*
P. Dyeri Meek, see *Dendrocr. Dyeri.*
P. Egertoni Phill., see *Taxocr. Egertoni.*
P. enormis M. & W., see *Cyathocr. enormis.*
P. florealis Shum., see *Zeacr. florealis.*
P. fusiformis Hall (not Schultze), syn. of *Poteriocr.* (*Scytalocr.*) *macrodactylus.*
P. fusiformis Schultze (not Hall), see *Homocr. fusiformis.*
P geometricus Goldf., see *Cyathocr. geometricus.*
P. gracilis Hall (no McCoy), see *Dendrocr. gracilis.*
P. granulosus Phill., see *Hydreionocr. granulosus?*
P. hemisphericus Müller (not Shum.), syn. of *Cyathocr. geometricus.*
P. hemisphericus Shum. (not Müller), see *Eupachycr. Craigii.*
P. Hoveyi Worthen, syn. of *Poteriocr.* (*Scytalocr.*) *robustus*
P. impressus Richt. & Ung. (not Phill.) Imperfectly defined.
P. isacobus Aust., see *Poteriocr.* (*Scaphiocr.*) *isacobus.*
P. Keokuk Hall, see *Poteriocr.* (*Scaphiocr.*) *Keokuk.*
P. longidactylus Aust., 1843, *Poteriocr.* (*Scaphiocr.*) *longidactylus.*
P. longidactylus Shum. 1855, *Poteriocr* (*Scaphiocr*) *Missouriensis.*
P. longidactylus McChesn., 1859, syn. *Poteriocr.* (*Scytalocr.*) *decabrachiatus.*

P. McCoyanus De Kon. & Leh., see *Hydreionocr. McCoyanus* (?)
P. mespiliformis Richt. & Ung. Not sufficiently known.
P. Meekianus Shum., see *Cyathocr. Meekianus.*
P. multiplex Trautsch., see *Poteriocr (Scaphiocr) multiplex.*
P. municipalis Troost. Catalogue name.
P. nanus Roemer, see *Homocr. nanus*
P. nuciformis Fischer (Goldf.), see *Eupachycr. simplex.*
P. occidentalis O. & Shum., see *Agassizocr. occidentalis.*
P. parvus Hall, see *Homocr. parvus.*
P Phillipsianus De Kon. & Leh., see *Hydreionocr. Phillipsianus.*
P pisiformis Roemer, see *Arachnocr. pisiformis.*
P. posticus Hall, see *Dendrocr. posticus.*
P. proboscidialis Worthen, see *Poteriocr. (Scaphiocr.) proboscidialis.*
P. Rhenanus Wirtg. & Zeiler, see *Taxocr. Rhenanus.*
P. rhombiferus O. & Shum., see *Barycr. rhombiferus.*
P. solidus M. & W., syn. of *Poteriocr. (Scaphiocr) æqualis.*
P. spinosus O. & Shum., see *Poteriocr. (Scaph.) spinosus.*
P. subgracilis D'Orb., see *Dendrocr. gracilis.*
P. subimpressus M. & W., see *Poteriocr. (Scaphiocr.) subimpressus.*
P. Swallovi M. & W., see *Poteriocr. (Scaphiocr.) swallovi.*
P. tenuidactylus M. & W., syn of *Poteriocr. (Scaphiocr.) tenuidactylus.*
P. tenuissimus Eichw. Fragments of column.
P. tumidus O. & Shum., see *Agassizocr. tumidus.*
P. varians Eichw. Fragments of column.
P. ventricosus Hall, see *Cœliocr. ventricosus.*
P. zeæformis Schultze. Not defined.

Scaphiocrinus Hall. A variety of *Poteriocrinus.*

S. abnormis Worthen, see *Poteriocr. (Scytalocr.) abnormis.*
S. ægina Hall, see *Poteriocr. (Decadocr.) aegina.*
S. æqualis Hall, 1861 (not 1859), see *Poteriocr. (Pachylocr.) subaequalis.*
S. Bayensis M. & W., see *Poteriocr. (Decadocr.) Bayensis.*
S. carinatus M & W. (not Hall), see *Poteriocr. (Pachylocr.) liliiformis.*
S. carbonarius M. & W., see *Graphiocr. carbonarius.*
S. decadactylus Worthen, see *Poteriocr. (Scytalocr.) grandis* W. & Spr.
S. depressus M. & W., see *Poteriocr. (Decadocr.) depressus.*
S. fiscellus M. & W., see *Poteriocr. (Decadocr.) fiscellus.*
S. Halli Hall, see *Poteriocr. (Decadocr.) Halli.*
S. hemisphericus Shum. (Meek), see *Eupachycr. Craigii.*
S. juvenis M. & W., see *Poteriocr. (Decadocr.) juvenis.*
S. longidactylus McChesn., see *Poteriocr. (Scytalocr.) decabrachiatus.*
S. lyriope Hall, see *Poteriocr. (Decadocr.) lyriope.*
S. macrodactylus M. & W., see *Poteriocr. (Scytalocr.) macrodactylus.*
S. macropleurus Hall, see *Vasocr. macropleurus.*
S. McAdamsi Worthen, see *Graphiocr. McAdamsi.*
S. notabilis M. & W., see *Poteriocr. notabilis.*
S. orbicularis Hall, *Eupachycr. orbicularis.*
S. rudis M. & W., see *Graphiocr. rudis.*
S. scalaris M. & W., see *Poteriocr. (Decadocr.) scalaris.*
S. simplex Hall, see *Graphiocr. simplex.*

S. spinobrachiatus Hall, see *Graphiocr. spinobrachiatus.*
S. striatus M. & W., see *Graphiocr. striatus.*
S. subtortuosus Hall, see *Poteriocr. (Decadocr.) subtortuosus.*
S. tortuosus Hall, *Graphiocr. tortuosus.*
S. Wachsmuthi M. & W., see *Graphiocr. Wachsmuthi.*
S. Whitei Hall, see *Poteriocr. Whitei.*

Sphærocrinus Roemer. A variety of *Cyathocrinus.*

Taxocrinus Phillips.

T. Austini Angl., see *Gnorimocr. Austini.*
T. briareus Schultze, see *Cyathocr. briareus.*
T. distensus Angl., see *Gnorimocr. distensus.*
T. excavatus Angl., see *Gnorimocr. excavatus.*
T. expansus Angl., see *Gnorimocr. expansus.*
T. interbrachiatus Angl., see *Gnorimocr. interbrachiatus.*
T. oblongus Angl., see *Gnorimocr. oblongus.*
T. ovalis Angl , see *Gnorimocr. ovalis.*
T. punctatus Angl.,, see *Gnorimocr. punctatus.*
T. polydactylus McCoy, see *Onychocr. polydactylus.*
T. rigens Angl., see *Gnorimocr. rigens.*
T. Salteri Angl., see *Gnorimocr. Salteri.*
T. simplex Salter, see *Pionocr. simplex.*
T. tesseracontadactylus d'Orb., see *Pionocr. tesseracontadactylus.*
T. tubuliferus Angl., see *Gnorimocr. tubuliferus.*

Zeacrinus Troost.

Z. arboreus Worthen, see *Poteriocr. (Pachylocr.) arboreus.*
Z. armiger M. & W., see *Hydreionocr. armiger.*
Z. asper M. & W., see *Poteriocr. (Pachylocr.) asper.*
Z. concinnus M. & W., see *Poteriocr. (Pachylocr.) concinnus.*
Z. depressus Troost., see *Hydreionocr. depressus.*
Z. discus M. & W., see *Hydreionocr. discus.*
Z. excavatus Schultze, see *Gnorimocr. excavatus.*
Z. formosus Worthen, see *Eupachycr. formosus.*
Z. lyra M. & W., see *Caliocr. lyra.*
Z. maniformis Hall, see *Poteriocr. (Scytalocr.) maniformis.*
Z. merope Hall, see *Poteriocr. (Pachylocr.) merope.*
Z. mucrospinus McChes., see *Hydreionocr. mucrospinus.*
Z. paternus Hall, see *Poteriocr. (Pachylocr.) paternus.*
Z. perangulatus White , see *Poteriocr. (Pachylocr.) perangulatus.*
Z. planobrachiatus M. & W., see *Poteriocr. (Pachylocr.) planobrachiatus.*
Z. sacculus White., syn. of *Zeacr. Troostanus.*
Z. scoparius Hall, see *Zeacr. Troostanus.*
Z. Stimpsoni Lyon, see *Poteriocr. (Decadocr.) Stimpsoni.*
Z. subtumidus Worthen, see *Eupachycr. subtumidus.*

EXPLANATION OF PLATE 15.

Letters referring to all figures on this plate: *u* = underbasals; *b* = basals; *r* = radials; r^1 = primary radials; r^2 = secondary radials; r^3 = tertiary radials; *p* = patelloid plates; *a* = arm plates; *i* = interradials; *d* = axillary plates; *an* = anal plates; *br* = brachial plates; *A* = anterior side; *P* = posterior side.

Fig. 1. Diagram of *Forbesiocrinus*, showing the fundamental arrangement of plates in the Ichthyocrinidæ.

Fig. 2. Diagram of *Taxocrinus*, showing, in connection with Fig. 1, the distinction in the anal side between this genus and *Forbesiocrinus*.

Fig. 3. Diagram of *Barycrinus*, showing the fundamental arrangement of plates in the Cyathocrinidæ.

Fig. 4. Apical plates in *Actinocrinus*.

Fig. 5. Apical plates in *Platycrinus*.

EXPLANATION OF PLATE 16.

Fig. 1. Diagram of *Anomalocrinus*.

Fig. 2. Diagram of *Heterocrinus*.

Fig. 3. Diagram of *Iocrinus*.

This and the following figures on this plate are given to show the development of the anal plates from one genus to another.

Fig. 4. Diagram of *Hybocrinus*.

Fig. 5. Diagram of *Dendrocrinus*.

Fig. 6. Diagram of *Homocrinus*.

Fig. 7. Diagram of *Poteriocrinus*.

Fig. 8. Diagram of *Cyathocrinus*.

EXPLANATION OF PLATE 17.

Fig. 1. Pentacrinoid larva of *Antedon rosacea*. (After Allman.) *s* = stem; *cd* = centrodorsal plate; *b* = basals; *r* = radials; *or* = oral plates.

Fig. 2. Ventral side of *Cyathocrinus*, showing the oral plates, the apical and radial dome plates being removed.

$\frac{d}{or}$ = oral plates—equivalent to *d* in Fig. 4.

Fig. 3. Ventral side of *Cupressocrinus*, showing the hydrospires; *h* = consolidating apparatus of European authors; *g* = openings which, from

their relative position, we suppose may be equivalents of the passage in the inner lancet pieces in *Pentremites*, designated as *l* in Fig. 5.

Fig. 4. Summit of *Pentremites*, showing the deltoid pieces and their appendages—hidden from view by the test in perfect specimens; *a* = anal opening; *h* = hydrospires; *o* = inner wall or floor of the passage (so-called ovarian openings) leading to the hydrospires; the outer wall, which is a part of the pseudambulacrum, having been removed from the specimen; *d* = the outer or visible portion of the deltoid pieces—equivalent to *d* in Fig. 2; *l* = plates lying directly below the lancet piece, with tubular passage running lengthwise through them (see *l* in Fig. 5); *b* = passage formed by the edges of two deltoid pieces and the inner lancet piece, externally covered by the pseudambulacrum—equivalent to the opening at the base of the arms in Paleocrinoids.

This figure is a representative of the structure of this portion of the Blastoid, as ascertained by examination of a number of specimens, some in which parts of the test have been removed, others in form of polished sections. It is based upon observation, not imagination, and this figure, in connection with No. 5, will, we hope, enable the reader to understand a construction always difficult to explain, and which is now, for the first time, correctly figured, as we believe. We have not attempted to illustrate the details upon which our figure is based, because our object at present is only to point out certain affinities between some forms of Palæocrinoidea and the Blastoidea.

Fig. 5. Cross section of *Pentremites pyriformis* Say (at one-half the height of the ambulacrum, one ray of the latter being removed).

f = the halves of the forked plate; *L* = lancet pieces; *l* = inner lancet pieces; *p* = pore pieces; *m* = ambulacral groove and food passage —covered in perfect specimens; *c* = pores on the ambulacral field.

Figs. 6, 7, 8. Hydrospires of *Caryocrinus ornatus*. 6. Surface view, showing the openings through the test. 7. Representing the course of the flat internal tubes. 8. Transverse section.

(Note.—The figures on this plate are more or less enlarged.)

NOVEMBER 11.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-two persons present.

The death of J. Aitken Meigs, M.D., a member, was announced.

The following papers were presented for publication:—

"Reply to Dr. M. C. Cook's criticism of paper on Variability of Sphæria Quercuum, Sz." By J. B. Ellis.

"On a collection of Crustacea from Virginia, North Carolina, and Florida, with a revision of the genera of Crangonidæ and Palæmonidæ." By J. S. Kingsley.

Correction to paper on Hyraceum.—Dr. A. J. Parker called attention to the fact that in the paper entitled "Note on Hyraceum," Proc. A. N. S. Philad. 1879, p. 12, sulphydric acid should be substituted for sulphuric acid in fifth line from the bottom of the page.

NOVEMBER 18.

Mr. MEEHAN, Vice-President, in the chair.

Twenty-three persons present.

A paper entitled "On the Stratigraphical Evidence afforded by the Tertiary Fossils of the Peninsula of Maryland." By Angelo Heilprin, was presented for publication.

On the Genus Garberia.—At the meeting of the Botanical Section, held on 10th inst., Mr. Redfield presented the following communication from Dr. ASA GRAY:—

"I wish to secure an opportunity which occurs to dedicate a genus of plants peculiar to Florida to Dr. A. P. Garber, of Pennsylvania, who has done such good botanical service in his recent faithful exploration of the southern portion of Florida. Among the rest, he has rediscovered the interesting plant which will now commemorate his name and services. This plant is the *Liatris fruticosa*, of Nuttall, before collected only by Mr. Ware in scanty specimens. In the Transactions of the American Philosophical Society (N. Ser., vii. 285), Nuttall formed for it a subgenus, *Leptoclinium*. In the Proceedings of the American Academy of Arts and Sciences, xv. 48, issued only a month ago, I raised this to generic rank, in view of characters which need not here be recapitulated. But I carelessly overlooked the patent fact that the late George Gardner had published, in 1846, a *Liatris* (*Leptoclinium*) *Brasiliensis*, which he supposed to be a relative of Nuttall's *Liatris* (*Leptoclinium*) *fruticosa*, and that Bentham, in the Genera Plantarum, in view of the pentangular achenium of the Brazilian plant and other characters, founded a genus upon it, and unhappily gave it the name of *Leptoclinium*. All this I unaccountably overlooked. Now, although the name *Leptoclinium* ought properly to belong to the North American plant, a subgeneric name has no rights as against a published generic name. So a new name must be provided for the Florida plant. I had thought at the first of dedicating it to Dr. Garber, but I deferred to the subgeneric name given already by Nuttall; and I now do with alacrity what I ought to have done in the first place. The name and synonymy will stand thus:—

GARBERIA FRUTICOSA. *Liatris fruticosa*, Nutt., in Am. Journ. Sci. v. 299, and Trans. Am. Phil. Soc. l. c. (subgen. *Leptoclinium*). *Leptoclinium fruticosum*, Gray, Proc. Am. Acad. xv. 48, S. Florida, *Ware*, *Garber*."

NOVEMBER 25.

The President, Dr. RUSCHENBERGER, in the chair.

Thirty-eight persons present.

A paper entitled "Carcinological Notes, No. I.," by J. S. Kingsley, was presented for publication.

Authority was granted the Mineralogical Section to change the name to the "Mineralogical and Geological Section of the Academy of Natural Sciences of Philadelphia."

The following were elected members: Benjamin Sharp, H. Russell Bassler, John C. Dawson, John Wilson, Otto Luthy, and Mrs. Mariné J. Chase.

Theodore Kjerulf, of Christiania, and J. W. Pike, of Vineland, N. J., were elected correspondents.

The following papers were ordered to be printed:—

REPLY TO DR. M. C. COOKE'S CRITICISM OF PAPER ON "VARIABILITY OF SPHÆRIA QUERCUUM, SZ."

BY. J. B. ELLIS.

In the last number of Grevillia the editor of that Journal makes some statements with regard to my paper on *Sphæria Quercuum*, published in the Proceedings of the Academy of Natural Sciences of Philadelphia last March, which need correction. He says "It matters not that the sporidia vary in size and form, that in some (of the species) they should be obtuse, in others rather acute at the extremities, in some hyaline, in others deep brown." Dr. Cooke, who has examined the specimens, must have known that these various forms of sporidia instead of being characteristic of different species are all to be found in the same perithecium, the narrow and acute forms being in fact only young or imperfect. As to the sporidia being "hyaline in some and in others deep brown," the record in Grevillea contradicts that statement, so far at least as the species of C. and E. are concerned, *Melogramma Aceris* alone excepted; and even in this species my specimens have the sporidia hyaline. *S. eriostiga* is also said to have the sporidia brown and biseptate; but it is added that these were free spores, the sporidia actually observed in the asci being hyaline. In my previous paper I stated, and subsequent observation has confirmed the statement, that brown biseptate spores are found in *all* the different forms but as yet not in asci. They occur but sparingly it is true, but a careful and patient search is sure to reveal their presence. I wish here to amend my original statement so far as the color of the sporidia is concerned. In all fresh specimens examined, the sporidia are hyaline. Some specimens on *Quercus alba* and on *Vaccinium Pennsylvanicum*, both of which had been poisoned, have brown sporidia, but as the color may be due to the action of the poison, it will be safer to assume that the sporidia are hyaline till the examination of fresh and living specimens shall show them to be brown.

It is asked why twenty other species having similar sporidia were excluded from the list? Simply because I had not actually examined specimens of these species, and it was not intended to give mere opinion, but to state facts actually observed. As to "ignoring all variations of internal structure" and "discarding all external features," I am willing to let the specimens speak for themselves.[1]

[1] I intended to add to the original paper a foot note, designating all the forms with perithecia not united in a stroma as *var. simplex*, but as no additions could be made after the article was in type, I was obliged to content myself with adding this note with pen and ink to the copies sent me for distribution.

ON A COLLECTION OF CRUSTACEA FROM VIRGINIA, NORTH CAROLINA, AND FLORIDA, WITH A REVISION OF THE GENERA OF CRANGONIDÆ AND PALÆMONIDÆ.

BY J. S. KINGSLEY.

The specimens enumerated below were collected, with a few exceptions, by Prof. H. E. Webster, of Union College, at Northampton County, Virginia (eastern shore, Atlantic side), beach of Chesapeake Bay, opposite Fort Monroe, Va., in the vicinity of Beaufort, N. C., and Marcou Pass, Florida Bay, Harbor Key, Plantation Key, and Key West, Southern Florida, and Oyster Bay, Charlotte Harbor, Sarasota Bay and Little Sarasota Bay, on the west coast of Florida. I have endeavored to indicate to a certain extent the geographical distribution of the species by giving, in most instances, a list of localities from which specimens have been reported, with the authority for the statement. In cases where I have personally examined specimens, I have placed an exclamation mark (!) after the locality followed by the name of the collector. The arrangement followed in the Maioidea is that of Miers (Jour. Linn. Soc'y, xiv. pp. 634–673, 1879). In the remaining groups of the Brachyura, mainly that of Dana, the Anomura, according to Stimpson (Proc. Acad. Nat. Sci. Philadelphia, 1858, pp. 225–238), while the order of the Macrura is essentially that of Dana. A short notice of some of the new forms will be found in the American Naturalist, vol. xiii. p. 584, September, 1879.

ORDER DECAPODA.

Sub-Order MAIOIDEA *vel* OXYRHYNCHA.

FAMILY **INACHIDÆ** Miers.

Sub-Family **Leptopodiinæ** Miers.

Genus **LEPTOPODIA** Leach.

Leptopodia sagittaria Leach.

Cancer sagittarius Fabr., Ent. Syst., ii. p. 442.
Inachus sagittarius Fabr., Suppl. Ent. Syst., p. 359.
Macropus sagittarius Latreille, Hist. Crust. et Insects, ii p. 112.
Leptopodia sagittaria Leach, Zool. Misc., ii. pl. lxvii.

Leptopodia ornata Guilding, Trans. Linn. Soc'y London, xiv. p. 335 (1823).

Leptopodia lanceolata Brullé in Webb and Berthelot's Hist. Canaries, pl. i. (1836–1844).

Five specimens were collected at Sarasota Bay, Fla. This species has quite an extended range in the tropics. Stimpson reports it from the Florida Reefs and Madeira Is.; von Martens from Cuba; Guadeloupe (Latr., Martens, and Desbonne), Gulf of Mexico and Antilles (Edw. and Gibbes), Canary Is. (Brullé), Cayenne and Bahia, Brazil (A. M. Edw.). Alphonse Milne Edwards maintains the identity of *Leptopodia debilis* Smith[1] with this species. If it prove identical, the following localities on the west coast of America will have to be added to the list: Valparaiso (Bell, Edw., and Lucas), Panama (Smith), Realijo, west coast of Nicaragua! (McNiel).

I find among the Guerin collection in the Museum of the Academy of Natural Sciences of Philadelphia, a specimen labelled "*Leptopodia vittata* Guer., Senegal." I have not been able to find any description of this species under that name, and possibly it was a MS. one. However I am unable to separate it from Floridan forms.

Genus **METOPORHAPIS** Stm.

Metoporhapis calcarata Stm.

Leptopodia calcarata Say, Journ. Acad. Phila., i. p. 445. Edw., Hist. Crust., i. p. 276.

Metoporhapis calcarata Stm., Ann. Lyc., vii. p. 198.

Nine specimens of this rare species were collected at Sarasota Bay and one, young, at Charlotte Harbor. The other localities are Beaufort, N. C. (Stm.); Charleston, S. C. (Say, Edwards, Gibbes).

Sub-Family **Achæinæ.**

Genus **CORYRHYNCHUS** Kingsley. (*Podonema* Stm., præoc.)

Coryrhynchus riisei Kingsley.

Podochela riisei Stm., Ann. Lyc., vii. p. 196, pl. ii. f. 1.

Podonema riisei Stm., B. M. C. Z., ii. p. 126.

Coryrhynchus riisei Kingsley, Am. Naturalist, xiii. p. 585.

---

[1] *Leptopodia sagittaria* Bell; Edw. et Lucas in D'Orbigny, Voyage dans l'Amérique Meridionale, p. 3, pl. iv. f. 3.

Leptopodia debilis Smith, Second and Third Report, Peabody Acad. Sci., p. 87.

Specimens were collected at Sarasota Bay. Stimpson had it from St. Thomas and Tortugas. I have seen specimens from Key West (A. S. Packard, Jr.).

Sub-Family **Inachinæ** Miers.

Genus **CHORINUS** Leach.

Chorinus heros Leach.

Cancer heros Herbst, Krabben und Krebse, pl. 42, f. 1.
Chorinus heros Leach MS., M. Edw., Crust., i. p. 315. Von Martens, Arch. für Naturgesch., xxxviii. p. 80, pl. iv. f. 2.

Specimens in the Museum of the Peabody Academy (Florida, C. J. Maynard) afford the following measurements:—

Length of Carapax.	Breadth.	Ratio.
44 mm.	22.5 mm.	100 : 51
42 mm.	22. mm.	100 : 52

It has been reported from Key West (Gibbes), Cuba (Martens, A. M. Edw.), Antilles (M. Edw.), Martinique and Barbadoes (A. M. Edw.), Guadeloupe (Desbonne).

Sub-Family **Acanthonychinæ** Miers.

Genus **EPIALTUS** Edw

Epialtus longirostris Stm.

Epialtus longirostris Stm., Ann. Lyc., vii. p. 199. A. M. Edw., Crust. Mex. et Ant. Cent., p. 141, pl. xxvii, f. 5.

Two specimens of this species were collected at Sarasota Bay.

Epialtus minimus Lockington (Proc. California Acad., 1877, p. 77) is a closely allied species, and possibly both should be separated from the species with a shorter rostrum.

Key West (Stm.), St. Thomas (Stm., A. M. Edw.).

Family **MAIIDÆ**.

Sub-Family **Maiinæ**.

Genus **PELIA** Bell.

Pelia mutica Stm.

Pisa mutica Gibbes, Proc. Am. Assoc., iii. p. 171.
Pelia mutica Stm., Ann. Lyc., vii. p. 177. A. M. Edw., Crust. Mex. et Am. Cent., p. 73, pl. xvi. f. 2.

Specimens were collected at Northampton Co., Va., Beaufort, N. C., and Florida Bay, Fla. Prof. Gibbes' types were from

Charleston, S. C. Stimpson found it at Martha's Vineyard, Mass. Dr. Packard collected specimens at Key West, Fla.!

FAMILY **PERICERIDÆ** Miers.

Sub-Family **Pericerinæ** Miers.

Genus **LIBINIA** Leach.

Libinia dubia M. Edw.

Libinia dubia M. Edw., Hist. Crust., i. p. 300, pl. xiv bis, f. 2. Streets, Proc. Phila. Acad., 1870, p. 104. A. M. Edw., Crust. Mex. et Am. Cent., p. 129, pl. xviii, f. 5.

Libinia distincta, Guerin in de Sagra's Cuba, p. 12.

Northampton Co., Va., Morehead Depot and Beaufort, N. C., Little Sarasota Bay, Fla. Two males from the latter locality have the following dimensions:—

Length of Carapax.	Breadth.	Ratio.	Length of 2d feet.
73 mm.	65 mm.	100 : 89	143 mm.
64 mm.	50 mm.	100 : 78	104 mm.

Other localities are Cape Cod to Florida (Smith); Nantucket, Mass.! (Packard), Long Island (Streets), Charleston, S. C. (Gibbes), Key West! (Packard).

Libinia emarginata Leach.

Libinia emarginata Leach, Zoological Miscellany, iii. p. 130, pl. 108 (1815).

Libinia canaliculata Say, Jour. Phila. Acad., i. p. 77, pl. iv. f. 1. M. Edw., Hist. Crust., i. p. 300. Dekay, N. Y. Fauna, Crustacea, p. 2, pl. iv. f. 4.

Libinia affinis Randall, Jour. Phila. Acad., viii. p. 107 (1839).

Randall's types show no characters of specific importance separating them from *L. emarginata*, and hence his name will have to pass into synonymy.

Prof. Webster's localities are North Hampton Co., Va.! Sarasota Bay! and Marcou Pass, Fla.! Other stations are Casco and Cape Cod Bays (Smith), Massachusetts Bay! Nantucket, Mass.! (Packard), Key West, west coast of Fla., and Nassau, N. P. (Smith), W. C. North America! (Nuttall).

Genus **MICROPHRYS** M. Edw. (= *Milnia* Stm.)

Microphrys bicornuta.

Pisa bicornuta Latr., Encyc. Method, t. x. p. 141.

Pericera bicorna M. Edw., Hist. Crust., i. p. 337.

Pisa bicorna Gibbes, Proc. Am. Assoc., iii. p. 170.

Pericera bicornata Guerin in Raman de Sagra, p. 12. Von Martens, Arch. für Naturgesch., xxxviii. p. 85, pl. iv. f. 4.

Pericera bicornis Sauss., Crust. Mex et Antilles, p. 12, pt. i. f. 3.

Milnia bicornuta Stm., Ann. Lyc., vii. p. 180.

Microphrys bicornuta A. M. Edw., Mission Sci. Mex. et Am. Cent. Crust., p. 61, pl. xiv. f. 2–4.

Pisa galbica et *Pisa purpurea* Desbonne and Schramm, Crust. Guad., p. 18.

Omalacantha hirsuta Streets, Proc. Phila. Acad., 1871, p. 238.

Specimens were collected at Plantation Keys, Florida Bay, Key West. Specimens from Plantation Keys gave the following measurements:—

Sex.	Length of Carapax.	Breadth.	Ratio.
♂	27.4 mm.	18.7 mm.	100 : 68
♂	31. mm.	21.2 mm.	100 : 68
♀	22. mm.	14.8 mm.	100 : 68

An examination of the single specimen which formed Streets' type of *Omalacantha hirsuta*, which is preserved (in a dry state) in the Museum of the Philadelphia Academy, convinces me that Alphonse Milne Edwards was correct in supposing it a variety of *M. bicornutus*. It stands midway between the typical form (fig. 3, of A. Edw.) and that described by Desbonne as *Pisa galbica* (fig. 4, of A. Edw). It, however, differs from both in a much smaller chiliped.

Tortugas (Stm.), Key West! (Packard), Antilles (Edwards, Saussure), Bermudas (Smith), Guadeloupe (Desbonne), Mexico (A. M. Edw.), Aspinwall! (McNiel), Desterro, Brazil (A. Edw.), Abrolhos, Brazil (Smith).

Genus **MACROCOLŒMA** Miers.

Macrocœloma trispinosa Miers.

Pisa trispinosa Latreille, Encyc. Method, x. p. 142.

Pericera trispinosa M. Edw., Hist. Crust., i. p. 336. Von Martens, l. c., xxxviii. p. 84, pl. iv. f. 4. Schramm, Rev. et Mag. de Zool. III., ii. p. 342.

Pericera nodipes Desbonne and Schramm, op. cit., p. 15, pl. v. f. 13.

Macrocœloma trispinosa Miers, Jour. Linn. Soc'y, xiv. p. 665.

A single male was collected at Key West. Key West (Gibbes, Stim.), Tortugas (Stm.), Cuba (Martins), Guadeloupe (Desbonne).

Sub-Family **Othoniinæ.**

Genus **OTHONIA**,[1] Bell.

Othonia aculeata Stm.

Hyas aculeatus Gibbes, Proc. Am. Assoc., iii. p. 171.
Othonia aculeata Stm., Ann. Lyc., vii. p. 49. A. M. Edw., Crust. Mex. et Am. Cent., p. 115, pl. xxiv. f. 4.
Othonia lherminieri Desbonne and Schramm, op. cit., p. 20. A. M. Edw., op. cit., p. 116, pl. xxiv. f. 5.
Othonia anisodon von Martens, l. c., xxxviii. p. 83, pl. iv. f. 2.

Professor Webster collected specimens of this species at Sarasota Bay and Harbor Key, Fla. I have examined others in the Museum of the Peabody Academy from Florida (C. J. Maynard) and Key West (A. S. Packard). I can see no constant differences to separate the forms described as *lherminieri* and *anisodon* from typical forms. The teeth of the antero-lateral margin are variable, and differ frequently on the two sides of the same specimen. A young specimen from Sarasota Bay had but four teeth on the anterolateral margin besides the angle of the orbit, but I could find no other differences. In ten specimens the ratio of the length to the breadth ranged from 100 : 81 to 100 : 94, with an average of 100 : 86. Other localities are Key West (Gibbes, Stm.), Tortugas (Stm., A. M. Edw.), Cuba (Martens), Guadeloupe (Desbonne), St. Thomas (A. M. Edw.).

Sub-Family **Mithracinæ.**

Genus **MITHRACULUS** White.

Mithraculus coronatus White.

Cancer coronatus Herbst, pl. xi. f. 63.
Mithraculus coronatus White (pars), List Brit. Mus. Crust., p. 7. A. M. Edw., Crust. Mex. et Am. Cent., p. 105, pl. xx. f. 1.

Five specimens were collected at Key West, from which place I have examined others collected by Dr. A. S. Packard, Jr.

Sex.	Length of Carapax.	Breadth.	Ratio.
♂	14.5 mm.	17.9 mm.	100 : 123
♂	10.8 mm.	14.9 mm.	100 : 138
♀	12. mm.	14.5 mm.	100 : 121

[1] The generic name *Othonia* was used by Johnston (London's Magazine of Natural History, viii. p. 181, 1835) for a genus of worms, but since he has been followed by no other author, with the exception of Gosse, and as his single species has been assigned to the genus *Amphicora*, I refrain from proposing a new name for Bell's genus.

Other localities are Tortugas and Aspinwall, Abrolhos, Brazil (Smith), St. Thomas and Guadeloupe (A. M. Edw.).

Mithraculus sculptus Stm.

Maia sculpta Lamarck, An. sans Vertebres, v. p. 242.

Mithrax sculptus Edw., Mag. de Zool., 1832, pl. v.; Hist. Crust. i. p. 322.

Mithraculus sculptus Stm., Am. Jour. II., xxix. p. 132. A. M. Edw., Crust. Mex. et Am. Cent., p. 105, pl. xx. f. 2.

Specimens were collected at Key West. I have seen others from the same locality collected by Dr. Packard, and from Tortugas (Lieut. Jacques). It has been reported from Antilles (Edw.), Cuba, Surinam, and Venezuela (Martens), Guadeloupe, St. Thomas, Martinique, Woman Key, Fla., and Cumana (A. Edw.).

Mithraculus cinctimanus Stm.

Mithraculus cinctimanus Stm., Am. Jour. Sci. and Arts. II., xxix. p. 132 (sine descr.); Ann. Lyc., vii. p. 186. A. M. Edw., Crust. Mex. et Am. Cent., p. 112, pl. xxiii. f. 3.

The twelve specimens of this species that I have examined agree well with Stimpson's description, except in the coloration of the hands. In these specimens (alcoholic), the hands are white with the basal two-thirds darker; there is also a band of darker on the fingers. Prof. Webster collected specimens at Plantation and Harbor Keys. In the Peabody Academy are specimens from Key West (Packard). Other localities are Tortugas (Stm.), St. Thomas (Stm., A. Edw.), Guadeloupe (A. M. Edw.).

Mithraculus hirsutipes Kingsley. Pl. xiv. f. 1.

Mithraculus hirsutipes Kingsley, Proc. Bost. Soc'y, xx. 147.

Two males were collected at Sarasota Bay, which agree well with my types, except in the comparatively narrower carapax.

Length of Carapax.	Breadth.	Ratio.
11 mm.	11.8 mm.	100 : 107
9 mm.	9.6 mm.	100 : 107

There were two young specimens collected at Sarasota Bay, which may be the young of either of the last two species. They differ, however, from *cinctimanus* in the absence of the large tooth at the base of the dactyli of the cheliped, and in having the ridge running backward from the palatal region broken; from *hirsutipes* in the smoother carapax, more prominent frontal horns, and in having the antennal spines as in *cinctimanus*, etc.

Genus **MITHRAX** Leach.

Mithrax spinosissimus Edw.

Maia spinosissima Lamarck, An. sans Vert., v. p. 241.
Mithrax spinosissimus Edw., Mag. de Zool., ii. pls. ii. and iii.; Hist. Crust., i. p. 321.

Two young specimens from Key West. Other localities are Martinique, Antilles (M. Edw.), Key West (Gibbes), Florida Keys (Stm.), Cuba (Martens), Santa Cruz! (Charles Lawrence), Guadeloupe (Desbonne).

Mithrax hispidus Edw.

Cancer hispidus Herbst, op. cit., pl. xviii. f. 100.
Maia spinicincta Lamarck, op. cit., v. p. 241.
Mithrax spinicincta Desmarest, op. cit., p. 150, pl. xxiii. f. 1, 2.
Mithrax hispidus Edw., Mag. de Zool., ii.; Hist. Crust. i. p. 322. A. M. Edw., Crust. Mex. et Am. Cent., p. 93, pl. xxi. f. 1.
Mithrax sp. Desbonne and Schr., op. cit., p. 8, pl. ii. f. 4 and 5.

Prof. Webster collected a single specimen of this well-known species at Key West. It has been reported from S. Carolina (Gibbes), Key Biscayne (Stm.), Key West! (Packard), Tortugas! (Lieut. Jacques), Antilles (Edw.), Cuba (Martens), Guadeloupe (A. M. Edw., Desbonne, Saussure), Martinique (A. M. Edw.), Abrolhos, Brazil (Smith).

Mithrax pleuracanthus Stm.

Mithrax pleuracanthus Stm., B. M. C. Z., ii. p. 116. A. M. Edw., Crust. Mex. et Am. Cent., p. 93, pl. xx. f. 3.

Specimens were collected at Sarasota Bay. Stimpson's types were from Key West and St. Thomas; Alphonse Milne Edwards had specimens from Martinique and Guadeloupe.

Family **PARTHENOPIDÆ**.

Sub-Family **Parthenopinæ**.

Genus **PLATYLAMBRUS** Stm.

Platylambrus serratus A. M. Edw.

Lambrus serratus Edw., Hist. Crust., i. p. 357 (teste A. M. Edw.).
Lambrus crenulatus Saussure, l. c., p. 13, pl. i. f. 4.
Platylambrus crenulatus Stm., B. M. C. Z., ii. p. 129.
Platylambrus serratus A. M. Edw., op. cit., p. 156, pl. xxx. f. 1.

A female was collected at Charlotte Harbor. (?) Indian Ocean (Edw.), Antilles (Saussure), Loggerhead Key and Tortugas (Stm.), Cuba (von Martens), Vera Cruz (A. M. Edw.), Guadeloupe (Desbonne and A. M. Edw.).

M. Alphonse Milne Edwards considers this the same as the *Lambrus serratus* described by H. Milne Edwards, and the description applies well to the specimen now before me. Milne Edwards, Sr., gives the Indian Ocean as the habitat of *L. serratus*, and Adams and White (Voyage of the Samarang, Crustacea, p. 30, 1841) report it from the Philippine Islands.

Sub-Family **Cryptopodiinæ.**

Genus **HETEROCRYPTA** Stm.

Heterocrypta granulata Stm.

Cryptopodia granulata Gibbes, Proc. Am. Assoc., iii. p. 173; Proc. Elliot Soc'y, i. p. 36 (fig.).

Heterocrypta granulata Stm., Ann. Lyc., x. p. 102. A. M. Edw., Crust. Mex. et Am. Cent., p. 186, pl. xxix. f. 4.

Specimens were collected at Northampton Co., Va.; near Piver's Island, Beaufort, N. C., Florida Bay, and Sarasota Bay. Fort Macon! (Packard), Charleston, S. C. (Gibbes), St. Thomas (Stm., A. M. Edw.).

CANCROIDEA.

Family **CANCRIDÆ.**

Sub-Family **Cancrinæ.**

Genus **CANCER** Leach (restr.).

Cancer irroratus Say.

Cancer irroratus Say, l. c., i. p. 59 (pars), pl. iv. f. 2.

Platycarcinus irroratus Edw., Hist. Crust., i. p. 414.

Cancer sayi Gould, Invert. Mass., p. 323.

Platycarcinus sayi Dekay, N. Y. Fauna Crust., p. 7.

Platycarcinus irroratus Dekay, op. cit., pl. ii. f. 2.

Cancer borealis Packard, Memoirs Bost. Soc'y, i. p. 303.

A young specimen was taken at Northampton Co., Va. It was rather more advanced than the form described by Prof. Smith (Fish Comm., p. 533); the length was 5 mm., breadth 6 mm.; the front is more produced, and the teeth of the anterolateral margin are more irregular than in the adult, but not to such an extent as in the younger form. I have not thought it worth while to enumerate all the reported localities for this species. I have examined specimens from Labrador (Packard), Eastport, Me. (Hyatt), Casco Bay (Cooke), Is. of Shoals (R. H. Wheatland), Salem, Mass., Nantucket (Packard), Narragansett Bay, R. I., So. Shore, Long Island. Dr. Coues reports it from Fort Macon, Prof. Gibbes from Charleston Harbor, S. C., and Mr. Faxon writes me that there are specimens in the Museum of Comparative Zoology, at Cambridge, Mass., from Florida and Hayti (Dr. Weinland). In the Museum of the Peabody Academy of Science, Salem, Mass., is a fossil carapax of this species from the Post Pleiocene deposits of Gardiner, Maine.

Sub-Family **Xanthinæ**.

Genus **ACTÆA** De Haan.

Actæa spinifera, sp. nov.

Closely resembles *A. hirsutissima*, of the eastern seas, as figured and described by Rüppell[1] and Dana.[2] Carapax everywhere above areolate, more prominently so in front. Each areolet with small prominent rounded tubercles, which are covered with numerous stiff hairs, the spaces between the tubercles and between the areolets are smooth and naked; front with two depressed and produced lobes, the margins of which are armed with tuberculiform teeth; orbits with traces of two fissures above, spined above and below. Antero-lateral margins with five subequal teeth separated by rather deep grooves, the first three of which are continued on the under surface of the carapax; the teeth themselves have their margins armed with small spines. The postero lateral margin is strongly concave, as much so as in *A. hirsutissima*. Cheliped stout, of moderate length, inner surface of the joints smooth and naked, meros compressed, upper edge acute and haired, outer surface naked, upper and outer surfaces of carpus and hand with spiniform tubercles and stiff hairs, on the hand these tubercles tend to arrange themselves in rows; fingers short, stout, gaping, acute, black, their tips being white. Meral joints of the ambulatory feet compressed, upper margin acute, and terminating in an acute spine, sides smooth, remaining joints and posterior surface of the meros of the last pair with spines and hairs similar to those on the chelipeds; dactyli terminating in a small acute claw.

[1] Beschreibung und Abbildung von 24 Arten Kurzschwänzigen Krabben * * * des rothen Meeres, Frankfurt, 1830, p. 26, pl. v. f. 6.

[2] U. S. Expl. Exped., p. 164, pl. viii. f. 3.

Abdomen and sternum granulate, the granulations being more prominent on the basal joints of the abdomen.

A single male was collected at Plantation Key, from which I derive the following measurements: Length, 14.2 mm.; breadth, 21 mm.; ratio, 100 : 148. This species is readily separated from all other North American species by the spines on the anterolateral teeth.

Actæa nodosa Stm.

Actæa nodosa Stm., Ann. Lyc.. vii. p. 203. A. M. Edw., Nouv. Arch. du Mus , i. p. 266, pl. xvii. f. 6.

A specimen from Plantation Key affords the following measurements: Length, 17.5 mm.; breadth, 23.7 mm.; ratio, 100 : 135.

Tortugas (Stm.), Guadeloupe (Desbonne).

Genus MENIPPE De Haan.

Menippe mercenaria Stm.

Cancer mercenaria Say, l. c., i. p. 448.
Cancer (Xantho) mercenaria Edw., Hist. Crust., i. p. 399.
Pseudocarcinus ocellatus Edw., Hist. Crust., i. p. 409 (?).
Pseudocarcinus mercenaria Gibbes, Proc. Am. Assoc., iii. p. 176.
Menippe mercenaria Stm., Ann. Lyc., vii. p. 53.
Menippe ocellata Von Martens, l. c., xxxviii. p. 87.

Prof. Webster collected specimens of this well-known but synonymically abused species at Beaufort, N. C., Florida Bay, Plantation Key, Charlotte Harbor, Oyster Bay, Little Sarasota and Sarasota Bays.

Other localities are Fort Macon! (Coues, Packard), Charleston, S. C. (Gibbes), Key West! (Packard), Isthmus of Panama (Streets), Cuba (Martens). Mr. Faxon tells me there are specimens in the Museum of Comp. Zoology from Cuba (Poey), and Galveston, Texas (Boll).

Genus PANOPEUS M. Edw.

Panopeus herbstii Edw.

Cancer panope Say, Jour. Acad. Nat. Sci. Philadelphia, i. p. 58, pl. iv. f. 5 (nec Herbst).
Panopeus herbstii Edw., Hist. Crust., i. p. 403. Dekay, op. cit., p. 5, pl. ix. f. 26. Smith, Proc. Bost. Soc'y, xii. p. 276.

Occurs in this collection from Northampton Co., Va., Beaufort, N. C., Sarasota, Little Sarasota, Florida, and Oyster Bays, and Charlotte Harbor, Florida. Other localities are Fort Macon, N.

C.! (Packard), Bluffton, S. C.! (Dr. Mellichamp), Key West! (Packard), Aspinwall! (McNiel), Long Island Sound and Bahamas (Smith), Cuba (Martens), Rio Janeiro (Heller). According to Mr. Faxon there are specimens in the Museum of Comparative Zoology from Boston (Gould?, 1853) and Providence River, R. I.

Panopeus packardii Kingsley.

Panopeus packardii Kingsley, Proc. Bost. Soc'y, xx. p. 152.

Specimens occur from Sarasota Bay, Harbor Key, and Charlotte Harbor, Fla. The majority of these specimens have the sinus between the angle of the orbit and the second normal tooth more shallow than did my types, which were from Key West (Packard).

Panopeus texanus Stimpson.

Panopeus texanus Stm., Ann. Lyc., vii. p. 55.
Panopeus sayi Smith, Proc. Bost. Soc'y, xii. p. 284.

Specimens occur in the Union College collection from Northampton Co., Va., Beaufort, N. C., and Sarasota Bay, Fla. I have also seen specimens from Eastham, Mass. (W. C. Fish), Wood's Holl, Mass. (Packard, Verrill), New Haven, Conn. (Yale College). A careful examination of a large series has led me to unite these two forms, as I cannot find constant differences to separate them. There is all variation in the subhepatic tubercle, from one as prominent as typical specimens of *P. herbstii* to complete absence; the form of the anterolateral teeth varies, while the terminal segment of the male abdomen is the same in each form; in some the fingers of both hands were slender, some had them pointed on one hand and excavate on the other, while others had the fingers of both hands excavate. I am the more ready to unite them since Prof. Smith suggests their possible identity.

Panopeus depressus Smith.

Panopeus depressus Smith, Proc. Bost. Soc'y, xii. p. 283; Fish Com., p. 547, pl. i. f. 3.

Specimens occur from Northampton County, Va., Beaufort, N. C., and Charlotte Harbor, Fla. Other localities are Provincetown, Mass. (Smith), New Haven! (Yale College), Maryland! (C. Cooke), West Florida! (Col. Jewett).

Genus EURYTIUM Stm.

Eurytium limosum Stm.

Cancer limosus Say, l. c., i. p. 446.
Panopeus limosus Edw., Hist. Crust., i. p. 404.
Eurytium limosum Stm., Ann. Lyc., vii. p. 56.

Prof. Webster collected specimens at Sarasota and Little Sarasota Bay, Fla. Other localities, New York (Dekay), So. Carolina (Gibbes, Stm.), Key West, Fla.! (Packard), Smyrna, Fla. (Gibbes), Key Biscayne, Fla. (Stm.). Mr. Faxon tells me that there are specimens in the Museum of Comparative Zoology from Hayti (Dr. Weinland) and Brazil (Thayer Expedition).

Genus **CHLORODIUS** Leach.

Chlorodius floridanus Gibbes.

Chlorodius floridanus Gibbes, l. c., iii. p. 175.
Leptodius floridanus A. M. Edw., Hist. Crust. Fossiles, i. p. 228.

But a single specimen of this common species was collected by Prof. Webster, at Plantation Key, Fla. I have examined others from Key West! (Packard), Aspinwall! (McNiel), and Abrolhos, Brazil! (Hartt).

Chlorodius longimanus M. Edw.

Chlorodius longimanus M. Edw., Hist. Crust., i. p. 401.

A single specimen was collected at Key West, by Prof. Webster. I have seen others from the same locality collected by Dr. A. S. Packard, which differ from Edwards's description in having the meros of the chelipeds armed with five distant tuberculiform teeth. Edwards's specimens were from Porto Rico.

Chlorodius dispar Stm.

Chlorodius dispar Stm., B. M. C. Z., ii. p. 140.

Eighteen specimens were collected at Key West, and as they show a considerable range of variation, I give a description of a specimen varying most widely from Stimpson's type.

Carapax transversely oval, very broad, smooth, naked; antero-lateral margin almost entire, the three last teeth alone showing, and they but very slightly. Front sinuate, four lobed, resembling that of *Panopeus herbstii*, a straight fringe of hairs above the margin. Orbits entire above and below, the inner inferior angle prominent. Chelipeds long, about equal in length, but differing greatly in diameter, the right being usually the larger. Fingers of the larger about half the length of the palm, short, stout, gaping, with the extremities acute, not at all excavate. Smaller cheliped, with the carpus and propodus polished and deeply punctate. Hand long, no stouter than the preceding joint, subcylindrical, fingers about half as long as the palm, closing completely, and spoon excavate. Smaller specimens agree perfectly with Stimpson's description, while the smallest specimen has all the antero-lateral teeth obsolete.

Sex.	Length of Carapax.	Breadth.	Ratio.
♂	7.8 mm.	13.2 mm.	100 : 169
♂	3.9 mm.	5.5 mm.	100 : 149

Stimpson's types, two in number, were from Cruz del Padre, Cuba.

Family ERIPHIDÆ Dana.

Sub-Family Oziinæ Dana.

Genus HETERACTÆA Lockington.[1]

In the two species which I have examined the following characters may be noted. Form similar to that of *Pilumnus*, which it closely resembles in the antennæ and external maxillipeds. It, however, differs in the absence of a palatal ridge and in the curious naked crests on the meral joints of the ambulatory feet. The orbits have the external hiatus more or less distinct, and below have two lobes. It forms one of these synthetic forms, which like *Xanthodius*, *Eurytium*, *Eurycarcinus*, *Pilumnopeus*, *Micropanope*, etc., combine the characters of both Cancroid and Eriphioid Crustacea. The type is *Heteractæa lunata*.[2]

Heteractæa ceratopus Kingsley.

Pilumnus ceratopus Stm., Ann. Lyc., vii. p. 215.

Pilumnus sp. Desbonne et Schramm., op. cit., p. 33, pl. iii. f. 9-10.

A male was collected at Key West, Fla. Key Biscayne, Fla. (Stimpson), Guadeloupe (Desbonne).

Genus PILUMNUS Leach.

Pilumnus aculeatus M. Edw.

Cancer aculeatus Say, l. c., i. p. 449.

Pilumnus aculeatus Guerin, Iconog. Regne Animal, Crust., pl. iii. f. 2. Edw. Hist. Nat. Crust., i. p. 420. Gray, in Griffith's Cuvier, vol. 13, pl. iv. f. 2, 1833. Martens, l. c., xxxviii. p. 91, pl. iv. f. 6.

---

[1] Proceedings of the California Academy of Sciences, vol. vii. p. 97, 1876.

[2] **Heteractæa lunata** Kingsley.

Pilumnus lunatus Edwards et Lucas in D'Orbigny's Voyage dans l'Amérique Meridionale, Crustaces, p. 20, pl. ix. f. 2.

Heteractæa pilosa Lockington, Proc. Cal. Acad., vii. p. 97.

Gulf of California! (Fisher), C. St. Lucas and Central America (Stimpson), Chili (Edw. et Lucas, Nicollet).

Specimens were collected at Sarasota Bay and Marcou Pass.

Pilumnus dasypodus Kingsley.

Pilumnus dasypodus Kingsley, Proc. Bost. Soc'y, xx. p. 155.

Harbor Key and Sarasota Bay, Fla. My types were from Key West.

Pilumnus gemmatus Stm.

Pilumnus gemmatus Stm., Ann. Lyc., vii. p. 214.

Specimens were collected at Plantation and Harbor Keys, Charlotte Harbor, and Florida Bay. I have seen others from Key West (Packard). Stimpson's types were from St. Thomas.

Genus **EUPILUMNUS** (nov.).

Carapax depressed. Basal joints of antennæ as in *Pilumnus*. External maxillipeds with the meral joint short and narrow, it being only about two-thirds as wide as ischial joint, which is short and broad.

Eupilumnus websteri, sp. n., plate xiv. f. 3.

Carapax depressed, nearly flat, regions not indicated, above with a short, sparse pubescence, front slightly arcuate, the margin with fine spiniform teeth. Orbits above smooth, not toothed. External angle spiniform, below with spines near the inner angle. Antero-lateral margin with three prominent spiniform teeth, with smaller ones between them, several small spines on the hepatic region, and one on the branchial behind the lateral teeth. Anterior margin of palate spined. The chelipeds are lacking in the single specimen. Ambulatory feet compressed, spined above, dactyli short, curved, spined below.

Key West, Fla. Length, 6 mm.; breadth, 8.1; ratio, 100 : 135.

Sub-Family **Eriphiinæ** Dana.

Genus **ERIPHIA** Latreille.

Eriphia gonagra M. Edw.

Cancer gonagra Fabr., Suppl. Ent. Syst., p. 337.
Eriphia gonagra Edw., Hist. Crust., i. p. 426, pl. xvi. f. 16, 17.

Specimens were collected at Plantation Key, Fla. Other localities are Key West! (Packard), Tortugas (Stm.), Florida Keys, Bahamas (Smith), Aspinwall! (McNiel), Abrolhos, Brazil! (Hartt), Rio Janeiro (Dana, Heller), Cuba (von Martens), Jamaica et Carolina (Bosc).

FAMILY **PORTUNIDÆ.**

Sub-Family **Lupinæ.**

Genus **ACHELOUS** De Haan, Stm.

Achelous spinimanus De Haan.

Portunus spinimanus Latr., Encyc. Methodique, x. p. 189.
Lupa spinimana Desmarest, op. cit., p. 98. Edw., Hist. Nat. Crust., i. p. 452.
Achelous spinimanus De Haan, Fauna Japonica Crust., p. 8. A. M. Edw., Archives du Museum, x. p. 341, pl. xxxii. f. 1.

Little Sarasota Bay.

Achelous gibbesii Stm.

Lupa gibbesii Stm., Ann. Lyc., vii. p. 57.
Achelous gibbesii Stm., Ann. Lyc., vii. p. 222.
Neptunus gibbesii, A. M. Edw., Nouv. Archives du Museum, x. p. 326, pl. xxxi. f. 1.

Beaufort, N. C.; Oyster Bay and Sarasota Bay, Fla. The range of this species so far as known is included within the limits of the above localities.

Genus **CALLINECTES** Stm.

Callinectes hastatus Ordway.

Lupa hastata Say, l. c., i. p. 65.
Lupa diacantha Dekay, op. cit., p. 10, pl. iii. f. 3.
Callinectes hastatus Ordway, Jour. Bost. Soc'y, vii. p. 568.

Three sterile females were collected at Beaufort, N. C.

Genus **NEPTUNUS** De Haan.

Neptunus sayi Stm.

Portunus pelagicus, Bosc, Hist. Nat. Crust., edit. i. t. i. p. 220, pl. v. f. 3 (teste A. Edw.), edit. ii. t. i. p. 235, pl. v. f. 3 (non Linne).
Lupa pelagica Say, Jour. Acad. Nat. Sci., i. p. 97. Dekay, op. cit., p. 11, pl. vi. f. 8.
Lupa sayi Gibbes, l. c., iii. p. 178. Dana, op. cit., p. 273, pl. xvi. f. 8.
Neptunus sayi Stm., Ann. Lyc., vii. p. 92. A. M. Edw., Arch. du Mus. x. p. 317, pl. xxix. f. 2.

Plantation Key, Fla.

FAMILY **PLATYONICHIDÆ.**

Genus **CARCINUS** Leach.

Carcinus mœnas Leach.

Cancer mœnas Linne, Syst. Nat., edit. xii. p. 1043. Herbst, pl. vii. f. 46.
Portunus mœnus Leach, Edinburg, Encyclopedia, vii. p. 390 (teste Bell).

Carcinus mœnas Leach, op. cit., vii. p. 429 (teste Auct.); Malacos. Podophth. Brit., pl. v. f. 1–4. Dekay, op. cit., p. 8, pl. v. f. 5–6. Alph. M. Edw., Arch. du Mus., x. p. 391.
Cancer granulatus Say, l. c., i. 61.
Carcinus granulatus Smith, Fish Comm., p. 547.

A single male from Northamptom Co., Va. This is the farthest south on the Atlantic coast of the United States from which this species has been reported.

Genus PLATYONICHUS Latreille.

Platyonichus ocellatus (Herbst sp.) Latreille.

Portunus pictus Say.

Beach of Chesapeake Bay, opposite Fort Monroe. Mr. James Hector (Trans. New Zealand Inst., ix. p. 473, pl. xxviii. f. 1, 1877) reports this species from Wellington, New Zealand.

OCYPODOIDEA.

Family CARCINOPLACIDÆ.

Genus EURYPLAX.

Euryplax nitida Stm.

Euryplax nitida Stm., Ann. Lyc., vii. p. 60; B. M. C. Z., ii. p. 150. Smith, Trans. Conn. Acad., ii. p. 162.

Specimens collected by Prof. Webster, at Sarasota Bay, Fla., have the front slightly arcuate with a slight sinus at the middle, but not emarginate. The carpi of the chelipeds are not flattened. Otherwise the specimens agree perfectly with the descriptions quoted above. Proportions of a male: length, 14.7 mm.; breadth, 23.5 mm.; ratio, 100 : 160. There is a single specimen in the Museum of the Peabody Academy of Science, which came with *Platyonichus ocellatus*, *Squilla empusa*, and two or three other species with the label New Orleans. Other localities are Florida Keys and St. Thomas (Stm.), Egmont Key, Fla. (Smith).

Family OCYPODIDÆ.

Genus GELASIMUS Latr.

Gelasimus minax Le Conte.

Northampton Co., Va.

Gelasimus pugillator (Bosc sp.) Latreille.

Beaufort, N. C., and Sarasota Bay, Fla.

Gelasimus vocator (Herbst) Martens.

Northampton Co., Virginia; Fort Macon, N. C., and Sarasota Bay, Fla.

Genus OCYPODA.

Ocypoda arenaria Say.

Beach of Chesapeake Bay, opposite Fortress Monroe, and Sarasota Bay, Florida.

Family GRAPSIDÆ.

Sub-Family Grapsinæ.

Genus GONIOPSIS De Haan, Edw.

Goniopsis cruentatus De Haan.

Cancer ruricola De Geer, Mémoires pour servir à l'Histoire des Insectes, vii. p. 417, pl. xxv. (non Linne).
Grapsus cruentatus Latreille, Hist. Crust. et Insects, vi. p. 70. Edw., Hist. Crust., ii. p. 85.
Grapsus longipes Randall, l. c., vii. p. 125.
Goniopsis cruentatus De Haan, Fauna Japonica, p. 33. Edw., Am. Sci. Nat. III., xx. p. 164, pl. vii. f. 2.
Goniopsis ruricola White, List Crust. Brit. Museum, p. 40. Saussure, op. cit., p. 30, pl. ii. f. 18.
Goniograpsus cruentatus Dana, U. S. Expl. Exped. Crust., p. 342, pl. xxi. f. 7.
Grapsus (*Goniopsis*) *cruentatus* von Martens, l. c., xxxviii. p. 105.

A male was collected at Sarasota Bay. Other localities are Florida Keys (Smith), Cuba (Saussure, Martens), Antilles, Brazil (M. Edw.), Guadeloupe (Desbonne), Surinam (Randall), Venezuela, Liberia (Martens), Abrolhos, Brazil (Smith), Rio Janeiro (Dana, Heller), ? Gulf of Fonseca, west coast of Nicaragua (Smith).

Genus PACHYGRAPSUS Randall.

Pachygrapsus transversus Gibbes.

Grapsus transversus Gibbes, l. c., iii. p. 181.
Pachygrapsus transversus Gibbes, l. c., p. 182. Kingsley, Proc. Bost. Soc'y, xx. p. 158.
Metopograpsus dubius Saussure, op. cit., p. 29, pl. ii. f. 16.
Metopograpsus miniatus Saussure, op cit., p. 28, pl. ii. f. 17.
Grapsus (*Leptograpsus*) *rugulosus* Martens, l. c., xxxviii. p. 108.
Grapsus (*Leptograpsus*) *miniatus* Martens, l. c., xxxviii. p. 109.

Sarasota Bay. Other localities are Florida Keys and Texas (Stm.), Key West! (Packard, Gibbes), St. Thomas (Saussure), Cuba (Martens), Gulf of Fonseca, west coast Nicaragua! (McNiel), Panama (Smith).

Genus **GRAPSUS** Lamarck.

Grapsus maculatus Edw.

Pagurus maculatus Catesby, Natural History of the Carolinas, ii. pl. xxxvi. f. 1. 2d edit., l. c.
Cancer grapsus Fabr., Suppl., p. 342.
Grapsus pictus Latr., Hist. Crust. et Ins., vi. p 69, pl. 47, f. 2.
Goniopsis pictus De Haan, Fauna Japonica, Crustacea, p. 33 (1833).
Grapsus maculatus M. Edw., Am. Sci. Nat. III., xx. p. 167, pl. vi. f. 6.
Grapsus altifrons Stm., Ann. Lyc., vii. p. 230.

Specimens were collected at Plantation Key, Fla. According to Martens, the *Cancer tenuicristata* of Herbst, on examination of his types, proves to be *Grapsus rudis*, Edw., from the East Indies.

Santa Cruz! (Charles, Lawrence), Cuba (Saussure, Martens), Guadeloupe (Desbonne), Tortugas (Stm.), Madiera, Cape Verdes, Peru, Paumotu Is., Sandwich Is. (Dana), C. St. Lucas (Stm.), Mazatlan (Saussure), Gallapagos Is. (Miers), Chili (Nicolet), Tahiti! (A. Garrett).

Genus **PLAGUSIA** Latreille, Miers.

The species of this genus have been recently revised by Mr. Miers (Ann. and Mag. Nat. Hist., Feb. 1878, pp. 147–154).

Plagusia depressa Say.

?*Cancer depressus* Fabr.; ?*Cancer squamosus* Herbst; *Plagusia sayi* Dekay; *Plagusia squamosa* Latr.; *Plagusia gracilis* Sauss.

A single specimen (length 42.2, breadth 45.2 mm.) was found at Plantation Key.

Sub-Family **Sesarminæ**.

Genus **SESARMA** Say.

Sesarma cinerea Say.

Grapsus cinereus Bosc, op. cit., edit. 1, p. 204, pl. v. f. 1 (teste auct.).
Sesarma cinerea, Say, l. c., i. p. 442 (non *Grapsus cinereus*, p. 99), Edw., Hist. Crust., ii. p. 75.

Northampton Co., Va., Beaufort, N. C., Sarasota and Little Sarasota Bays, Florida.

Sesarma reticulata Say.

Sesarma reticulata Say, l. c., i. pp. 73, 76, 442, pl. iv. f. 6; Edw., Ann. Sci. Nat., III. xx. 182.
Sesarma cinerea Dekay, op. cit., p. 15.

Northampton Co., Va., and Little Sarasota Bay, Fla.

Genus **ARATUS.**

Aratus pisonii M. Edw.

Sesarma pisonii M. Edw., Hist. Crust., ii. p. 76, pl. xix. f. 4–6.
Aratus pisonii M. Edw., Ann. Sci. Nat., II. xx. p. 187; Stm., Ann. Lyc., vii. p. 232.
Sesarma (*Aratus*) *pisonis* von Martens, Wieg. Arch., xxxv. p. 12, pl. 1, f. 4 (1869); id., xxxviii. p. 111.

Specimens were collected at Sarasota Bay, Florida. It ranges south to Rio Janeiro (Heller). I am unable to separate specimens from the west coast of Nicaragua (McNeil) from the east coast forms.

Family **PINNOTHERIDÆ.**

Genus **PINNOTHERES.**

Pinnotheres ostreum Say.

Pinnotheres ostreum Say, l. c., i. p. 67, pl. iv. f. 5.

Beaufort, N. C.

Pinnotheres maculatus.

Pinnotheres maculatus Say, l. c., i. p. 450.
Pinnotheres ostreum Smith, Fish Commisson, pl. i. f. 2.

Beaufort and Morehead Depot, N. C.

Genus **PINNIXA** White.

Pinnixa cylindrica White.

Pinnotheres cylindrica Say, l. c., i. p. 452.
Pinnixa cylindrica White, List Crust. Brit. Mus., p. 33; Ann. and Mag. Nat. Hist., xviii. p. 177; Smith, Fish Comm., p. 546, pl. 1. f. i.
Pinnixa lævigata Stm., Ann. Lyc., vii. p. 68.

Specimens were collected at Florida and Sarasota Bays, Fla. It has previously been known from Vineyard Sound (Smith) to South Carolina (Stimp.).

Pinnixa chætopterana Stm.

Pinnixa cylindrica Stm., Ann. Lyc., vii. p. 68 (non Say).
Pinnixa chætopterana Stm., Ann. Lyc., vii. p. 235.

Eastern shore Virginia, Beaufort, N. C., and Florida Bay, Fla.

LEUCOSOIDEA.

Family **CALAPPIDÆ.**

Genus **CALAPPA** Fabr.

Calappa marmorata Fabr.

Calappa marmorata Fabr., Suppl. Ent. Syst. p. 346; M. Edw., Hist. Crust. ii. p. 104.

Prof. Webster collected specimens at Beaufort, N. C., Key West, and Sarasota Bay, Fla. Other localities are Antilles (Auct.), Pensacola, Tortugas, and Key West (Stm.), Charleston, S. C. (Gibbes), Cuba (Martens), Bermudas (Goode), Guadeloupe (Desborne). Mr. Faxon tells me he has taken specimens at Newport, R. I.

Family MATUTIDÆ.

Genus HEPATUS Latreille.

Hepatus decorus Gibbes.

Cancer decorus Harbst, op. cit., p. 154, pl. xxxvii. f. 6.
Hepatus decorus Gibbes, Proc. Am. Assoc., iii. p. 183.
Hepatus vanbenedeni Herklots, Bidjr. tot de Dierkunde, I. p. 35, pl. 1, f. 1 (1852).

Specimens were collected at Beaufort, N. C., Charlotte Harbor, Marcou Pass, and Sarasota Bay, Fla. Dr. Stimpson suggests a comparison of the young of this species with *H. tuberculatus* Saussure, but, on examination, the difference is as great as in the adult.

Family LEUCOSIDÆ.

Sub-Family Iliinæ.

Genus PERSEPHONE.

Persephone punctata Stm.

Cancer punctata Brown, Natural History of Jamaica, pl. 42, f. 3.
Persephone latreillei et P. lamarckii Leach, Zool. Mis., iii. p. 22.
Guaia punctata Edw., Hist. Crust., ii. p. 127.
Persephone guaia Bell, Trans. Linn. Soc'y, xx. p. 292.
Persephone punctata Stm., Ann. N. Y. Lyc., vii. p. 70.

Beaufort, N. C., Sarasota and Florida Bays, Fla.

Sub-Family Ebaliinæ.

Genus LITHADIA.

Lithadia cariosa Stm.

Lithadia cariosa Stm., Ann. Lyc., vii. p. 238.

Beaufort, N. C., Harbor Key, Fla., and Sarasota Bay, Florida. The Floridan forms have a less irregular carapax, but otherwise I can detect no difference.

Lithadia lacunosa, sp. n.

Carapax convex, with small circular depressions, similar in form and appearance to those on a lady's thimble. Closely resembling *L. cariosa* in form. Inner portions of branchial and cardiac regions moderately protuberant. Hepatic region but slightly excavate, the ridge crossing it being broad, low, and rounded, otherwise as in *L. cariosa.* Front elevated, and connected with cardiac region by a broad rounded ridge (in *cariosa* this ridge is narrow and more abrupt); a small tooth on the postero-lateral margin. The sulcus separating the cardiac from the branchial region is well marked, but not so much as in *cariosa.* Chelipeds with small tubercles. Abdomen of the male with a strong tooth directed backward, arising from the proximal margin of the penult joint.

A male from Sarasota Bay gives the following measurements: Length of carapax 9.7 mm., breadth 11.1 mm., ratio 100 : 135.

This species differs from *cariosa* in the broader carapax, the ornamentation, and more even surface; from *pontifera* in lacking the "bridged" fossæ between the cardiac and brachial regions; from *cadaverosa* in more even carapax and ornamentation, and in having but one tooth on the antero-lateral margin; from *cubensia* in having the meros of the chelipeds subcylindrical, and not expanded behind.

DROMIOIDEA.

Family DROMIIDÆ.

Genus DROMIDIA Stm.

Dromidia antillensis Stm.

Dromidia antillensis Stm., Proc. Phila. Acad., 1858, p. 225; Ann. Lyc. vii. p. 71.

A single specimen from Key West. Other localities are Tortugas and Key Biscayne (Stm.), St. Thomas, and Abrolhos, Brazil (Smith).

Genus HYPOCONCHA Guerin.

Hypoconcha arcuata Stm.

Hypoconcha arcuata Stm., Proc. Phila. Acad., 1858, p. 226; Ann. Lyc., vii. p. 72.

Professor Webster collected specimens at Florida and Sarasota Bays. I have seen others from Key West (A. S. Packard, Jr.). Stimpson had specimens from South Carolina and St. Thomas. It seems to me that both Guerin and Stimpson are right in explaining the manner in which this crab holds the protecting shell, that the two posterior pairs of feet and the projecting abdomen each do their part.

PORCELLANOIDEA.

Family POCELLANIDÆ.

Genus PETROLISTHES Stm.[1]

Petrolisthes sexpinosus Stm.

Porcellana galathina Say, l. c., i. p. 458 ? (non Bosc).
Porcellana sexspinosa Gibbes, Proc. Am. Assoc., iii. p. 190.
Petrolisthes sexpinosus Stm., Proc. Phila. Acad., 1858, p. 227.

Professor Webster collected specimens at Key West, Harbor Key, Florida Bay, and Sarasota Bay.

I am inclined to follow Stimpson in supposing that this is not the *Porcellana galathina* of Bosc, as it differs considerably from his figure, which represents a species with smaller hands, shorter fingers, the ridges of the carapax different, while the carapax itself is nothing like that of this species. This species has been reported from Georgia and Florida (Say), South Carolina and Key West (Gibbes) and Florida Keys (Stm.).

Petrolisthes jugosus Streets.

Petrolisthes jugosus Streets, l. c., 1872, p. 134.

I refer, with a doubt, a single specimen collected at Key West to this species, as it presents the following points of difference from Dr. Streets' description: The lobes of the front are indistinct. (The right hand is missing.) The posterior border of the hand is not pubescent, and there is no trace of a furrow on the upper portion of the hand; the anterior margin of the carpus has four teeth. In every other respect it agrees perfectly. Dr. Streets' specimens came from the Island of St. Martins, W. I.

[1] I would here straighten the synonymy of two species of this genus—

Petrolisthes danæ.
Porcellana bosii Dana, U. S. Expl. Exped. Crust., p. 421, pl. xxvi. f. 2 (non Savigny).
Porcellana danæ Gibbes, Proc. Elliot Soc'y, i. p. 11.
Petrolisthes braziliensis Smith, Trans. Conn. Acad., ii. p. 38.
Rio Janeiro (Dana).

Petrolisthes Helleri.
Porcellana danæ Heller, Reise der Osterreich Fregatte Novara, Crustaceen, p. 74 (non Gibbes).
Nicobars (Heller).

Petrolisthes armatus Stm.

Porcellana armata Gibbes, Proc. Am. Assoc., iii. p. 90; Proc. Elliot Soc'y, i. f. 11, pl. i. f. 4; Martens' Wieg. Arch., xxxviii. p. 121, pl. v. f. 11.

Petrolisthes armatus Stm., Proc. Phila. Acad., 1858, p. 227, vii. p. 73.

Specimens were collected at Sarasota, Charlotte, and Florida Bays. Other localities are Key West! (Packard), Florida (Gibbes), Aspinwall, St. Thomas, and Panama (Stm.), Cuba (Martens), Fonseca, west coast Nicaragua! (McNiel), Gulf of California (Lockington).

Dr. von Martens quotes *P. galathina* Bosc as a synonym of this species, which is surely erroneous.

Genus **PISOSOMA** Stm.

Pisosoma glabra, sp. n. Plate xiv. fig. 2.

Carapax convex, a little broader than long, polished, microscopically punctate. Front advanced, broad, three lobed, the median lobe being slightly more advanced than the lateral ones. Antennæ about twice as long as the carapax, the basal joints similar to those of *Petrolisthes*. Chelipeds short, stout; meros subcubical, its anterior margin distally armed with an acute tooth directed toward the carpus; carpus stout, broader than long, its anterior margin expanded, with a strong tooth on the proximal portion, the remainder with rounded teeth, the posterior portion of the upper surface is roughened, and the posterior margin distally armed with minute rounded teeth. Hand twice as long as broad, microscopically granulate, a shallow sulcus on the posterior portion of the palm producing a cristate appearance of the posterior margin; fingers not so long as palm, completely closing, the dactylus with a shallow groove above. Beneath, the chelipeds are smooth and polished. Ambulatory feet sub-cylindrical, hairy above. This species differs from Stimpson's description of his imperfect specimen of *P. riisei* in the simple, not bimarginate character of the front, etc.

Five specimens were collected at Key West.

Length of carapax 4.1 mm., breadth 4.5 mm., ratio 100 : 110.

Genus **PORCELLANA** Lamarck, Stimpson.

Porcellana pilosa Edw.

Porcellana pilosa Edw., Hist. Crust., ii. p. 255.

Carapax longitudinally convex, surface even, and covered with short stiff hairs arranged in transverse rows. Front advanced, three-lobed, median lobe projecting beyond the others. Chelipeds short, stout, unequal, and clothed above with a short pubescence, interspersed in which are stiff hairs, similar to those of the carapax. Carpus short, length and breadth about equal, the inner margin expanded, and armed with four or five acute teeth. Hands short and broad, almost sub-chelate, the thumb being very short, and the dactylus strongly curved. Ambulatory feet with pubescence and hairs similar to those on the carapax.

Specimens were collected at Sarasota Bay and Key West.

Length of Carapax.	Breadth.	Ratio.
4 mm.	5.1 mm.	100 : 128
6 mm.	6.2 mm.	100 : 103

Edwards's specimens were from Charleston, S. C.

Porcellana sayana.

Pisidia sayana Leach, Dict. Sci. Nat., xviii. p. 54.
Porcellana ocellata Gibbes, Proc. Am. Assoc., iii. p. 190. Ibid., Proc. Elliot Soc., i. p. 12, pl. i. f. 2.

Quite a number appear in this collection from Sarasota Bay. Gibbes' types came from South Carolina; Stimpson reports it from Fort Macon, N. C., Florida Keys, and St. Thomas.

At my request Mr. Edward J. Miers very kindly examined Leach's type in the British Museum, which was sent by Say under the name *Porcellana galathina*. He says: "Leach's specimens of *Porcellana* (*Pisidia*) *sayana* are certainly not referable to *P. sexspinosa*, as described by Gibbes, but appear to belong to *P. ocellata* of the same author. They agree well with Gibbes' description and with specimens of *P. ocellata* received by the British Museum from the Smithsonian Institution, differing only in being of smaller size and in no longer presenting any traces of the pink reticulations."

Porcellana sociata Say.

Porcellana sociata Say, Journ. Phila. Acad., i. p. 456.
Pisidia socia Leach, Dict. Sci. Nat., xviii. p. 54.
Porcellana sociata Gibbes, Proc. A. A. A. S., iii. p. 190. Ibid., Proc. Elliot Soc., i. p. 12, pl. i. f. 6.

Professor Webster collected specimens at Florida Bay and Harbor Key. Other localities are Fort Macon (Stm.), South Carolina, and Key West (Gibbes), Georgia, and Florida (Say, Leach).

Genus **POLYONYX** Stm.

Polyonyx macrocheles Stm.

Porcellana macrocheles Gibbes, Proc. Am. Assoc., iii. p. 191. Ibid., Proc. Elliot Soc., i. p. 6, pl. i. f. 5.

Polyonyx macrocheles Stm., Proc. Phila. Acad., 1858, p. 229. Faxon, B. M. C. Z., v. 256, pls. II. and III. (Development).

In this species the males are smaller, with a narrower carapax and with the chelipeds proportionately longer than in the female, as will be seen by the following measurements:—

Locality.	Sex.	Length.	Breadth.	Ratio.	Length of Larger Hand.
Sarasota Bay	♀	8.2 mm.	13.2 mm.	100 : 161	23.2
"	♀	7.5 mm.	12 mm.	100 : 160	22
"	♂	5.5 mm.	7.6 mm.	100 : 138	20.4
"	♂	6.4 mm.	9.2 mm.	100 : 144	24.5
Beaufort, N. C.	♂	6 mm.	9 mm.	100 : 150	23.7

According to Prof. Webster's labels, this species was found at Beaufort, N. C., and Shark Shoal, N. C., in tubes of *Chætopterus*, as was noticed by Stimpson. Stimpson and Gibbes had specimens from South Carolina. Newport, R. I. (Faxon).

Genus **EUCERAMUS** Stm.

Euceramus prælongus Stm. Plate xiv. fig. 4.

Euceramus prælongus Stm., Am. Journ. Sci. and Arts, II. xxix. p. 445.

Professor Webster obtained specimens of this curious crustacean at Beaufort, N. C. (7 faths.), and Florida and Sarasota Bays, Fla., from which the following description is drawn:—

Carapax nearly cylindrical, the sides but slightly arcuate; surface even, with minute transverse striæ, which curve forward on the sides. Front, between the eyes, about one-third the width of carapax, three toothed, median tooth longer and projecting further than the laterals. There is a slight excavation of the anterior margin over the eyes and antennæ. A minute acute spine at the antero-lateral angle, and a little posterior to this is a slight emargination of the lateral margin. Eyes minute, but little prominent.

Antennal flagella about three-fourths the length of the carapax. Feet stout; chelipeds stout; hands slightly roughened, fingers about as long as the palm, not gaping; second pair shorter than the third and fourth; fifth pair small, and curved in the same manner as in the other *Porcellanidæ*. Terminal segment of abdomen and its appendages resembling those of the allied genera, but narrower. Length of carapax 12 mm., breadth 6 mm., ratio 100 : 50.

Genus **HIPPA** Fabr., Edw.

Hippa emerita Fabr.

?*Cancer emerita* Linne, Syst. Nat. Ed., xii. p. 1055.

Cancer testudinarius Herbst, pl. xxii. f. 3.

Hippa emerita [*us*] Fabr., Suppl. Ent. Syst., p. 370. Desmarest Consid., p. 174, pl. xxix. f. 2. Edw. Hist. Crust., ii. p. 209. Dana, U. S. Ex. Ex. Crust., p. 409, pl. xxv. f. 9. Miers, Journ. Linn. Soc., xiv. p. 313, pl. v. f. 9.

Hippa talpoida Say, l. c., i. p. 160. Dekay, op. cit., p. 18, pl. vii. f. 17. Smith, U. S. Fish Comm., p. 548, pl. ii. f. 5. Ibid., Trans. Conn. Acad., iii. p. 311.

In the Union College collection appear specimens from the beach of Chesapeake Bay opposite Fort Monroe, Beaufort, N. C., Sarasota Bay, Fla. Specimens from the first locality measure 26 mm. in length of carapax. Mr. Miers has made a mistake in quoting Prof. Gibbes, as this species does not occur at Boston except in collections.

Cape Cod to Florida (Smith), Venezuela (Miers), Cuba and Mexico (Guerin), Rio Janerio (Dura, Heller, Miers), Corinto, West Coast Nicaragua! (McNiel). These specimens are certainly *H. emerita*, and not *H. analoga*, Stm.

Family ALBUNEIDÆ.

Genus **ALBUNEA** Fabr., Stm.

Albunea paretii Guerin.

Albunea paretii Guerin, Revue et Magazin de Zoologie, II. v. p. 48, pl. i. f. 10.

Albunea oxyophthalma Leach (MS.), White, List Crust. Brit. Museum, p. 57 (sine descr., teste Miers). Miers, Journ. Linn. Soc., xiv. p. 329, pl. v. f. 14–15.

A single specimen from Sarasota Bay agrees with Mr. Miers's description and figures, except that the median emargination is less deep and the lateral portion of the front more advanced and more curved, the eyes also appear to be rather more slender. It agrees well with Guerin's short description, and, as his was the first published description, his name will of course hold. Miers gives as localities St. Christophers, Cayenne, and Brazil. Guerin was not certain of the locality of his specimens, they were either from Genoa or America. His types do not exist in the collection of the Philadelphia Academy.

Genus **LEPIDOPS** Stm.

Lepidops venusta Stm.

Lepidops venusta Stm., Proc. Phila. Acad., 1858, p. 230. Ibid., Ann. Lyc., vii. p. 79. Miers, Journ. Linn. Soc , xiv. p. 332.

A single specimen, which I refer without a doubt to this species, was dug up on the beach near Fort Macon, N. C. It agrees well with Stimpson's description, and certainly is not *L. scutellata*, from which it differs in the shape of the eyes, the form of the front, the dactyli of the second pair of feet, etc. Stimpson's type was from St. Thomas.

PAGURIOIDEA.

Professor Webster collected a large number of specimens belonging to this sub-order, but I am unable to report on them.

THALASSINOIDEA.

Family **GEBIDÆ.**

Genus **GEBIA.**

Gebia affinis Say

Gebia affinis Say, l. c., i. p. 241. Smith, Fish Comm., p. 549, pl. ii. f. 7.

Specimens were collected at Beaufort, N. C., and Sarasota Bay, Fla. Long Island Sound to South Carolina (Smith), Charleston, S. C. (Gibbes).

Family **CALLIANASSIDÆ.**

Genus **CALLIANASSA.**

Callianassa stimpsoni Smith.

Callianassa stimpsoni Smith, Fish Comm., 1871–2, p. 549, pl. ii. f. 8.

Professor Webster collected specimens at Beaufort, N. C., and Northampton County, Va., Atlantic side. Southern States to Long Island Sound (Smith).

ASTACOIDEA.

Family **PALINURIDÆ.**

Genus **PANULIRUS** Gray.

Panulirus americanus Streets.

Palinurus americanus Lamarck, Ms.; Edw., Hist. Crust., ii. p. 298.
Panulirus americanus Streets, l. c., 1871, p. 242.

A single specimen was collected at Plantation Key, Fla., Antilles (Edw.), Key West (Gibbes), Isthmus of Panama (Streets).

I give below a revision of the genera of *Caridea* belonging to the families *Crangonidæ*, *Atyidæ*, and *Palæmonidæ*. It is founded on the arrangement of Dana. The genera of which I have seen specimens I have designated by the letter "o." As I have recently published a synonymical list of the North American Shrimps (Bulletin Essex Institute, x. pp. 53–71, 1878), I have refrained in most cases from giving the synonymy of the species collected by Prof. Webster.

CARIDEA.

Body generally laterally compressed, the carapax not united to the epistome, usually a broad lamelliform appendage (antennal scale) on the basal joint of the antennæ, sometimes, however, it is wanting; antennulæ bi- or tri-flagellate; mandibles varying in form, sometimes with, sometimes without a palpus; external maxillipeds generally pediform; feet generally long and slender; gills composed of lamellæ, five to eight pairs; abdomen long, the sides produced downwards.

Family CRANGONIDÆ.

Mandibles slender, incurved, cutting edge narrow, not dilate or bifid, without a palpus, first and second pairs of feet unequal.

Sub-Family Crangoninæ.

First pair of feet stouter than the second. Hand sub-chelate, the dactylus closing on the margin of the palm, the pollex being spiniform. External maxillipeds pediform.

o Genus Crangon Fabr.[1] Rostrum very short, eyes free, antennulæ biflagellate, first pair of pereiopoda stout, but little longer than the second, second pair slender, elongate, chelate, remaining pairs acuminate. Branchiæ five on each side. Type *Crangon vulgaris* Fabr.

Crangon vulgaris Fabr. Several specimens were collected at Northampton Co., Va.

[1] Including *Steiracrangon* Kinahan, Proc. Royal Irish Acad., viii. p. 68 (1862).

o Genus PONTOPHILUS Leach, Sars.[1] Rostrum short, eyes free; antennulæ biflagellate; first pair of pereiopoda stout, second pair very short, slender, chelate. Branchiæ seven, including a rudimentary one on the second maxillipeds. Type *Pontophilus spinosus* Leach.

o Genus SABINEA Owen.[2] Rostrum very short, eyes free, stout; second pair of pereiopoda very short, not chelate, dactylus minute. Branchiæ as in *Pontophilus*.

o Genus NECTOCRANGON Brandt.[3] Rostrum wanting; eyes nearly hidden by the carapax; second pair of pereiopoda chelate; dactyli of fourth and fifth pairs dilated, natatorial. Branchiæ five on each side, none on the second maxilliped. Type *Nectocrangon lar* (Owen sp.).

o Genus PARACRANGON Dana.[4] Rostrum elongate, eyes free; second pair of pereiopoda obsolete, fourth and fifth pairs acuminate gressorial. Type *Paracrangon echinatus* Dana.

Sub-Family **Lysmatinæ.**

First pair of pereiopoda stouter than the second, both pairs chelate, fingers subequal, carpus of the second pair annulate. External maxillipeds pediform.

o Genus NIKA Risso.[5] Rostrum short, antennulæ biflagellate Hands of first pair of pereiopoda dissimilar, one being chelate, the other not; carpus of second pair elongate, multiarticulate; hand minutely chelate. Type *Nika edulis* Risso.

o Genus LYSMATA Risso.[6] Rostrum elongate, sub-ensiform, dentate; antennulæ triflagellate; first pair of pereiopoda stout, of medium length, chelate; second pair elongate, carpus multiarticulate; hand rudimentary. Type *Lysmata seticauda* Risso.

o Genus HIPPOLYSMATA Stm.[7] Rostrum elongate, antennulæ biflagellate. External maxilliped elongate, furnished with exog-

[1] Forhandlingar i Vedenskabs Selskabet i Christiania, 1861, f. 183. Including *Ægeon* Risso.

[2] Appendix to the voyage of Captain Ross, p. 82 (1835).

[3] *Argis* Kroyer Naturhistorisk Tidsskrift. iv. p. 267 (1842–3) (nom. præoc.). *Nectocrangon* Brandt, in Middendorff's Reise in den Ausserten Norden und Osten Siberiens, Band II. Zoologie, Theil I. p. 114 (1851).

[4] U. S. Exploring Expedition, Crustacea, p. 537.

[5] *Processa* Leach. [6] *Melicerta* Risso.

[7] Proc. Phila. Acad., 1860, p. 26.

nath; first four pairs of feet with exopodite; first pair rather stout, chelate, second filiform chelate, carpus multiarticulate. Type *Hippolysmata vittata* Stm.

Hippolysmata wurdemanni (Gibbes, sp.) Stm. Professor Webster collected a large number of this species at Sarasota and Florida Bays, Fla. There also occur in the collection some young specimens from Bird Shoal, Beaufort, N. C., which I doubtfully refer to this species. I have seen specimens from Fort Jefferson (Lieut Jacques), and Key West (Packard).

o Genus TOZEUMA Stm.[1] Body greatly elongate, slender, compressed; rostrum slender, very long, sometimes scarcely shorter than the body; antennulæ short, biflagellate: external maxillipeds very short, without exognath or flagellum, pereiopoda without palpi; first pair very short, stout, chelate, second filiform, chelate; carpus triarticulate, telson elongate, lanceolate. Type *Tozeuma lanceolatum* Stm.

Tozeuma carolinensis Kingsley (Plate xiv. fig. 8), was collected at Charlotte Harbor, Fla., and Beaufort, N. C.; at the latter place in a surface net.

o Genus LATREUTES Stm.[2] Carapax with a dorsal median spine. Rostrum elongate, lamellate, antennulæ biflagellate, basal scale short, orbiculate, hidden under the eyes; antennal scale acute; external maxillipeds short, with exognath; first four pairs of pereiopoda with palpi, first two pairs chelate, second with the carpus triarticulate. Type *Latreutes ensiferus* (Edw., sp).

Genus RHYNCHOCYCLUS Stm.[3] Rostrum large, lamellate, obiculate, antennulæ biflagellate, peduncle short; external maxillipeds short, with exognath; first four pairs of pereiopoda palpigerous; first two chelate, second with the carpus triarticulate. Type *Rhynchocyclus planirostris* (De Haan, sp.).

o Genus CONCORDIA,[4] nov. Dorsum of carapax strongly protuberant; rostrum very short, eyes free; antennulæ with two very short flagella; antennal scale very small; flagellum moderate; external maxillipeds short, stout; first pair of pereiopoda shorter

[1] Proc. Phila. Acad., 1860, p. 26. *Angasia* White, Sp. Bate Proc. Zool. Soc. London, 1863, p. 498.

[2] Proc. Phila. Acad., 1860, p. 27.

[3] *Cyclorhynchus* De Haan, Fauna Japonica, Crustacea, p. 174 (nom. præoc.) *Rhynchocyclus* Stm., Proc. Phila. Acad., 1860, p. 27.

[4] Named in honor of Union College, to which the specimens belong.

and stouter than the second pair, which in turn are shorter than the remaining pairs; the carpus two articulate. Type *Concordia gibberosus*, sp. n.

Concordia gibberosus, sp. n. (Plate xiv. fig. 5). Carapax with the dorsum strongly elevated, and armed with five spiniform teeth; the first of which is on the rostrum, the last at about the middle of the carapax; carapax between the teeth ecarinate; rostrum very short, not exceeding the short and stout eyes; antennulæ with two very short flagella, the outer swollen and ciliate; antennal scale extending slightly beyond the peduncle of the antennulæ; flagella short, small, regularly tapering, about twice the length of the carapax. First pair of pereiopoda short, stout; fingers about as long as the palm, second pair longer and more slender; carpus two-jointed, first joint longer than the meros, and about twice as long as the second, remaining feet slender, elongate, the propodal joints with a few spines on the posterior margin; dactyli short, curved, with spines on the concave margin; abdomen strongly bent at the middle; telson narrow, tapering, sides straight, extremity acute.

A female with eggs from Fort Macon was about 8 mm. long.

Sub-Family **Gnathophyllinæ.**

Second pair of pereiopoda larger than the first pair, external maxilliped broad, operculiform.

o Genus GNATHOPHYLLUM, Latr. Rostrum short, compressed, antennulæ with two very short flagella, carpus of the second pair of pereiopoda not annulate.

FAMILY **ATYIDÆ.**

Mandibles stout, not palpigerous, crown broad, dilated, slightly divided. Second pair of maxillipeds short and broad; first two pairs of pereiopoda nearly equal, the carpus of the second not annulated.

Sub-Family **Atyinæ.**

Pereiopoda without exopodite.

o Genus ATYA Leach Rostrum short, depressed; antennulæ biflagellata; external maxillipeds small, slender; first two pairs of pereiopoda similar, carpus lunate, bearding the propodus on the lower portion, fingers with long pencils of hairs; third, fourth, and fifth pairs much larger and stouter. Type *Atya scabra* Leach.

o Genus EVATYA Smith.[1] Rostrum prominent, carinate, with spines above, anterior portion of carapax with scattered spines and spiny carinations. Third pair of pereiopoda very stout and tuberculate, basis and coxa anchylosed, ischium and meros firmly united, propodus much shorter than carpus, dactylus very short, unguiform. Type *Evatya crassa* Smith.

o Genus ATYOIDA Randall.[2] Rostrum, antennæ, antennulæ, and the two anterior pairs of pereiopoda as in *Atya;* third pair of pereiopoda elongate, scarcely stronger than the two anterior pairs.

Known species:—

Type *A. bisulcata* Randall. l. c. p. 140. *Sandwich Islands.*
A. tahitensis Stm. Proc. Phila. Acad., 1860, p. 28. *Society Islands.*
A. mexicana Stm. Am. Journ. Sci. and Arts, II., xxvii. p. 446. Caradina mexicana Saussure, op. cit., p. 45, pl. iv. f. 26, *Mexico.*
A poeyi Guerin, in Raman de Sagra Hist. Cuba, *Cuba.*
A. glabra Kingsley. Proc. Phila. Acad., 1878, p. 93, *West Coast Nicaragua.*

o Genus CARADINA M. Edw. Rostrum moderate, antennulæ biflagellate; second pair of pereiopoda longer than first, fingers of both pairs with pencils of hairs, carpus of first pair very short, excavate in front, of second pair oblong, subcylindrical. Type *Caradina typus* M. Edw.

Genus ATYEPHYRA Brito Capello.[3] Rostrum many toothed, carapax with supraorbital and antennal spines; hands hairy, and resembling those of Atya; eyes well developed.[3] Type *A. rosiana.*

Genus TROGLOCARIS Dormitzer.[4] Rostrum thin, with fine teeth on the borders; supraorbital and antennal spines present; eyes rudimentary, pereiopoda much as in Caradina. Type *Troglocaris schmidtii* Dorm.

[1] Second and third Reports Peabody Academy of Science, p. 95 (1871).

[2] Journ. Phila. Acad., viii. p. 140 (1839). According to E. von Martens (Archiv für Naturgeschichte, xxxiv. pl. i. p. 47, 1868), this is not a valid genus, as the young of *Atya* have the third pair of pereiopoda as in *Atyoida.*

[3] Discr. esp. nov. de Crustaceos de Portugal, p. 5, 1866.

[4] Lotos, III. p. 85 (1853).

Sub-Family **Ephyrinæ.**

Pereiopoda with an exopodite.

Genus MIERSIA Kingsley.[1] Rostrum toothed, antennulæ biflagellate, two anterior pairs of pereiopoda, chelate small; the carpus of the second pair not annulate; the three posterior pairs slender. Type *Miersia pelagica* (Risso sp.).

The known species are:—

pelagica (Risso sp.). *Mediterranean.*
punctulata (Risso sp.). *Mediterranean.*
compressa (De Haan sp.). *Japan.*

FAMILY **PALÆMONIDÆ.**

Mandibles stout, incurved, deeply bipartite, apical process narrow, oblong.

Sub-Family **Alpheinæ.**

First pair of feet the larger, chelate; second slender, filiform, generally chelate, carpus frequently annulate.

Section I. MANDIBLES WITH A PALPUS.

o Genus ALPHEUS Fabr.[2] Rostrum very short or wanting, antennulæ biflagellate, eyes hidden under the carapax; mandibles with a two-jointed palpus; external maxillipeds slender, moderate; first pair of pereiopoda generally greatly differing in size; carpus of second pair annulate. Type *Alpheus rapax* Fabricius.

Alpheus minus Say. Numerous specimens were collected. The localities are Beaufort, N. C., Key West, Harbor Key, Sarasota, and Florida Bays, and Marcou Pass. Three specimens from Harbor Key were the largest that I have ever seen, measuring respectively 40.3 mm., 40.8 mm., and 42.3 mm. in length. Among those collected at Key West were several of the form described by Gibbes as *A. formosus*, and two which approached *A. floridanus* in size, form of front, and hand.

Alpheus websteri, sp. n. Carapax slender, compressed, rostrum acute, separated from the orbital hoods by deep sulci. Orbital hoods acute, but not spinose. Penult joint of antennular peduncle

[1] *Ephyra* Roux, Edwards, De Haan, Dana, Heller (nom. præoc.).

[2] Including *Betæus* Dana. Vide Kingsley, Bulletin U. S. Geol. and Geog. Survey, iv. p. 189, 1878.

about twice as long as the last joint. Antennal scale narrow, regularly tapering, lamellar portion not extending to the spine terminating the external margin. External maxillipeds elongate, extending beyond the antennal peduncle, the last joint with a long pencil of hairs. Larger hand inflated, the upper outer proximal portion circumscribed by an impressed line, a slight constriction of the margins near the articulation of the dactylus; thumb short, with a shallow groove on the outer surface, which extends a short distance on the palmar portion. Dactylus contorted, extending beyond the thumb, extremity rounded. The dactylus and distal portions of the propodus punctate and setose, especially on the inner surface. Smaller hand subcylindrical, fingers about as long as palm, gaping, tips acute, margins fringed. Carpus of second pair five-jointed, first joint three times, and second twice as long as the third or fourth, which are subequal and slightly shorter than the fifth. The telson regularly tapering, the extremity sinuate-truncate. The exopodite of the sixth pair of pleopoda (abdominal feet) bears on the external distal angle of the penultimate joint, an articulated conical black spine, the color persisting in alcohol, and which will readily separate this from any species with which I am acquainted. Its affinities are with *A. sulcatus* of Panama and Peru.

Three specimens from Key West, the largest 25 mm. in length.

Alpheus heterochelis Say. Specimens were collected at Sarasota Bay, Charlotte Harbor, Marcou Pass, Harbor Key, and at Northampton County, Virginia, Eastern Shore, Atlantic side; this last being the farthest north from which the species has been reported.

Alpheus packardii, sp. n. Front, antennulæ and antennæ as in *A. heterochelis* except that the sulci between the base of the rostrum, and the ocular hoods are deeper, and last joint of antennular peduncle longer than in that species. External maxillipeds short, not reaching to the tip of antennal scale. Chelipeds unequal, meros with an acute tooth on the upper distal angle; larger hand strongly compressed, with a sharp tooth above near the articulation of the dactylus, beyond this the hand becomes narrower by means of a sharp bend of the inferior margin, dactylus contorted, and working at an angle of about 30° with the plane of the hand. Smaller hand more slender, but similarly ornamented and armed, the dactylus, however, being spatulate, working vertically, and with its margins and those of the opposing thumb densely fringed with hairs. Carpus of the second pair with the first two joints equal, and each as long as the third and fourth together, which, in turn, are subequal, and each slightly shorter than the fifth joint. This species, in a systematic arrangement of the North American forms, would stand between *A. heterochelis* and *A. transversodactylus*, but more nearly to the former. The differences from that species are not easy to describe, but are well marked in the specimens.

I have dedicated this species to my friend and former instructor, Dr. Alpheus S. Packard, Jr., not only as a token of esteem, but also from a recognition of the appropriateness of the name. Three males from Key West. Length, 22 mm.

Alpheus candei Guerin in de Sagra's Historia de Cuba Crustaces (p. L. pl. ii. f. 9). *Alpheus transversodactylus* Kingsley. Two specimens were taken at Key West.

Bes des these species of *Alpheus* there is a single specimen approaching *A. candei* most nearly in form, but differing from that species in form of front, and in having a large swollen pyriform hand without grooves, etc., which I hesitate to describe as new.

o Genus Alope White.[1] Rostrum short, toothed above, and placed in a groove formed by two spines which arise at the anterior portion of the carapax, and extend nearly as far as the rostrum. Eyes but little salient, antennulæ biflagellate; external maxilliped very long; hands of first pair of pereiopoda equal; carpus of second pair annulate. Type *Alope palpalis* White.

Genus Arete Stimpson.[2] Rostrum short, rounded above; eyes free, antennulæ biflagellate; antennal scales larger. External maxillipeds slender, moderate; hands of first pair of pereiopoda large, equal, inversely depressed; dactyli external; second pair short; carpus 4-articulate. Type *Arete dorsalis* Stm.

o Genus Athanas Leach. Rostrum short; antennulæ triflagellate; eyes but little salient; external maxillipeds short, slender. Frst pair of pereiopoda long, stout, unequal; second filiform; carpus 5-articulate.

o Genus Hippolyte Leach.[3] Rostrum moderate, more or less

[1] Annals and Magazine of Natural History, second series, vol. i. p. 225, 1848.

[2] Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 32.

[3] *Bellidia* Gosse. Annals and Magazine of Natural History, 4th series, vol. xx. p. 313 (1877). I have not seen Costa's description of *Periclemenes* (Annal. del Accad. degli Aspiraz. Natur di Napoli II. p. 285, 1844). Erichson

ensiform, not articulated to the carapax; antennulæ biflagellate; external maxillipeds slender; first pair of feet short, equal; second pair slender; carpus multiarticulate. Type *Hippolyte spinus* (Sowerby sp.).

Genus CARIDION Göes.[1] Rostrum elongate, cultrate; mandibles with a three-jointed palpus: antennulæ biflagellate; first two pairs pereiopoda nearly equal, chelate, carpus of the first pair very short; of the second elongate, obsoletely biarticulate. Type *Caridion gordoni* (Spence Bate sp.).

Genus BYTHOCARIS G. O. Sars.[2] Rostrum very small, simple, unarmed; antennulæ biflagellate; antennal scale large and broad; external maxilliped with the last joint dilated, obliquely truncate, and armed with teeth, a minute exognath present. First pair of feet as in *Hippolyte*: second pair slender, weak; carpus multiarticulate. Type *Bythocaris simplicirostris* G. O. Sars.

Genus CRYPTOCHELES G. O. Sars.[3] Rostrum small, narrow, toothed above; antennulæ biflagellate; antennal scale large, externally dentate; last joint of external maxillipeds with the apex somewhat bipartite, a small exognath present. First pair of pereiopoda very short; hand very elongate and attenuate, digits very short, and with difficulty visible; second pair slender; carpus 7-jointed. Type *Cryptocheles pygmæa* G. O. Sars.

o Genus RHYNCHOCINETES M. Edw. Resembling *Hippolyte*. Rostrum ensiform, movable, articulated to the carapax; antennulæ biflagellate; carpus of second pair of pereiopoda not jointed. Type *Rhynchocinetes typus* M. Edw.

o Genus OGYRIS Stm.[4] Carapax not rostrate, or with rostrum very small, as in the genus *Alpheus*. Eyes very long; antennulæ

in the Archiv für Naturgeschichte, 1846, pt. 2, p. 310-311, says that there are no points mentioned by Costa which would not apply to *Hippolyte*. On the other hand Heller (Crustaceen des südlichen Europa, p. 256, 1863) regards one of Da Costa's species (*P. elegans*) as belonging to the genus *Anchistia* of Dana For remarks on the synonymy of *Hippolyte* and that of *Virbius*, attention is called to Smith, Trans. Conn. Acad. v. pp. 62 and 63, 1879.

[1] Œfversigt af K. Vetensk. Akad. Förhandl. 1863, p. 170. *Doryphorus* Norman, Ann. et Mag. Nat. Hist. 3d series, viii. p. 276, 1861 (nom. præoc.).

[2] G. O. Sars, Saerskilt aftrykt af Vidensk. Selsk. Forhandlinger, p. 5, 1869.

[3] Vidensk. Selsk. Forhandlingar, p. 150, 1868.

[4] Stimpson, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 36.

biflagellate, the peduncle with a spine externally on the basal joint; antennal scale shorter than antennal peduncle; mandible with a two-jointed palpus; external maxilliped long, with a slender exognath; pereiopoda without epipodites; carpus of the second pair triarticulate. Type *Ogyris orientalis* Stm.

Ogyris alphærostris, sp. n. (Plate xiv. fig. 7.) Carapax smooth, without dorsal carina; rostrum very small. triangular, reminding one of that of *Alpheus*. Eyes resembling those of *Hippa*, elongate, slender, half as long as the carapax, and extending slightly beyond the antennal peduncles, the cornea but slightly larger than the ocular peduncle. Antennulæ with a spine on the outer surface of the basal joint; biflagellate, flagella equal, and about as long as the peduncle. Antennæ with the basal scale narrow, lanceolate, reaching nearly to the tip of the penult joint of the peduncle; flagella three times as long as the peduncle, or one and one-half times the length of the carapax. External mallipeds long, stout, the distal joint being very small, and furnished with long hairs, exopodite slender. First pair of pereiopoda slender, chelate; meros, carpus, and hand nearly equal, fingers slightly longer than the palm. Second pair very long, slender, chelate; carpus triarticulate, hand similar to that of first pair. Third and fourth pairs subequal, slender; the dactyli slender and narrow, being not over one-third the width of the preceding joints. Fifth pair very slender, more so than any of the preceding with the ischium longer than the meros, which in turn is about as long as the three last joints; carpus, propodus, and dactylus subequal. The three last pairs of pereiopoda have long hairs on the distal joints. Abdomen smooth, rounded above; telson short, with the sides arcuate, and the tip rounded.

Union College, No. 407, Northampton Co., Va., Eastern shore, Atlantic side. H. E. Webster.

Length 19.5 mm.

Having but a single specimen, and that in poor condition, I have not been able to study it as thoroughly as I could wish. It agrees, as far as I have been able to examine it, with Stimpson's diagnosis of the genus except in the following particulars. The carapax is not cristate, and has a minute rostrum; the antennal flagella are much longer than in the type species; the mandibles, as the specimen is unique, I have not been able to examine. It is the second species of the genus known, and is interesting on account of its habitat; the other species, *O. orientalis* Stm., coming from China and Japan.

Genus PTEROCARIS Heller.[1] Carapax and abdominal segments broadly expanded at the sides. These expansions lamellate and three-lobed, corresponding one to the antennal segments, one to the mandibular, and the third to the abdominal segments. Eyes small, just visible in front of carapax; antennulæ biflagellate; antennæ with basal scale; external maxillipeds with exopodite and rudimentary epipodite. Type *P. typica* Heller.

Section II. MANDIBLES WITHOUT A PALPUS.

Genus AUTONOMEA Risso.[2] Rostrum short, eyes prominent, antennulæ biflagellate, antennal scale wanting. First pair of pereiopoda stout, chelate; second not chelate; carpus not annulate. Type *Autonomea olivii.*

o Genus VIRBIUS Stimpson[3] Dorsum of carapax and rostrum ecarinate; antennulæ biflagellate; antennal scale present. External maxillipeds short, with exopodite. Pereiopoda without epipodites. Carpus of first pair of pereiopoda excavate in front; carpus of the second pair triarticulate. Type *Virbius acuminatus* (Dana sp.).

o Sub-genus THOR Kingsley.[4] Rostrum short; antennulæ, antennæ, and external mallipeds as in *Virbius.* Carpus of first pair of pereiopoda not excavate; carpus of second pair 5-articulate. Type *Thor floridanus* Kingsley.

Thor floridanus Kingsley. (Pl. xiv. fig. 6.) Specimens were collected by Professor H. E. Webster at Harbor Key and Sarasota Bay, Florida.

[1] Sitzungsberichte der k. Akad. Wissenschaft. Wien. XLV. pt. i. p. 395, pl. i. f. 7–18 (1862).

[2] I take the fact that the mandible of *Autonomea* is without a palpus from Heller (Crust. Südlichen Europa, p. 223), though in his generic diagnosis on p. 249 he makes no mention of the mandible, but takes his description from Desmarest. Heller had never seen specimens of this genus. Risso (Crust. Nice, pp. 166–169, 1816) does not mention the mandibles.

[3] Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 35. For remarks on this genus, vid. Smith, Trans. Conn. Acad. v. p. 62, 1879. *Caradina tenuirostris* Spence Bate, Proc. Zool. Soc'y, London, 1863, p. 501, pl. xl. f. 4, from Australia, belongs to this genus.

[4] Proc. Acad. Nat. Sci. Philadelphia, 1878, p. 94.

Sub-Family **Pandalinæ.**

Antennulæ biflagellate, mandibles with a palpus, anterior pereiopoda very slender, not chelate; second filiform chelate; carpus multiarticulate.

o Genus PANDALUS Leach.[1] Type *Pandalus montagui* Leach.

Sub Family **Palæmoninæ.**

Two anterior pairs of pereiopoda chelate; carpus of none annulate; second pair larger than the first, pereiopoda without palpi.

Section I. MANDIBLES WITHOUT A PALPUS.

A. Antennulæ biflagellate.

Genus TYPTON Costa.[2] Rostrum small, eyes free, antennal scale absent, external maxillipeds pediform, with exognath. Type *Typton spongiola* Costa.

o Genus PONTONIA Latreille. Rostrum short, eyes prominent, antennulæ with the outer flagellum bifid at the extremity; antennal scale moderate. External maxillipeds suboperculiform with exognath; second joint broad, longer than remaining joints together, these last cylindrical. Type *Pontonia custos* (Forskal sp.). Guerin. *Pontonia tyrrhena* (Risso sp.) Latreille.

Pontonia unidens, sp. n. (Pl. xiv. f. 9.) Carapax pubescent, depressed; rostrum short, acute, slightly depressed, not extending as far forward as the eyes; orbital spine present though small; cervical suture well marked; eyes stout, reaching the last joint of the antennular peduncle. Antennulæ with the joints of the peduncle sub-equal; the flagella very short, not as long as the peduncle. Antennal scale about twice as long as broad, extremity rounded and reaching to the last joint of antennular pe-

[1] *Pontophilus* Risso, Hist. Nat. Europe Merid. t. v. p. 63, 1826; Brandt in Middendorff's Reise in den Aussersten Norden und Osten Siberiens, Bd. ii. Theil i. p. 122, 1851.

[2] Annali dell' Acad. Segli Aspir. Natur di Napoli ii. 1844 (Teste Heller). *Pontonella* Heller, Verhandlungen des Zool. Bot. Verein in Wein, 1856, p. 624. Rev. A. M. Norman (Ann. and Mag. Nat. Hist. IV. ii. p. 176, 1868) compares this genus with *Alpheus*. It is far more nearly related to *Pontonia*. Its resemblance to *Antonomea*, in the absence of the antennal scale, was noticed by Heller.

dunele. First pair of pereiopoda slender, longer than the carapax; meros, carpus, and hand nearly equal, the fingers half as long as the palm. Second pair of feet unequal; larger hand inflated, longer than the carapax, pubescent; fingers one third the length of the palm, incurved and slightly depressed; the dactylus with a large obtuse tooth near the base, which fits into a corresponding cavity in the pollex (as in many species of *Alpheus*); pollex without teeth. Smaller hand three-fourths as long as the larger, cylindrical straight fingers one-third as long as the palm. Remaining pereiopoda moderate, minutely unguiculate. Telson about twice as long as broad, sides strongly arcuate.

Key West, Fla., A. S. Packard, Jr.

Length 10 mm.

This species differs from *P. domestica* Gibbes in the pubescence of the carapax and hands, and in having but one tooth on the dactylus of the larger hand of the second pair and none on the thumb, etc. etc. It may prove to be the *Pontonia mexicana* of Guerin-Meneville in Ramen de la Sagra's Historia fisica, politica y natural de la Isla de Cuba, 1856. The types are in the Museum of the Peabody Academy of Science at Salem, Mass. None were collected by Prof. Webster.

Genus Coralliocaris Stm.[1] Rostrum small; eyes large and prominent; antennal scale very broad; external maxillipeds operculiform; all the joints of nearly equal width; second pair of pereiopoda large, long, subequal; dactyli of posterior pairs with a protuberance on the under side near the base. Type *Coralliocaris superbus* Dana, sp.

Genus Harpilius Dana.[2] Closely allied to *Pontonia*, but differing in having the distal joints of the external maxillipeds together longer than the second joint; second pair of pereiopoda long, slender, equal. Type *Harpilius lutescens* Dana.

o Genus Anchistia Dana.[3] Rostrum long, slender, frequently ensiform; eyes prominent; antennulæ with one flagellum partly bifid; extenal maxillipeds slender, pediform; second pair of pe-

[1] Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 38. *Œdipus* Dana, U. S. Ex. Ex. Crust., p. 572, 1851 (nom. præoc.).

[2] Op. cit., p. 574, 1851.

[3] Op. cit., p. 577 (1851), *Pelias* Roux, Memoire sur le Salicoques, p. 25 (1831). Heller, Sitzungsber. der K. Akad. Wiss. Wien, xlv. pt. 1, p. 406 (1862), non Merrian (1820).

reiopoda slender, long, equal; dactyli of posterior pairs long, slender, nearly straight. Type *Anchistia gracilis* Dana.

B. Antennulæ triflagellate.

Genus EURYHYNCHUS Miers.[1] "Rostrum triangular, broad at base, acute, very short, barely reaching the extremity of the eyes; anterior margin of carapax with a small spine between the eyes and the rostrum and another below the point of insertion of the peduncle of the antennæ; antennæ with a small basal scale; antennulæ triflagellate; outer maxillipeds slender, second pair of legs nearly as in *Anchistia;* tarsi of last three pairs of legs nearly straight, acute." Type *E. wrzesnowski* Miers.

I am uncertain as to the exact position of this genus, as the author says nothing concerning the mandibles. There also exist several discrepancies between the description and figures (Plate lxvii. f. 2–2 a). The spine on the anterior margin being represented as external to the eyes, and the first pair of feet being the larger, which, if true, would remove it to the *Alpheinæ*, from all genera of which, however, it is separated by the triflagellate antennulæ. Miers compares it with *Anchistia* and *Harpilius*, and in that locality I allow it to remain.

Genus PALÆMONETES Heller.[2] Antennæ, antennulæ, and pereiopoda as in *Palæmon;* carapax with antennal and branchiostegal spines, hepatic spine wanting; rostrum long, lamellate. Type *Palæmonetes varians* (Leach, sp.).

Palæmonetes carolinus Stm. Specimens were collected by Prof. Webster at Beaufort, N. C., and Marcou Pass, Fla.

Palæmonetes vulgaris (Say, sp.), Stm. Beaufort, N. C., Northampton Co., Va., and Charlotte Harbor, Fla.

o Genus UROCARIS Stm.[3] Body slender, compressed; rostrum cristate and toothed above, beneath straight, and edentulous; ocular peduncles long; abdomen slender, elongate, the sixth segment very much so. Type *Urocaris longicaudata* Stm.

Urocaris longicaudata Stm. (l. c., p. 39.). As Stimpson's description is very short, and as this species has not been noticed by subsequent writers, I append a short description, based upon speci-

[1] Proceedings of the Zoological Society of London, 1877, p. 662.

[2] Zeitschrift für Wissenschaftliche Zoologie, xix. p. 157.

[3] Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 39.

mens collected by Prof. Webster at Beaufort, N. C., Marcou Pass, and Charlotte Harbor, Fla. Only four specimens were obtained, two male and two female.

Rostrum compressed, not reaching the extremity of the antennular peduncles; above arcuate, with seven or eight teeth, the second of which is directly above the insertion of the eyes; antennal scale large, extending beyond the antennular peduncle, the sides parallel, the extremity obliquely rounded, truncate; first pair of pereiopoda reaching the tip of the antennal scale, the second longer, the fingers of each about as long as the palm, remaining feet bi-unguiculate, all very slender and almost filiform; abdomen between four and five times the length of the carapax; third segment (and sometimes the fourth also) of the abdomen swollen, fifth short, sixth about the length of the carapax; telson slender, elongate, sides straight, regularly tapering to the acute tip. The female appears to be rather stouter than the male. Length 15.5–20 mm.

Section II. Mandibles with a Palpus.

A. Antennulæ biflagellate.

Genus Palæmonella Dana.[1] Body not depressed; rostrum moderate; eyes of medium size; mandibular palpus two-jointed, very short; antennulæ bifiagellate, one flagellum with the apex bifid; external maxillipeds slender, pediform. Type *Palemonella tenuipes* Dana.

o Genus Hymenocera Latreille. Antennulæ biflagellate, one flagellum membranous, dilated, and foliaceous; first pair of pereiopoda very slender, hand minute, second stouter, very broad, hand and dactylus membranous.

B. Antennulæ triflagellate.

o Genus Palæmon Fabr.[2] Rostrum lamellate, dentate; eyes free; mandibles with a three-jointed palpus; external maxillipeds slender. Type *Palæmon squilla* (Linne, sp.).

[1] U. S. Expl. Exped. Crust., p. 582.

[2] *Leander*, Desmarest, Annales Société Entomologique de France, vii. p. 87, 1849. *Bithynis*, Philippi, Archiv für Naturgeschichte, xxvi. pt. 1, pp. 161–164 (1860). *Macrobrachium*, Spence Bate, Proc. Zool. Soc'y London, 1868, p. 363.

Genus CRYPHIOPS Dana.[1] Rostrum of medium size; eyes wholly hidden under the carapax, as in *Alpheus;* external maxillipeds slender. Type *Cryphiops spinulosimanus* Dana.

Sub-Family **Oplophorinæ.**

First pair of pereiopoda either didactyle or vergiform, second stouter, chelate; antennulæ biflagellate.

Genus OPLOPHORUS M. Edw. Rostrum long, dentate, pereiopoda all palpigerous; four anterior chelate; antennal scale with the external margin spined; abdomen armed above with one or more long spiniform processes. Type *Oplophorus typus* M. Edw.

Genus CAULURUS Stm.[2] Rostrum long or short; basal scale of antennulæ wanting; basal scale of antennæ externally unarmed; external maxillipeds pediform, with exognath; pereiopoda furnished with exopodite, the first two pairs chelate, the second pair slender and long; dorsum of abdomen unarmed; sixth abdominal segment long and slender. Type *Caulurus pelagicus* Stm.

As there is nothing except the length of the rostrum to separate *Xiphocaris* from *Caulurus*, I have thought best to unite them. *Xiphocaris* has but a single species, *Hippolyte elongata* Guerin = *Oplophorus Americanus* Saussure.

Genus THALASSIOCARIS Stm.[3] Rostrum and antennulæ as in *Oplophorus.* Feet not palpigerus, anterior pair not chelate; second pair stout, chelate; mandibular palpus triarticulate; third segment of abdomen prolonged into a long spine above. Type *Thalassiocaris lucidus* (Dana, sp.).

FAMILY **PENÆIDÆ.**

Genus SICYONIA Edw., Stm.

Sicyonia lævigata Stm. A single specimen of this species was collected at Sarasota Bay, Fla.

Sicyonia carinata M. Edw.

Palæmon carinatus Olivier, Encyclopédie Méthodique, viii. p. 667 (teste Edw.).

---

[1] Op. cit., p. 594.

[2] Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 42. *Xiphocaris*, E. von Martens, Archiv für Naturgeschichte, xxxviii. Bd. i. p. 139 (1872).

[3] Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 42. *Regulus*, Dana, op. cit., p. 597 (nomen præoccupatum).

Sicyonia carinata M. Edw., Hist. Nat. Crust., ii. p. 410. Dana, U. S. Ex. Ex. Crust., p. 602. Smith, Trans. Conn. Acad., ii. p. 40. Von Martens, Archiv für Naturgesch. xxxviii. p. 142.

Of this species, which is reported from Rio Janeiro by Edwards and Dana, and from Cuba by von Martens, two specimens were collected by Prof. Webster, one at Sarasota Bay and the other at Charlotte Harbor.

Genus PENEUS Fabr.

Peneus constrictus Stm. A single specimen was collected at Marcou Pass.

Peneus braziliensis Latreille. From Beaufort, N. C., Marcou Pass, Charlotte Harbor, and Sarasota Bay, Fla. I would here say that the specimens described by me as *Peneus brevirostris* (Proc. Acad. Nat. Sci. Philadelphia, 1878), from the west coast of Nicaragua, prove to be *P. braziliensis*, thus adding another to the list of species common to both coasts.

In my "List of Decapod Crustacea of the Atlantic Coast, whose range embraces Fort Macon" (Proceedings Philadelphia Academy, 1878, pp. 316–330), I enumerated sixty-five species, of which fifty-three had at that time been reported from Fort Macon. In this paper six more of these species are reported from there, while *Polyonyx macrocheles*, *Lepidops venusta*, *Hippolysmata wurdemanni*, and *Concordia gibberosa*, which were not enumerated in my list, were found there by Prof. Webster, and *Ogyris alphærostris*, from its near locality, may reasonably be expected there.

EXPLANATION OF PLATE.

Fig. 1. *Mithraculus hirsutipes*; 1*a*. Antennal region.

Fig 2. *Pisosoma glabra*.

Fig. 3. *Eupilumnus websteri*; 3*a*. External maxilliped.

Fig. 4. *Euceramus prælongus*; 4*a*. External maxilliped. 4*b*. Telson.

Fig. 5. *Concordia gibberosa*.

Fig. 6. *Thor floridanus*; 6*a*. Antennula. 6*b*. Mandible.

Fig. 7. *Ogyris alphærostris*.

Fig. 8. *Tozeuma carolinensis*.

Fig. 9. *Pontonia unidens*; larger hand outside; 9*a*. Ditto inside.

December 2.

The President, Dr. Ruschenberger, in the chair.

Thirty-six persons present.

December 9.

The President, Dr. Ruschenberger, in the chair.

Fifty persons present.

A paper entitled "Description of a Fœtal Walrus," by Harrison Allen, M.D., was presented for publication.

Complete Connection of the Fissura Centralis (*Fiss. of Rolando*) *with the Fossa Sylvii.*—Dr. A. J. Parker stated that Dr. Chas. K. Mills had lately observed, while examining the brain of a white person, that the central fissure ran completely into the fossa Sylvii without any bridging convolution being found present. The fissura centralis, as it exists in the higher primates, begins at the upper border of the hemisphere, and extends obliquely downwards and forwards, terminating above the Sylvian, so that we find an arched convolution surrounding its lower end and completely separating it from the Sylvian fissure. In 1866, however, Turner reported a case (Edinburgh Medical Journal, 1866) in which he found this fissure joining the Sylvian. This appears to be, up to that time, the only recorded case. Ecker, in speaking of this observation (Cerebral Convolutions of Man, trans. by R. T. Edes, M.D., 1873), says: "I have not yet seen a complete opening of the central furrow into the fissura Sylvii of which Turner speaks;" and Bischoff goes so far as to affirm (Die Grosshirnwindungen des Menschen, etc., Abhand. der k. bair. Akad. der Wissenschaften München, 1868), that the central fissure bends with its upper end gradually backwards, but it remains closed at its upper and lower end, and *never* opens into the fossa Sylvii. In the Proc. of Academy of Nat. Sciences Phila., 1878, Dr. Parker has reported a case similar to those observed by Prof. Turner and Dr. Mills, a photograph of which was exhibited; so that we have now at least three well-authenticated cases in which this relation of the two fissures referred to above existed. Bischoff objects to the observation of Turner on account of its disagreement with certain views in regard to the morphology of the cerebral convolutions which he advances in the paper referred to above. He considers that "a large number of the convolutions of the great hemisphere are arranged around the ends of the primary furrows in more or less simple or complicated arches." The primary fissures, according to him, are the anterior and posterior branches of the fossa Sylvii; the fissura centralis or fissure of Rolando, fissura perpendicularis interna or parieto-occipital fissure, fissura parallela or superior temporal fissure, and the fissura hippocampi. This latter fissure of Bischoff corresponds to Gratiolet's fissure des hippocampes, and includes both the fissura hippocampi and the fissura calcarina of other writers. The type is expressed, according to Bischoff, by these fissures, and the development of the convolutions consists merely of arched windings surrounding the ends of these primary furrows, and the further development of the convolutions arises in fact through the stronger development, bending backwards and forwards, rising and sinking of the lobules around the above-named furrows. Through this process there arise secondary folds and fissures, side convolutions and connections and separations of individual convolutions. The same, says Bischoff, may be different on the two sides of the same brain and in different individuals, the ground forms being, therefore, more or less hidden, but we can recognize them easily in all brains. He hopes, however, that it will soon be possible to explain and make intelligible these individual modifications. There are, however, convolutions which, as Bischoff remarks, do not appear to be in unison with this type, such as the first and second frontal and the convolutions of the occipital and temporal lobes. For these Bischoff says that he can find no particular plan on which they may be based. They arise one after the other, and become more and more complex, as it appears, from purely mechanical necessities of the surface increasing in a definite space. In this manner arise the first and second frontal fissures, the second temporal, fissura collateralis, etc., and their bordering convolutions. Thus, in the frontal lobe, Bischoff points out two upper frontal convolutions, and a third or inferior arching around the ascending branch of the fossa Sylvii. In the frontal lobe an anterior and a posterior central winding arching around the upper and lower extremities of the fissura centralis. Posterior to these, at the upper border of the hemisphere and extending over on to the mesial surface, a superior internal parietal group of convolutions (obere innere Scheitelgruppe) corresponding to the lobulus parietalis superior and præcuneus. Besides these, Bischoff points out five so-called arched parietal convolutions. A first or anterior parietal arched convolution (erste oder vordere Scheitelbogenwindung) surrounding the upper extremity of the horizontal branch of the fossa Sylvii. A second or middle (zweite oder mittlere Scheitelbogenwindung) surrounding the upper extremity of the superior temporal fissure. Posterior to these a third smaller arched convolution which curves around the upper end of the fissura temporalis media, the dritte Scheitelbogenwindung. He admits, indeed, that the arrangement of these arched convolutions is very variable and manifold, and therefore the appearance of these arches is not always easily discerned. He also distinguishes a superior internal (obere innere oder vierte Scheitelbogenwindung) surrounding the upper extremity of the fissura perpendicularis interna. This corresponds with the pli de passage supérieur externe, Gratiolet, gyrus occipitalis primus, Ecker; oberer Zug der hintern Centralwindung (in part), Huschke; erste obere Hinterlappenwindung, Wagner, first external annectent gyrus, Huxley; first bridging annectent or connecting gyrus, Turner. An inferior internal (untere innere oder fünfte, Scheitelbogenwindung) surrounding the lower extremity of the fissura perpendicularis interna. This corresponds with the pli de passage interne inférieur of Gratiolet; gyrus cunei of Ecker. The existence of a pli de passage interne supérieur is not admitted by Bischoff, who considers that this convolution is homologous with the pli de passage supérieur externe. Ecker dissents from this view of the case, and the speaker had attempted to show in a previous communication (Plis de passage in the Primates, Proc Acad. Nat. Sciences, Philadelphia, 1878) that at least in certain cases Bischoff is correct. In the occipital lobe Bischoff distinguishes three convolution groups, an outer upper, the so-called cunus, and two lower, an internal superior (lobulus lingualis), and an external inferior (lobulus fusiformis). In the temporal lobe Bischoff does not differ in his divisions from previous writers.

The observations referred to at the beginning of this communication in reference to the union of the central and Sylvian fissures is not in accordance with the views of Bischoff, at least in the absolute manner in which he proposes them; and that he considers the presence of these arching convolutions around the ends of the primary furrows as absolutely essential, is shown by his criticism of Turner's observation referred to above, and also of Dr. Rolleston's observations on the premier pli de passage. In seven human brains examined by Dr. Rolleston in reference to the development and character of this convolution, he found it in one case entirely wanting on one side. Bischoff regards this as an error, stating that this is a very typical and characteristic convolution, which, according to his view can never and will never be found wanting where deep and extensive anomalies in brain development have not taken place.

In conclusion, he could but repeat the opinion of Ecker, "what Bischoff says is also perfectly correct, that a large number of the convolutions of the cerebral hemisphere are arranged around the ends of the primary furrows in more or less simple or complicated arches; and it cannot be otherwise, for the ranges of mountains inclosing a valley must necessarily pass into each other where the valley ends, but no special explanation seems to be thereby disclosed."

DECEMBER 16.

The President, Dr. RUSCHENBERGER, in the chair.

Fifty-seven persons present.

DECEMBER 23.

The President, Dr. RUSCHENBERGER, in the chair.

Seventy-two persons present.

DECEMBER 30.

The President, Dr. RUSCHENBERGER, in the chair.

One hundred and ninety persons present.

The following reports were read and referred to the Publication Committee:—

REPORT OF THE PRESIDENT FOR THE YEAR ENDING NOVEMBER 30, 1879.

The history of the Academy for the year ending Nov. 30, 1879, is not very remarkable. It may be briefly stated.

The Academy offered, Feb. 1879, to receive on deposit the collections made by the second geological survey of the State of Pennsylvania; and asked the Legislature to appropriate money towards enlargement of the building for the purpose of affording ample space for the display of a distinct collection of specimens illustrative of all departments of the natural history of Pennsylvania, including those of the geological surveys. It is believed that a separate museum of the kind proposed would be attractive and interesting to visitors generally, as well as instructive. It would ultimately become an objective representation of all the natural resources of the State, and possibly suggestive of new applications of them in the industrial arts, and at the same time tend to enhance in public estimation the value of the study of the natural sciences.

All the members of the Legislature were invited to visit the institution in the evening of April 25th. Several of those who were present at this reception expressed opinions favorable to granting the petition of the Academy; but the Legislature finally adjourned without acting upon it.

A proposition to amend the by-laws, made May 6th, was unanimously rejected Oct. 28th.

Experience has demonstrated that the ordinary income of the Society is very much less than the amount of its necessary expenses. After due consideration of the subject by the council it was proposed to ask contributions from members and others towards the creation of a maintenance or working fund of sufficient amount to supply at least current deficiencies.

A committee of forty members was appointed, Sept. 16th, by the President, under authority of the Academy, to solicit contributions. The committee met, organized, and issued a circular in which reasons for the appeal are stated. Several subscriptions have been received and promised, making an aggregate of about $3000, or about one-twentieth of the amount considered to be necessary.

The financial condition of the Academy is fully stated in the report of the Treasurer.

Two young men have been recipients of the benefits of the Jessup Fund, one during the entire year, and the other for nine months. The application of this fund has been so beneficent in the past as to suggest that additional scholarships or fellowships of the same kind would contribute largely to the general progress of the natural sciences in this community.

The extent of increase of the museum and of the library, and their condition, are stated in the annual reports of the curators and the librarian.

The annual reports of the several sections of the Academy indicate that they are active and prosperous.

The Biological and Microscopical section gave a public reception on the first Monday of April, and a second on the first Monday of November. The Entomological section participated in the last. It is estimated that more than two thousand ladies and gentlemen were present at each reception, and all seemed pleased. Receptions of the kind are believed to be advantageous to the general interests of the Society.

The average attendance at the meetings has been 32; the most numerous, Feb. 4, 109, and the least, July 15 and August 26, 14.

Although well known to the few old members still living, it may be well on this occasion to recall part of the old story of the foundation of the Academy.

All the founders and early members were not at the time masters, or even advanced students, in any department of natural history. They were, generally speaking, young men whose livelihood depended upon the profits of their daily avocations—men who, though possibly not qualified to be professors, were learned enough to discern that they might lessen their own ignorance of natural things by employing their leisure together, in a joint way to learn what others already knew, and possibly add something to the common stock of knowledge.

The first formal meeting for organization, January 25, 1812, is recorded as a "meeting of gentlemen, friends of science and of rational disposal of leisure moments." At a subsequent meeting the association is described as "a society of generous, good-willing emulation for the acquirement, increase, simplification and diffusion of natural knowledge."

During the earliest years of the Society the members were often entertained at the meetings by some one, previously appointed, reading about some natural history subject, selected from a published book or essay, which was discussed after the reading. Such proceedings imply that mutual improvement was one of the objects of the association.

For the reason that the founders and first members regarded themselves to be learners they called their Society an Academy, meaning a school, the word being derived according to lexicographers from Ακαδημος, the name of an Athenian citizen whose house was converted into a school in which Plato taught.

The general policy of the organization included the idea of securing "the greatest good to the greatest number," and that all should cheerfully and sincerely co-operate to promote the welfare of the Society according to the ascertained views of the majority. March 21, 1812, the Society consisted of the six founders. In the minutes of the meeting of that day they say, "unless we be faithful and honorable to each other, and zealous for the interests of science, such an establishment as we desire may never take place."

The qualifications for membership were friendliness to science and good moral reputation and nothing more. To this day candidates are not required to possess any other qualifications. Membership of this Academy does not, nor was it ever intended to, imply any kind or degree of scientific attainment, any more than membership of a building association implies mechanical skill in any department of construction or house building.

There are societies whose certificate of membership is, in public estimation, at the same time a certificate of scientific attainments. The Academy cannot be properly classed with such societies, nor is there any conclusive reason why it should aspire to be, or to compete with institutions established on different principles or for different purposes.

The co-operative principle seems to have been recognized by the founders. They began at once to collect materials for a museum, and books for a library, to the use of which all the members were equally entitled, subject only to such restrictions as were considered necessary for their preservation.

From the formation of the society to the present time, its policy has been based on such principles, and to those principles it owes much of its substantial prosperity and present condition.

Original research was not the sole object of the society, nor was it ever designed that the society should be composed exclusively of masters in science, specialists, or experts. Members worthy to be so entitled are most desired and honored, most beneficial to the Society, and most deserving to be aided in all reasonable ways, in the use of its accumulated means and facilities of study, not in conflict with the rights which are alike and equally common to all members, learned and unlearned. No part of the museum or library can be held in reserve for the exclusive use of any class of specialists.

The purposes of the Academy are, and always have been:—

1st. To aid and encourage those who may labor to increase knowledge of natural objects, and of the laws under which they exist.

2d. To encourage and aid novitiates in natural science.

3d. To diffuse knowledge resulting from original researches, among the votaries of natural science everywhere.

4th. To render knowledge of the natural sciences generally attractive and interesting to the public.

The purpose first named, to encourage original investigations, is manifest in the free access to the museum and library, given to specialists who may desire to use those sources of information in their studies, and in the publication of the results of their labors when desired. This sort of encouragement is not restricted to members of the society. Publishing discoveries made elsewhere, or by others than members of the Society, is no discredit to the liberality of the Academy, and is surely not calculated to impede original research.

The purpose placed second, to encourage and aid novitiates, is realized by instructing them individually, and pointing out to them approved methods of study in order that they may become qualified to engage profitably in original investigations. The many beneficiaries of the Jessup Fund bear witness to the beneficent influences of the Academy under this head. They compensate the institution for the benefits it confers by the work they do for it under the direction of the curators, and by becoming under its auspices practical, working naturalists.

The importance of this purpose lies in the fact that initiatory training and elementary instruction are indispensable to the attainment of the highest grades of learning.

The third named purpose, to diffuse knowledge, is carried out by publishing a Journal, and the Proceedings of the Academy. The Journal now consists of eight octavo and seven quarto volumes: the fourth part of the eighth volume is in preparation. The "Proceedings of the Academy" numbers thirty-one 8vo volumes. During the year 385 pages have been printed.

The entomological section of the Academy has published during the year, more than two hundred pages of original matter, resulting from the researches of members of the section and others. Their printing has been done by members of the section in the hall of the Academy.

It is proper to mention in this connection, "The Natural History of the Agricultural Ant of Texas," a monograph of the habits and architecture of Pogonomyrmex barbatus, by Henry Christopher McCook, a member of the society, which has been issued with the imprint and under the auspices of the Academy. It is an octavo volume of 310 pages, illustrated by 24 plates.

Also the "Manual of Conchology, Structural and Systematic, with illustrations of the species," by George W. Tryon, Jr., conservator of the conchological section of the Academy, published by the author, and issued from the Academy. The first volume has appeared during the year. It is an octavo volume of 316 pages, illustrated by 112 plates, embracing 671 figures skilfully drawn by Dr. Edward J. Nolan, who is the Librarian and Recording Secretary of the Society.

Mr. Herman Strecker, of Reading, Pa., a member of the Academy, has published an octavo volume of 284 pages on the "Butterflies and Moths of North America," in the composition of which, he found valuable facilities in the library of the Academy. In the preface of his work he says:—"I shall never forget, when a little boy, how my heart bounded, when one day Professor Joseph Leidy took me into the basement of the Philadelphia Academy of Natural Sciences, and pointing to the books on entomology, told me I had permission to examine their contents."

The "Chronological History of Plants," a posthumous work by Dr. Charles Pickering, was published at Boston, in May, 1879. It is a quarto volume of 1222 pages. The work is conspicuous on account of the immense erudition and industry displayed by the author. It will ever stand an enduring monument significant of the respect due to his memory.

This volume is mentioned here because Dr. Pickering was a diligent student in the Academy, and served it efficiently and very constantly during eleven years, from the early part of 1827 till the middle of 1838. His studies in this Academy contributed largely to qualify him to deserve the very high position he attained in the scientific world.

Gratuitous labor has produced all the matter published by the Academy and its entomological section; and probably the authors of the volumes named have little hope of pecuniary profit from their work.

The fourth named purpose: to render knowledge of the natural sciences attractive and interesting.

During many years the students of all medical colleges in the city have been freely admitted to the museum on exhibiting their matriculating tickets to the janitor. Annual complimentary tickets have been issued to the teachers of the public schools, who are authorized to bring with them at each visit, a limited number of their pupils. The museum is accessible to all persons every day except Sunday, on the payment of an admission fee of ten cents. The amount received on this account indicates that the museum has been visited by 3540 persons besides members and those introduced by them.

Summaries of the proceedings of the Academy are published in the newspapers. They are supposed to be generally interesting.

In the ways indicated the several purposes of the institution are carried out, it is believed, with considerable success.

The sections afford opportunity to those having like pursuits and congenial tastes to work together, and are useful in their influence on the general interests of the society. It is not perceived that they are in any way detrimental to scientific progress.

The by-law of May, 1876, which authorizes the appointment of professors is inoperative, because the endowments for their support, which were hoped for at the time, have not been made, and because candidates have not applied for the positions.

In spite of the lack of professors, the Academy is reasonably prosperous. It is free from debt. It has a substantial home and land enough upon which to extend it. It has a large and excellent library adapted to its purposes, and large collections of natural objects, many of which have not been studied. It is conjectured that the library and museum cannot be duplicated at this time by the expenditure of half a million of dollars.

Among its members are some who are conspicuous for attainments, and for the discoveries they have made; many who are skilful specialists, and very many more who are availing themselves so diligently of the facilities which the Academy affords that there is ground to hope that when those who are now held in the highest estimation shall have passed away, their places will be filled by men as great or even greater than they are now believed to be.

Notwithstanding the general character of its membership, and the unpretentious methods and policy which it has followed in the past, there are associated with the Academy some among those who have died, whose names are widely known and respected on account of the positions they attained in science. We may name for examples, Charles L. Bonaparte, John Cassin, Edward Hallowell, Wm. M. Gabb, Richard Harlan, Charles A. Leseur, James Aitken Meigs, Samuel George Morton, Thomas Nuttall, George Ord, Charles Pickering, Thomas Say, and Gerard Troost; and others might be added who in their day were worthy and respected on account of their attainments, and their contributions to scientific progress.

There is no substantial reason to mourn now on account of the present condition or the future prospects of the Academy.

The whole is submitted,

W. S. W. Ruschenberger.

REPORT OF THE RECORDING SECRETARY.

The Recording Secretary respectfully reports that during the year ending Nov. 30, 1879, twenty-three members and eight correspondents have been elected.

The resignations of the following members have been received: Wm. Thompson, R. H. Day, C. P. Nancrede, J. S. Alexander, Frank Woodbury, Jos. Neumann, Thos. Stewardson, S. W. Pennypacker, and S. H. Guildford.

The names of nineteen members and three correspondents who have died during the year, have been recorded in the Proceedings under the date of announcement.

Twenty-two papers have been presented for publication, as follows: John A. Ryder, 4; H. C. Chapman, 3; Angelo Heilprin, 3; J. B. Ellis, 2; J. S. Kingsley, 2; Andrew Garrett, 2; W. N. Lockington, 2; Wm. G. Binney, 1; Dr. H. Bergh, of Copenhagen, 1; Edw. D. Cope, 1; Chas. Wachsmuth, and Frank Springer, 1. The Publication Committee has reported in favor of the publication of all these in the Proceedings.

One hundred and ninety-four pages of the Proceedings for 1878 and one hundred and ninety-one pages of the volume for 1879 have been printed during the year. The current volume will be illustrated by seventeen plates.

Verbal communications have been made by Messrs. Leidy, Meehan, Ford, Ryder, Koenig, Kelly, Ashburner, Potts, Horn, Evarts, Chapman, McCook, Kenderdine, A. J. Parker, Goldsmith, Hunt, Martindale, Canby, Rothrock, Warder, Porter, Foote, Cope, Pierce, Willcox, Dercum, Redfield, Barbeck, Brinton.

At the meeting held March 25th, Prof. Edw. D. Cope was elected to fill a vacancy in the Council caused by the death of Dr. J. H. McQuillen.

Edw. J. Nolan,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The Corresponding Secretary presents herewith the report of matters pertaining to his office during the year ending Nov. 30.

There have been eight Correspondents elected by the Academy, all of whom have been notified.

The correspondence received during the year has been, for the most part, that transmitting the publications of corresponding societies or other organizations, and from Correspondents acknowledging their election. Those letters requiring an answer have received proper attention.

The letters written have been in great part acknowledgments of donations to the Museum. These letters, numbering 177, cover a much greater number of donations.

Respectfully submitted,

Geo. H. Horn, M.D.,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

During the twelve months from Dec. 1, 1878, to Nov. 30, 1879, 2778 additions have been made to the library. These have included 513 volumes, 2250 pamphlets, and 15 maps; 2099 were octavos, 557 quartos, 57 duodecimos, and 50 folios.

They were derived from the following sources:—

Societies	1172	Trustees of New York State Museum and Library	3
I. V. Williamson Fund	529	Geological Survey of Canada	3
Editors	494	Hydrographic Office	2
Authors	222	Government of New South Wales	2
Wilson Fund	90	Geological Survey of Portugal	1
Dr. F. V. Hayden	65	British Government	1
Isaac Lea	31	Surgeon-General, U. S. A.	1
Department of the Interior	16	British Museum	1
T. R. Peale	16	Navy Department	1
Publishers	12	Argentine Centennial Commission	1
Department of Agriculture	11	Dr. Wm. H. Jones	1
Geological Survey of India	10	W. K. Brooks	1
Edward Stroud	9	Alexander Agassiz	1
J. H. Redfield	8	Mrs. Charles Pickering	1
Smithsonian Institution	8	John Jay Knox	1
War Department	6	Henry Vendryes	1
East Indian Government	6	Mariano Barcena	1
Geological Survey of Sweden	6	Alfred Gray	1
Lieut. C. A. H. McCauley	5	Charles F. Parker	1
Department of Agriculture, North Carolina	4	H. W. Howgate	1
Engineer Department, U. S. A.	4	John Collett	1
Geological Survey of Pennsylvania	3		

In addition to these, 19 volumes were received in exchange for duplicate books. They were distributed to the different departments of the library as follows:—

Journals	1997	Physical Science	18
Geology	197	Anthropology	16
General Natural History	92	Bibliography	16
Botany	84	Mineralogy	13
Conchology	74	Mammalogy	7
Anatomy and Physiology	55	Chemistry	7
Entomology	43	Encyclopedias	6
Voyages and Travels	37	Literature	4
History and Biography	34	Medicine	3
Ornithology	24	Herpetology	3
Agriculture	23	Mathematics	2
Helminthology	21	Ichthyology	2

During the year the card catalogue of the department of anatomy and physiology has been completed, the titles of 669 pamphlets having been added to the entries made last year. The catalogues of the books on helminthology, ichthyology, and herpetology have also been finished, leaving only those on anthropology and mineralogy to be yet entered. In addition to the books catalogued, there are in the library a large number of literary, artistic, and historical works to which I have before called attention for the purpose of recommending that they be sold, and the funds applied to the purchase of books more specially useful to the society. In the hope that this disposition may be made of these works, it is not the intention at present to extend the card entries to these departments, so that the catalogue will probably be completed early next year.

Constant effort has been made to complete, as far as possible, the sets of periodicals in the library, and to add those not yet in the possession of the Academy. This work will be materially forwarded by the issue of Mr. Scudder's invaluable Catalogue of Scientific Serials, which furnishes a means not before at hand of determining our deficiencies.

For the amounts expended on the purchase of books reference is made to the report of the Treasurer. The accompanying list of additions made during the year indicates, as heretofore, that for the most valuable items, apart from our exchanges, we are dependent upon the I. V. Williamson Fund.

All of which is respectfully submitted,

Edw. J. Nolan,

Librarian.

REPORT OF THE CURATORS.

The Curators report that during the year all the various collections of the Museum have been carefully inspected and cared for, and that they are all in good condition. A violent storm, which caused considerable destruction of glass and flooding of rain, wetted some parts of the collections, but the objects were speedily dried, so that little serious damage resulted, except the loss of several specimens of echinoderms. Mr. J. A. Ryder has been continuously engaged in identifying, arranging, and labeling the collection of fishes. There have been identified upwards of 700 species of 325 genera. The Bonaparte collection of fishes, considering the time it has been preserved, is in excellent condition.

Mr. Spencer Trotter has also been engaged in the arrangement of the birds.

The collection of vertebrate fossils from the New Jersey cretaceous and tertiary marls, which are very liable to decomposition from exposure to the air, have been treated so as to preserve them, and they have been arranged and labeled.

Most of the specimens received during the year have been placed in their proper positions in the various collections.

The most important addition to the Museum during the year, consists of the Archæological collection belonging to the American Philosophical Society, deposited with the Academy by resolution of Nov. 16, 1877. The collection mainly consists of the Poinsett collection of Mexican antiquities and many Peruvian and other American antiquities. The Academy is indebted to Mr. William S. Vaux, for defraying the expense of adapting one of the entresol rooms to the proper exhibition of the collection.

The contributions in the various departments during the year, excepting those reported on by some of the special sections, are as follow:—

Mammals.—Five skeletons: *Tapirus indicus*, *Auchenia*, *Dicotyles*, *Sus*, and *Phascolomys*, presented by Dr. H. C. Chapman. Seal caught off Marcus Hook, Levi Cromwell. Skeleton of a native of the Chatham Islands, W. H. Rau. Young Chimpanzee, Phila. Zool. Society. Red Fox, Harford Co., Md., I. C. Martindale. Monstrous new-born Sheep, W. H. Faulkener.

Birds.—Twenty-five species birds' nests with eggs, presented by John Pearsall. *Ardea herodias*, Florida, J. W. Millner and Jos. Willcox. *Tachypetes aquilus*, Jos. Willcox. Skeleton of Flamingo, Dr. H. C. Chapman. Nest and eggs of *Junco hyemalis*, mountains of North Carolina, W. N. Canby. *Perdix saxatilis* and *Ardea cornuta*, Syria, Prof. Janowsky. Ostrich egg, Dr. Geo. H. Horn. *Gallus domesticus*, Jos. O. Schimmel. *Dacelo gigantea*, *Turtur bitorquatus*, *Psittacus erythraeus*, *Chrysotis ocrocephala*, *Platycercus hæmatonotus*, *P. eximeus*, *P. pennanti*, *P. semitorquatus*, *Munia undulata*, *Amadina bicolor*, *Donacola castaneothorax*, Phila. Zool. Society.

Reptiles, Amphibians, and Fishes.—A collection of lizards and snakes, presented by Dr. H. C. Chapman. *Phrynosoma regale*, California, Dr. Jos. K. Corson. Twin *Testudo clausa*, S S Haldeman. *Amphiuma means*, *Gymnotus electricus*, Phila. Zool. Society. *Orthagoriscus mola*, Atlantic City, N. J., J. L. Howard. *Lophius americanus*, Atlantic City, N. J., S. D. Button. Embryo of Ray, Dr. H. C. Evarts.

Articulates. — *Artemia fertilis*, *Limnadia compleximanus*, *Streptocephalus watsoni*, and *Branchinectes coloradensis*, presented by Dr. A. S. Packard. *Streptocephalus sealii*, Woodbury, N. J., W. P. Seal. *Chirocephalus holmani*, Woodbury, N. J., Messrs. Seal and Holman. *Palinurus vulgaris*, Medt., John Ford. *Eubranchipus vernalis*, Long Island, F. Gissler. Two crustacean parasites and two worms, from *Orthagoriscus*, J. L. Howard. *Polyxenes fasciculatus*, Fairmount, J. A. Ryder. *Mygale hentzii*, *Buthus*, *Mantis*, *Cryptoglossa verrucosa*, *Eleodes armata*, *Scolopendra*, Ft. Yuma, Cal., Dr. Joseph K. Corson, U. S. A. *Lucanus elephas*, Swedesboro, N. J., Richard French. *Platylepas decorata*, Hernando Co., Fla., Jos. Willcox. Nests of the Honey Ant, *Myrmecocystis*, Colorado, Rev. H. C. McCook. Three insects mounted in soluble glass, and cocoons and raw silk of the silk-worm, Dr. S. Chamberlain.

Radiates and Protozoans.—A small collection from Mt. Desert, Me., presented by Dr. H. C. Chapman. *Sertularia argentea*, Boring-sponge in the shell of the oyster; *Pterogorgia setosa*, W. I., and *Doricidaris papillata*, Medt., John Ford. *Penella pilosa*, with attached *Conchoderma*, J. L. Howard. *Spongilla lacustris* and *Pectinatella magnifica*, Woodbury, N. J., W. P. Seal. *Cristatella idae*, Fairmount, Dr. Jos. Leidy.

Fossils.—Fossil fishes, and bones of *Uintatherium*, *Palæosyops*, and Crocodile, Green R., Wyoming, presented by Dr. H. C. Chapman. Fragments of jaws with molars of *Rangifer caribou*, from the loess of Muscatine, Iowa, Prof. F. M. Witter. Foot-prints of *Anthracopus ellangowensis*, Ellangowan Colliery, Mahanoy, Pa., W. D. H. Mason, through W. Lorenz. Bones of Gavial, miocene, N. J., and two coal fossils, *Lepidostrobus*, Carbondale, Pa., Dr. Jos. Leidy. Tooth of *Carcharodon megalodon*, picked up on the shore of Atlantic City, N. J., E. Lippincott. Fragment of bone, Vincenttown marl, N. J., Col. T. M. Bryan. Trilobite, T. A. Conrad. *Maclurea*, carboniferous limestone, Upton, Franklin Co., Pa., Annie Ryder. Casts of skull and jaw of *Acotherulum saturninum*, Phosphate beds of Jersey, Prof. Paul Gervais. Ramus of lower jaw and portion of tibia of *Mastodon andium*, S. A., deposited by Dr. I. C. Coates. Tooth of *Mosasaurus*, Chalk of

Meudon, France, *Leucociscus papyraceous*, *Protomyia macrocephala*, and *Micropsalis papyracea*, miocene of Rott, near Bonn, purchased.

Ethnological and Miscellaneous.—Necklace with ornament, two carved gourd vessels, bows and arrows, blow-gun, spears, from Costa Rica and California, collected by the late Wm. M. Gabb, together with a portrait of the latter, presented by Mrs. C. G. Gabb. Fire-stick of Digger Indians, Sacramento R., Cal., W. C. Desmond. Indian stone-pipe, Bedford Co., Pa., E. Draper. Cloth made from Yucca fibre, Mexico, Dr. C. C. Parry. Fragments of steatite vessels from an ancient steatite quarry, Rock Creek, near Washington, D.C., W. J. Rhees. Stone mortar, East Tennessee, A. D. Trimble. Stone implement, Hernando Co., Fla., Jos. Willcox. Copper bracelet, Thebes, C. F. Parker. Stone carving, Cave Temple of Elephanta, and sandals of the Arabs of Muscat, Dr. Ruschenberger. Five stone axes, Pa.; three ditto, N. J.; one ditto, with terra-cotta pot and bowl from a mound, New Madrid, Mo.; stone scrapers and chips, Wyoming Ty., in exchange, from Dr. Leidy.

Respectfully submitted by the Curators,
JOSEPH LEIDY, *Chairman.*

REPORT OF BIOLOGICAL AND MICROSCOPICAL SECTION.

During the past year there were held seventeen meetings with an average attendance of 60 persons.

There were two exhibitions given to the public, at the first of which there were exhibited 137 instruments, and at the second 179.

Lectures were delivered by members at each meeting, and a special course by Dr. J. Gibbons Hunt continued through the entire year.

The officers elected for 1880 are—

Director	Dr. Carl Seiler,
Vice-Director . . .	Dr. C. Newlin Pierce.
Corresponding Secretary .	Dr. Charles Shaffer,
Treasurer	Dr. Isaac Norris,
Recorder	Dr. Robert Hess,

Auditors	Dr. George Dixon,
	Charles P. Perot,
	S. Fisher Corlies,
Committee of Curators .	Dr. J. Gibbons Hunt,
	Charles Zentmayer,
	Jacob Binder,
Committee on Business .	Charles P. Perot,
	Charles Zentmayer,
	Dr. Charles Turnbull.

Robt. J. Hess,
Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

The Recorder of the Conchological Section respectfully reports that during 1879 papers have been accepted and published in the Academy's Proceedings aggregating 90 pages, by authors as follows:—

W. G. Binney, 1 page.
Andrew Garrett, 14 pages.
Dr. R. Bergh, 62 pages.
Angelo Heilprin, 6 pages.
R. E. C. Stearns, 7 pages.

On the 6th of last January the Section met with a severe loss in the death of the Rev. E. R. Beadle.

From its formation to the time of his death Dr. Beadle was the secretary of the Conchological Section, and his ability and extended acquaintance among scientists both at home and abroad went far towards making it a success. His loss will be deeply felt by many who, in common with ourselves, have been richly benefited by his acquaintance and influence.

The Conservator, Mr. George W. Tryon, Jr., reports that, during the year ending December 1, 2750 trays, containing 11,895 specimens of shells and mollusks, have been determined, labelled, mounted, and placed in the collection. The most of these belong to the Swift Collection, the arrangement of which, after three years' labor, is now completed. The Swift Cabinet was given to the Academy upon condition that it should not be incorporated with the general collection, and this condition is complied with by placing the specimens in drawers protected by glass tops, and placed under the corresponding genera contained in the table cases. It is proposed to appropriately letter the fronts of these drawers, and then unlock them so that they may be opened by the public. The Swift Collection is rich in West Indian shells, and particularly so in terrestrial species: it comprises 7058 trays, containing 30,384 specimens. Mr. W. G. Binney has frequently favored us with specimens of rare American terrestrial mollusks during the year, so as to nearly complete our series of these shells. Dr. W. D. Hartman, of Westchester, who is preparing for publication a revision of the Partulidæ, has carefully examined our collection of these perplexing shells, and added a number of species. We are indebted to Dr. J. J. Brown for a good collection of marine shells from the Bahama Islands, and to Mr. Henry Vendryes for a fine series of Jamaica Miocene shells. A typical suite of the land shells collected by the late Wm. M. Gabb in Costa Rica is among the important additions to our Museum during the year. A detailed list of donations is annexed to this report.

The Section is again greatly indebted to Mr. Charles F. Parker for valuable assistance in preparing specimens for exhibition, the whole of the additions to the cabinet during the year having been mounted on tablets, and placed on appropriate paper trays by him. We are also much indebted to Mr. John Ford for preparing sections of shells for the purpose of showing their internal form. It is proposed to exhibit a section of a characteristic form in each genus, and Mr. Ford has kindly undertaken to prepare them for us.

The officers of the Section for 1880 are—

Director . . .	W. S. W. Ruschenberger, M.D.
Vice-Director . .	John Ford.
Recorder . . .	S. Raymond Roberts.
Secretary . . .	John H. Redfield.
Treasurer . .	Wm. L. Mactier.
Conservator . .	George W. Tryon, Jr.

Respectfully submitted,

S. Raymond Roberts,

Recorder.

The following are the additions to the Conchological Cabinet received during 1879:—

Binney, Wm. G. *Bythinia tentaculata*, from Champlain Canal, W. Troy, New York; *Unio heterodon*, Mixville, Conn.; *Sphærium rhomboideum*, *Helix Rugeli*, and *H. Andrewsi*, Roan Mt., N. C.; *H. globulus*, *H. vernicosa*, and *H. rariplicata*, Cape Town, S. Africa; *H. oppilata* and *H. Buffoniana*, Mexico; 20 species N. Am. Helices, new to the collection; *Bulimus Natalensis*, Cape Town; *Urocyclus* and *Veronicella*, from Mozambique; *Simpulopsis corrugatus* and jaws and tongues of *Ampullaria urceus*, Trinidad; *Vitrina latissima*, *Onchidella Carpenteri*.

Bland, Thomas. 3 species of land shells from Curaçoa; 7 species marine shells from the tertiary of Jamaica.

Brown, Dr. J. J. 60 species marine shells, mostly collected by him at the Bahama Islands.

Calkins, W. W. *Cylindrella Guigonana*, Haiti.

De Tarr and Beecher. *Planorbis costatus*, types.

Fisher, Dr. Jas. L. (Nagasaki). *Soletellina Buddinghausii*. Japan.

Ford, John. Beautifully prepared sections of *Nautilus Pompilius*, and of 32 prosobranchiate Gasteropod shells; *Helix tridentata*, *H. alternata*, and *H. albolabris*, from Three Sisters' Islands, Niagara Falls; *Crepidula fornicata*, *C. unguiformis*, *Anomia ephippium*, Sandy Hook, N. J.

Gabb, Wm. M. 43 species (numerous specimens) terrestrial and fluviatile shells, principally types of species recently described by Messrs. G. F. Angas and W. G. Binney. Collected by Mr. Gabb in Costa Rica.

Hartman, Dr. W. D. *Partula recta* and *bicolor*; 16 species (49 specimens) of Partula; *Unio* from Japan, and *Cardium*, nov. sp. from Viti Isles.

Jones, Dr. W. H. Mollusks dredged by him at Havre, France, etc.

Lea, Dr. Isaac. *Unio Irwinensis* and *U. differtus*, Lea.

Lewis, Dr. James. *Bythinia tentaculata*, Oswego, New York.

Leidy, Dr. Joseph. *Mactra solidissima*, abnormal growth, Brigantine Beach, N. J.

Mactier, W. L. *Lacuna divaricata*, Nantucket.

Mickleborough, John. A collection of Silurian fossil shells from the Cincinnati Group, Cincinnati, Ohio.

Munroe, Prof. C. E. 5 species of Eocene shells, from Maryland.

Peale, Titian R. *Limax maximus*, New York City.

Pike, Prof. J. W. Silurian shells, from Richmond, Ind.

Shaffer, Miss M. *Loligo Pealei*, from a black fish caught in Delaware Bay.

Stearns, R. E. C. 12 species land and marine shells, from California and Japan.

Stein, Frederick. *Goniobasis papillosa*, from Florida.

Tryon, Geo. W., Jr. 137 species of terrestrial mollusks (of which 70 are new to the collection), collected by Andrew Garrett in the islands of Central Polynesia

Vendryes, Henry. Kingston, Jamaica. A typical collection of 88 species of Miocene shells, from the island of Jamaica.

Webb, H. W. 18 specimens (55 species) of terrestrial mollusks, from Balsas, Valley of Marañon, Peru.

REPORT OF THE ENTOMOLOGICAL SECTION.

The Section reports that its meetings have been regularly held during the past year on the second Friday evening of each month excepting in July and August. In December the meeting takes place immediately after that of the American Entomological Society on the second Wednesday evening.

The membership is now thirty, having been increased during the year by the admission of Geo. B. Cresson.

The average attendance at the meetings has been six.

At all of the meetings scientific communications have been made by the members, either in the form of verbal remarks or written papers, the authors in the latter case presenting verbally, in brief, the more important points of their papers.

Among the more interesting communications may be mentioned those presented by Rev. Dr. McCook, on the Honey Ant of our western country, the habits being now very fully made known through his untiring industry under unfavorable surroundings.

Written communications have been presented as follows: "Descriptions of new species of North American Hymenoptera," "Catalogue of North American Apidæ," both by E. T. Cresson; "On the Chrysides of North America," by Edw. Norton; "Catalogue of the Mutillidæ of North America, with description of new species," by Chas. A. Blake; "Synopsis of the Monotomidæ of the

United States," "Synopsis of the Nitidulidæ of the United States," "Notes on the Mycteridæ and other Heteromera of the United States," by George H. Horn, M.D.

The foregoing have been published as part of the Transactions of the American Entomological Society, and together with papers published during December of last year, amount to one hundred and seventy-three pages with one plate.

In addition to the above the following papers have been accepted for publication, and will form part of Volume VIII. of the Transactions: "Descriptions of new species of North American Hymenoptera," "Catalogue of North American Tenthridinidæ and Uroceridæ," by E. T. Cresson; "Notes on the Asaphes of Boreal America," "Revision of the Dascyllidæ of the United States," "Contributions to the Coleopterology of the United States," by George H. Horn, M.D.; "Short Studies on North American Coleoptera," by J. L. LeConte, M.D.

With the beginning of the year the Section has published the "Proceedings of the monthly meetings of the Entomological Section of the Academy of Natural Sciences," in which are contained a record of the doings of the Section with the shorter papers and verbal communications from the members, and a list of all publications received in exchange, by purchase or from the authors.

The total publications excluding Index are—

Transactions of the American Entomological Society .	173 pp.
Proceedings of the Section	34 pp.
Giving a total of	207 pp.

By the invitation of the Biological and Microscopical Section, the Entomological Section joined with them on the occasion of their last reception in the endeavor to make the resources of the Academy more widely known, and the exhibition more varied and entertaining to those who favored us with a visit. The crowded rooms and the interest shown by our visitors spoke well not only for the grand microscopical display, but also for our more modest exhibit.

During the year the collections have been carefully examined several times thoroughly by the Conservator and by the members while using them. They are reported in good order. Very few additions have been made.

At the annual meeting in December, the following officers were elected to serve during 1880:—

Director	John L. Leconte, M.D.
Vice-Director	Geo. H. Horn, M.D.
Recorder	Jas. H Ridings.
Treasurer	E. T. Cresson.
Conservator	Geo. B. Cresson.
Publication Committee	Geo. H. Horn, M.D., Samuel Lewis, M.D.

All of which is respectfully submitted,

GEO. H. HORN, M.D., *Vice-Director,*
for the Recorder.

REPORT OF THE BOTANICAL SECTION.

The Vice-Director of the Botanical Section has much pleasure in reporting to the Academy the satisfactory progress it has made during the past year. The Section now consists of thirty-five members, and the meetings held every month, except August and September, have been well attended. At these meetings many new and valuable facts in relation to our local flora, as well as to the science of Botany in general, have been contributed by many of the members. Of the papers read before the meetings one by Mr. Ellis, of Newfield, New Jersey, and one by Professor Asa Gray, have been of such general importance as to receive the recommendation of the Section to the Academy for publication in its proceedings.

In regard to the valuable Herbarium it is pleasant to report that the additions of the past and previous year together are far beyond those of any period for many years past.

That so many distinguished men should have aided the Academy in this handsome manner shows their high appreciation of its work and usefulness. In the arrangement of the Herbarium a place has been reserved for every genus, and it is gratifying to note that the *hiati* are now mostly of genera from regions rarely explored, and that even these are gradually being filled, so that the floras of even the most distant parts of the world are fairly represented on our shelves.

The work of revising the various families so as to bring the nomenclature in accord with modern views, and which in former reports it was believed could scarcely be accomplished without the employment of experts to be especially engaged for the purpose, still remains to be done—but the voluntary labors of several distinguished botanists have aided us the past year to a good beginning for even this herculean task, and we may hope that it will not be very long before the whole is treated in the same way.

It is no derogation to the assistance we have received from many members and friends to say that much of the excellent progress made is due to the energy of our Conservator Mr. John H. Redfield, whose report in detail has been adopted by the Section as part of this report.

THOMAS MEEHAN,
Vice-Director.

The Conservator reports that the work of the past year has been mainly directed to the improvement of the condition of the Academy's valuable Herbarium, and this labor has been interrupted only by the necessary care and attention bestowed upon the constant new accessions to its stores.

The order-tablets and genus lists for the North American Herbarium have been completed.

Mr. Isaac C. Martindale has carefully elaborated and catalogued the species of Clematis, Anemone, and one or two other allied genera, both in the general and in the North American departments, a tedious and difficult labor which has revealed both the extent and the weaknesses of our collection. Mr. Charles F. Parker has also neatly mounted these species, and the work of these two gentlemen, while only the beginning of a gigantic task, is a model for future workers.

Dr. Asa Gray, of Cambridge, has during the year revised for us some of the most perplexing of the genera of the North American Compositæ, such as Vernonia, Solidago, Chrysopsis, etc., and Mr. Parker is securing to us the result of this labor, by mounting the plants (with Dr. Gray's notes affixed) as fast as elaborated.

Mr. Bebb, who, in 1878, worked out for us the willows of our North American Herbarium, has this year performed a similar service upon those of the general Herbarium, with infinite addition to their scientific value.

Mr. F. L. Scribner has continued his careful and scrutinizing work upon our grasses, mounting them as he progresses, and we may expect an early completion of so much of the work as relates to the North American Herbarium.

The Conservator has mounted and ticketed that portion of the North American Herbarium which extends from the Order Goodeniaceæ to Order Gentianaceæ inclusive, and hopes to continue the work.

The accessions to our collection have been constant, extensive, and valuable. The number of species received during the year has been 2181, of which a good proportion were new to our shelves. All these have been carefully poisoned, labeled, mounted, and distributed in the proper orders. Mr. C. F. Parker has been of most essential service in this work, giving us many hours of labor over and above his engagements with the Academy.

Among the valuable additions of the year may be specially mentioned 623 species of Florida plants, embracing many new and rare species, collected by Dr. A. P. Garber, of Columbia, Pa., and by him generously presented to the Academy; and many hundreds of rare plants from Northern and Central Asia, Northern, Southern, and Central Africa, Borneo, Kerguelen Land, Polynesia, California, Oregon, etc., presented by Dr. Asa Gray, of Cambridge, Mass.

A complete list of the donations during the year is appended to the report now respectfully submitted.

JOHN H. REDFIELD,
Conservator.

Additions to Botanical Museum and Herbarium, 1879.

January. Dr. Asa Gray; 174 species of plants from Northern and Central Asia, Borneo, Polynesia, and Africa, and 37 species mostly from California, Nevada, and Washington Territory.

February. Dr. James Hamer, Collegeville, Montgomery Co., Pa.; specimen of Phallus, in spirits.

March. Wm. M. Canby, Wilmington, Del.; Callisia, collected in Florida, by Miss Mary C. Reynolds.

April. Dr. George E. Post, of American Protestant College, Beirut, Syria; 189 species of Syrian plants, being a third instalment sent in exchange for Colorado and Utah plants.

Dr. Asa Gray; 60 species plants, collected by Hooker and Ball in Marocco in 1871; 22 species from Southern Europe; 55 species of Carices from Sweden and Lapland, and 3 species North American plants.

Dr. A. P. Garber, Columbia, Pa.; 555 species of plants collected by him mostly near Manatee, Florida.

John H. Redfield; 102 species European plants, mostly from Buda-Pesth, Hungary; also *Asplenium mucronatum*, from Tijuca, Brazil.

Thomas Meehan; Viola Beckwithii, collected in Washington Territory, by Mrs. F. E. Putnam.

Dr. J. A. Warder, Cincinnati, O.; sections of wood of *Catalpa bignonioides*, variety speciosa.

May. Dr. Asa Gray; 49 species plants, collected in Kerguelan Land, by J. H. Kidder, of British Transit Expedition, and 73 species collected mostly in Northern Borneo, by F. W. Burbridge.

John H. Redfield; 29 species of plants, collected by Dr. C. C. Parry and Dr. E. Palmer, chiefly in the region of San Luis Potosi, Mexico, in 1878.

Dr. C. C. Parry, of Davenport, Ia.; part of a saddle-cloth in common use in Mexico, made from the fibre of Yucca.

Wm. M. Canby; *Shortia galicifolia*, collected by M. E. Hyams, in McDowell Co., N. C.; also *Baptisia sulphurea*, from Limestone Gap, Indian Territory, collected by G. D. Butler.

Isaac C. Martindale; Ellis's 2d Century of North American Fungi, being 100 species of Fungi, neatly mounted in book form.

June. Miss E. S. Boyd; 37 species ferns from Sandwich Islands.

George E. Davenport, Boston, Mass.; 5 species ferns, from Florida.

Wm. M. Canby; 2 species California ferns, new to the collection.

Ashmead Bros., Jacksonville, Fla., through Dr. G. H. Horn; *Sarracenia variolaris*, Mx., from Florida.

A. L. Siler, of Osmer, Utah; Cones of *Abies Engelmanni*, from Kanab Cañon, Southern Utah.

September. Dr. Asa Gray; 64 species plants, mostly from Oregon and California.

John H. Redfield; 282 species plants, collected by Dr. C. C. Parry and Dr. E. Palmer in 1878, chiefly in the region of San Luis Potosi, Mexico; also 81 species, collected in Western North Carolina in June 1879, by Dr. Asa Gray, Wm. M. Canby, C. S. Sargent, and J. H. Redfield; also *Aspidium aculeatum* Sw. var. *Braunii*, collected in Bushnellsville Clove, Catskill Mts.

Dr. A. P. Garber; 68 species of Florida plants, collected by him, supplementary to the collection received from him in April, most of these being new or rare species.

Isaac C. Martindale; *Teucrium occidentale* Gr., collected by him on banks of Delaware River, below Philadelphia.

October. Dr. Asa Gray; 47 species of phanerogamous plants from Mexico and West Indies, and 12 mosses from Borneo.

Titian R. Peale; *Drosera filiformis*, from Ocean Grove, N. J.

November. Wm. M. Canby; 18 species North American plants, nearly all new to the collection.

Chas. F. Parker; *Epiphegus Virginiana* Bart. var. *Rauana*, collected by C. F. Austin, on High Peak, Catskill Mts., N. Y.

December. Isaac C. Martindale; 96 species plants, some from New Zealand, but mostly foreign species collected on the ballast deposits in the neighborhood of Philadelphia.

Dr. Geo. Engelmann, St. Louis, Mo.; 5 varieties of *Quercus*, mostly hybrids.

Prof. Thos. C. Porter, Lafayette College, Easton, Pa.; *Solidago Buckleyi*, from Monticello, Ga.

Susannah Kite, Friends Library, Germantown, Phila.; *Clematis Scottii* Porter, from Colorado.

Thos. Meehan; *Salicornia arbuscula* R. Br., from Victoria, Australia, collected by Baron von Müller.

REPORT OF THE MINERALOGICAL SECTION.

The Director of the Mineralogical Section of the Academy of Natural Sciences, would respectfully report that meetings of the Section have been held regularly every month, except July and August. The attendance has been larger than in the prior year, and there has been no lack of interest.

Reference to the annexed list of donations will show that the increase of the collection of the Academy has been satisfactory.

The local collection has been arranged and labeled.

At the February meeting it was decided to admit, as associate members, persons interested in mineralogy but ineligible to active membership by reason of not being members of the Academy. Several such have been elected, and have attended the meetings and taken much interest in the proceedings.

Through the courtesy of the Biological and Microscopical Section, the Mineralogical Section has had the use of microscopes in the examination of sections of rocks, and of minerals included in others. Several interesting exhibitions of this character were had, showing an entertaining, and, as yet, little explored region, in which it is hoped the lady members of the Section may find a field peculiarly suited to their opportunities of study.

It is purposed to present to the Academy for publication a statement of the more important communications made to the Section.

The following list of additions made to the Mineralogical Cabinet during the year has been furnished by Mr. Chas. F. Parker:—

G. W. Baker. Nodules of Hematite, Venezuela.

A. J. Brand. Native Copper, Madison Co., W. Va.

Col. T. M. Bryan. Asphaltum, Amber, Flint and Geode of the same, probably pseudomorph of Sponge, from the marl of Vincenttown, N. J.

Dr. J. M. Cardeza. Fossiliferous(?) Sandstone, Del. Co., Pa.; Lignite, Elkton, Md.

Mrs. Hugh Davids. Stilpnomelane, Weilburg, Nassau; Braunite, Ilmenau, Thuringia; Ardenite, Salm-Chateau, Belgium; Berthierite in Quartz, near Freiberg, Saxony; Megabasite on Quartz, Bohemia.

John Ford. Tourmaline, W. side of Schuylkill, Phila.; Chlorite with Magnetite, above Manayunk: Pink Marble, Marble Hall, Mont. Co., Phila.

Mrs. Gabb. Borax, near Clear Lake, Cal.

G. N. P. Gale. Collection of minerals and rocks, Orange Co., N. Y.

J. Geismar. Gypsum, marl of Burlington Co., N. J.

E. Goldsmith. Peat, Nantucket Island, Mass.

J. M. Hartman. One hundred minerals from various localities, including a fine suite of Iron ores from Sweden.

Dr. H. Haupt, Jr. Stalactite, Giles Co., Va.

Dr. F. V. Hayden. A fine collection of Geyserites, etc., Geysers of the Yellowstone National Park.

W. W. Jefferis. Lignite, Penna. R. R. Tunnel, Baltimore, Md.; Bronzite, Bare Hills, Md.; Corundum and Culsageeite, Chester Co., and Kyanite, Lancaster Co., Pa.; Micaceous Iron, Lake Superior.

Dr. Jos. Leidy. Steatite pseudomorph of Staurolite, Lisbon, N. H.; Apophyllite, Isle Haute, Bay of Fundy.

H. C. Lewis. Native Sulphur, Surry Co., N. C.; Lignite, Kinkora, N. J.; Diatomaceous Earth, Richmond, Va.

Dr. Linn. Muscovite with peculiar markings, Macon Co., N. C.

W. L. Mactier. Amber, Nantucket, Mass.

J. W. Peck. Calcite, from beneath a bed of upper Silurian Pentamerus, Delhi, Ind.

Theo. D. Rand. Twelve Rocks, Mahanoy City, Pa.; Diabase, near Pottstown, Pa.; Euphyllite in Tourmaline, Pyrite, Quartz, xls., Chester Co.; Almandine, Dixon's Quarry, Delaware; forty-four Rocks, neighborhood of Phila.; Petroleum, Enniskillen, Canada; Willemite, Franklin, N. J.; Drusy Quartz, Calcite, Montgomery Co., Pa.; Quartz, Andalusite, Delaware Co., Pa.; seventeen Rocks, Delaware Co., Pa.; Stalactite, Page Co., Va.; Molybdenite, Frankford, Phila.

Dr. Ruschenberger. Obsidian, Mauna Loa, Hawaii, eruption of 1856.

W. S. Vaux. Cuprite, Cornwall, England; Pyrosmalite, Nordmarken, Sweden; Gypsum, Monte Doneto, Bologna; four crystals of Orthoclase, Baveno, Lake Maggiore, Italy; Axinite, Medals, Switzerland; Vanadinite, Lead Hills, Scotland; a fine specimen of Harmotome, Strontian, Scotland; Octahedral Quartz and Hematite, St. Lawrence Co., N. Y.; Apatite and Biotite, Burgess, Canada; Spinel, Orange Co., N. Y.; a very fine specimen of Proustite, Chanarcillo, Copiapo, Chili.

Jos. Willcox. Corundum, from Chester Co., Pa., and Ala.; Tourmaline, Pyroxene, and Hornblende, St. Lawrence Co., N. Y.; Pyrophyllite, Chesterfield, S. C.; Margarite, Andesite, Chester Co., Pa.; Phlogopite, Apatite, Ontario, Canada; twelve Staurolites, Tannin Co., Ga.

Minerals in exchange for duplicate books. Ilmenite, Bavaria; Astrophyllite, El Paso Co., Cal.; Calcite in Limestone, Fluorite and Calcite in Limestone, Millerite and Dolomite, St.

Louis, Mo.; Orthoclase, Gothite on Quartz, Orthoclase, Pike's Peak, Col.; Limonite, Neguanee, Mich.; Pyrolusite, Nova Scotia; Stalactite, Stalagmite.

Minerals purchased. Adamite on Quartz, France; Gersdorffite, Styria; Eudyalite and Arfvedsonite with Feldspar, Greenland; Wavellite, Montgomery Co., Ark.; Corundum and Lesleyite, Corundum, Barnhardtite, N. C.; Langite, Cornwall, England; Euxenite, Arendal, Norway; Helvite with Quartz and Zinc-blende, Saxony; Melilite in Lava, Humite, Vesuvius; Senarmontite, Algeria; Bytownite, Canada; Fergusonite in Quartz, with black Mica, Ytterby, Sweden; Sepiolite, Bonitz; Covellite, Dillenberg; Glaucodot, Sweden.

Minerals deposited by Am. Phil. Soc. Red Porphyry, Sweden; Pipe-stone, Sioux Country; Leopardite, N. C.; Zinc, the first manufactured in America, made from ore from Perkiomen Mine, Montgomery Co., Pa.

The collection of minerals of the Franklin Institute, and the rocks of the Rogers Survey of Penna., heretofore in its custody, have been deposited, on condition of their return on demand.

I would also report the completion of the numbering of the minerals in the Museum, in accordance with the catalogue, and the preparation of an alphabetical index of the same.

All of which is respectfully submitted,

THEO. D. RAND,
Director.

The election of Officers for 1880 was held, with the following result:—

President . . .	W. S. W. Ruschenberger, M.D.
Vice-Presidents . .	Wm. S. Vaux, Thomas Meehan.
Recording Secretary .	Edward J. Nolan, M.D.
Corresponding Secretary	Geo. H. Horn, M.D.
Treasurer . . .	Wm. C. Henszey.
Librarian . . .	Edward J. Nolan, M.D.
Curators . . .	Joseph Leidy, M.D., William S. Vaux, Charles F. Parker, R. S. Kenderdine, M.D.

Councillors to serve three years	Rev. H. C. McCook, Edw. Potts, Isaac C. Martindale, Theo. D. Rand.
Finance Committee .	Edw. S. Whelen, Clarence S. Bement, Aubrey H. Smith, S. Fisher Corlies, Geo. Y. Shoemaker.

ELECTIONS DURING 1879.

MEMBERS.

January 28.—H. Dumont Wagner, Charles Henry Hart, Jacob Binder, Geo. A. Binder.

March 25.—Joseph Mellors, Wm. S. Auchincloss.

April 29.—Robert Meade Smith, M.D., J. J. Kirkbride, M.D., Jas. F. Magee, Wm. S. Magee, Henry C. Coates, Henry W. Stelwagon, M.D., Robert S. Davis.

May 27.—Chas. Pennypacker.

June 24.—William P. Foulke.

July 29.—John M. Taylor, M.D.

October 28.—Russell S. Hill.

November 25.—John C. Dawson, H. Russell Bassler, Mrs. Mariné J. Chase, Benjamin Sharp, Otto Luthy, John Wilson.

CORRESPONDENTS.

March 25.—George Bentham, of London; Wm. H. Leggett, of New York; John M. Coulter, of Hanover, Ind.

July 21.—Gustav Mayr, of Vienna; C. Emery, of Palermo.

September 30.—Lieut. C. A. H. McCauley, U. S. A.

November 25.—Theodor Kjerulf, of Christiania; J. W. Pike, of Vineland, N. J.

ADDITIONS TO THE LIBRARY.

From December 3, 1878, to November 25, 1879, inclusive.

Albert and Markoe, reply to Hon. Mr. Tappan, 1843. T. R. Peale.
Abich, H. Karten und profile zur Geologie der Halbinseln Kertsch und Taman.
Geologischen Beobachtungen auf Reisen in den Gebirgs ländern-zwischen Kur und Araxes. Dr. F. V. Hayden.
Adams, H. H. D. and H. Giacomelli The bird world. In exchange.
Agricultural reports, general index, 1837–1861. Agricultural Department.
Allen, T. F. Characeæ Americanæ. Pts. 1 and 2. I. V. Williamson Fund.
American Museum of Natural History, N. Y., 10th report, 1879. The Trustees.
Amman, J. Stirpium rariorium in Imperio Rutheno sponte provenientium. 1739. In exchange.
Arctic world, 1876. In exchange.
Ardissone, F. Le floridee Italiche.
La vie des cellules. The Author.
Uso delle diatomee nella determinazione della penetrazione degli obiettivi. The Author.
Astor Library, report, 1878. The Trustees.
Baillon, M. H. Dictionnaire de Botanique. 11 Fasc.
Natural history of plants. Vol. V. I. V. Williamson Fund.
Balbiani, G. Generation des Vertébrés. I. V. Williamson Fund.
Barber, E. A. Indian graves in Chester Co., Pa. The Author.
Bárcena, M. Dicurso dedicó á la memoria de P. Angelo Secchi. The Author.
Barker, Jos. B. Navy Department. Bureau of Medicine and Surgery Reports, 1879. The Department.
Barney, E. E. Additional facts in relation to the Catalpa Tree. The Author.
Bary, A. De. Die Erscheinung der Symbiose. 1879. I. V. Williamson Fund.
Bataviaasch Genootschap van Kunsten en Wetenschappen, Tweede Vervolg-Catalogus der Bibliotheek. The Society.
Bayle, E., and R. Zeiller. Explication de la Carte geologique de la France. Atlas, 1re et 2e partie. Dr. F. V. Hayden.
Benson, L. S. Mathematics in a dilemma. The Author.
Berg, C. Fauna entomologica de Patagonia.
Lepidopteren Patagonien's.
Sobre la Vida de las Abejas.
Género Streblota y las Notodontinas de la Republica Argentino.
Udsigt over det Sydlige Norges geologi. Text 4to and Atlas folio. 1879. The Author.
Bernard, C. Leçons de physiologie operatoire, 1879. I. V. Williamson Fund.
Berthelot, Sabin. Vitalité des Mers, 1878. I. V. Williamson Fund.
Bessels, E. Die amerikanische Nordpol-Expedition. I. V. Williamson Fund.
Beudant, F. S. Cours élémentaire d'histore naturelle Minéralogie. 6me Ed. Dr. F. V. Hayden.

Binney, Wm. G. Jaw and lingual dentition of Costa Rica land shells. The Author.
Boissier, E. Flora Orientalis. Vol. 4, Fasc. 2. I. V. Williamson Fund.
Bolton, H. Carrington. Behavior of natural sulphides with iodine and other reagents. The Author.
Bommer, J. E. Platanes et leur culture.
Monog. de la Classe des Fougères.
Fécondation artificielle des Palmiers.
Rapport sur le mémoire sur la famille des Pomacées de M. J. Decaisne.
Des matières colorantes des feuilles.
Sur l'Amylogenèse dans le regne végétal. The Author.
Borre, A. Preudhomme de. Difformités observées chez l'Abax ovalis et le Geotrupes sylvaticus.
Oeuf et la jeune larve d'une espèce de Cyphocrania.
Quelques conseils aux chasseur d'insectes. The Author.
Bortier, M. Cobergher, auteur du dessechement des Moëres. The Author.
Brehms Thierleben Bd. 4, 9 H.—Bd. 5, 2-13 H., Bd. 6, 1-11 H. I. V. Williamson Fund.
Brent, J. C. Letters on the National Institute, Smithsonian Inst., the Fine Arts, etc. T. R. Peale.
Brocklesby, J. Microscopic World, 1851. In exchange.
Bronns' Klassen. 5er Bd. 25-29 Lief., 6er Bd. III. Abth. 1 Lief., V. Abth., 21-25 Lief. Wilson Fund.
Brougham, H. Dialogues on instinct, 1845. In exchange.
Brühl, C. B. Zootomie aller Thierklassen. Atlas, Lief. 11, 12, 13. I. V. Williamson Fund.
Brugnone, J. Miscellanea Malacologica. Pars 1 and 2. I. V. Williamson Fund.
Brush, G. J. and E. D. Dana. On the mineral locality in Fairfield Co., Conn. 2d paper. The Authors.
Buckton, G. B. British Aphides. Vol. II. Wilson Fund.
Bureau of Navigation. Hydrographic Office. List of lights of North and South America; of South and East Coast of Africa and the East Indies. Hydrographic Office.
Bureau of Statistics, Treasury Department, Quarterly report, Sept. 30, 1878, to June 30, 1879. The Department.
Butler, A. G. Lepidoptera heterocera in British Museum. Part II. The Trustees of the Museum.
Calkins, W. W. Marine shells of Florida. The Author.
Candèze, E. Elatérides nouveaux. The Author.
Capellini, G. Il calcare di leitha il Sarmatiano.
Prehnite dei Monti Livornesi.
Pietro Leccese e di alcuni suoi fossili. The Author.
Capus, G. Guide du naturaliste préparateur. I. V. Williamson Fund.
Central Park Menagerie, report of Director, 1878. The Author.
Cerna, D. Phenol (Carbolic Acid), its poisonous effects, and the soluble sulphates as antidotes.
Thevetia iccotli and its glucoside. The Author.
Certes, M. A. Méthode de conservation des infusoires. The Author.
Chamberlain, T. C. Wisconsin Geol. Surv., Report, 1877.
Wisconsin Kettle Moraine. Report of Wisconsin Geological Survey, 1878. The Author.
Chief of Engineers, Reports, 1878, Pts. 1, 2, 3. The War Department.
Chief of Ordnance, Annual report, 1878. War Department.
Chili. Memoires of the Departments and seven other volumes. University of Chili.
Church, J. A. Heat of the Comstock Mines, 1878. The Author.

Cincinnati Society of Natural History, Zoological nomenclature. The Author.
Clarke, W. B. Sedimentary formations of New South Wales. 4th Ed. The Author.
Cogniaux, A. Cucurbitacées nouvelles. 1 and 2 Fasc. The Author.
Cohn, F. Kryptogamen-Flora von Schlesien. 2er Bd., 1e and 2e H. I. V. Williamson Fund.
Colvin, V. Survey of Adirondack Wilderness, N. Y., 1873. In exchange.
Commissioner of Agriculture, letter relative to the manufacture of maize and sorghum sugars.
Reports of 1877 and 1878. The Author.
Comptroller of the currency, report, 1878. John J. Knox.
Commissioners of Education, report, 1877. The Bureau of Education.
Commissioners of Public Charities of Penna. 9th report. The Commissioners.
Conant, A. J. Foot-prints of vanished races in the Mississippi Valley. I. V. Williamson Fund.
Contributions from the E. M. Museum of geology and archæology of Princeton College. No. 2. The College.
Cooper, E. Forest culture and the Eucalyptus trees. The Author.
Cooper, J. G. Notes on some land-shells of the Pacific Slope. The Author.
Cope, E. D. Eleventh contribution to the herpetology of tropical America.
The modern museum.
Genera of Felidæ and Canidæ.
Contributions to the zoology of Montana.
Extinct species of Rhinoceridæ of North America.
Palæontological Bulletin, No. 30.
Theromorphous reptilia. The Author.
Coquand, M. H. Geologie de l'Arrondissement de Corte.
Notice geologique sur les environs de Pandermo. The Author.
Cotter, J. C. B. Contribuiçoes para o conhecimento da Fauna terciaria de Portugal. The Author.
Costa, O. G. Microdoride Mediterraneo. T. 1.
Molluschi del Regno di Napoli, 36 plates. I. V. Williamson Fund.
Coutance, A. Structure musculaire chez les Mollusques acéphales. I. V. Williamson Fund.
Cox, E. T. Geological Survey of Indiana, 8th, 9th, and 10th annual reports. John Collett.
Coxe, R. S. Life and character of Gen. Wm. Henry Harrison. T. R. Peale.
Crepin, F. Fragments paléontologiques pour servir à la flore du terrain houillier de Belgique. 1er Fragment.
Note sur le Pecopteris odontopteroides.
Plantes fossiles des depôts Devoniens.
Materiaux pour servir à l'histoire des roses. 4me Fasc. The Author.
Cresson, E. T. North American Aphidæ, with description of new species. The Author.
Cressy, Noah. Bezoar Stones, Calculi and other animal concretions. The Author.
Crowther, H. Whitby. The Author.
Curators of the Museum of Wesleyan University, eighth annual report, 1879. The Authors.
Curioni, G. Geologia. Pts. 1 and 2. 1877. Dr. F. V. Hayden.
Dall, W. H. Alaska and its resources, 1870 I. V. Williamson Fund.
Use of the generic name Gouldia in zoology.
Californian species of Fusus
New species of mollusks from the northwest coast of America. The Author.

Dana, J. D. Manual of mineralogy and geology. I. V. Williamson Fund.
Some points in lithology. The Author.
Darlington, W. American weeds and useful plants, 1859. Chas. F. Parker.
Davenport, G. E. Catalogue of the Davenport herbarium of North American ferns. The Author.
Dawkins, Boyd. Our earliest ancestors in Britain.
Range of the mammoth in space and time. The Author.
Dawson, J. W. New species of Loftusia.
Microscopic structure of Stromatoporidæ, and on palæozoic fossils mineralized with silicates in illustration of Eozoon. The Author.
De Hart, J. M. Antiquities and platycnemism of the mound builders of Wisconsin. The Author.
Dennis, G. Cities and cemeteries of Etruria. 2 vols. I. V. Williamson Fund.
Department of Agriculture, special Reports Nos. 10–15, 17. Hon. W. G. Le Duc.
Department of Mines, New South Wales, report, 1878. Government of New South Wales.
Dodge, R. I. The Black Hills, 1876. In exchange.
Drainage Map showing a portion of Wyoming, Idaho, and Utah. Department of Interior.
Dufrénoy et Elie de Beaumont, MM. Voyage metallurgique en Angleterre. Planches, 1827. Dr. F. V. Hayden.
Dumortier, B. C. Embryogénie des mollusques gasteropodes. Dr. F. V. Hayden.
Durand, Theo. Flore Liegeoise. The Author.
Earl, G. W. Native races of the Indian Archipelago, 1853. In exchange.
Eaton, D. C. Ferns of North America. Pts. 10–21. J. H. Redfield.
Eimer, Th. Die Medusen. I. V. Williamson Fund.
Eisenach, H. Uebersicht der Bisher in der Umgegend von Cassel beobachteten Pilze. The Author.
Ely, H. Geology in the garden. 1859. In exchange.
Elsass-Lothringen Abhandlungen zur geologischen Specialkarte. Bd. 2, 1. Dr. F. V. Hayden.
Elliot, D. G. Monograph of Bucerotidæ. Pts. 4–6.
Monograph of Felidæ. Pts. 1–4. Wilson Fund.
Classification and synopsis of the Trochilidæ. Smithsonian Institution.
Encyclopedia Britannica. 9th Ed. Vol. IX. I. V. Williamson Fund.
Encyclopédie Methodique. Insectes et vers. Vols. 3-9, 11-14 text; Vols. 8, 9, 11–13 atlas. Dr. F. V. Hayden.
Encyclopædie der Naturwissenschaften. 1e Abth. 1–5 Lief. I. V. Williamson Fund.
Enklaar, J. E. Verdamping van Water van Onderscheidene Gronden onder Verschillende Omstandigheden. Utrecht Society of Arts and Sciences.
Exposition internationale d'Horticulture organisée par la Société Royale de Flore, Rapports. The Society.
Eyferth, B. Schizophyten und Flagellaten, 1879. I. V. Williamson Fund.
Finsch, O. Reise nach West-Sibirien. 1 and 2 Abth. I. V. Williamson Fund.
Fischer & Crosse, MM. Mission scientifique au Mexique. Recherches zoologiques. 7me partie. Études sur les mollusques. The Authors.
Fischer, P. Distribution geographique des brachiopodes et des mollusques du littoral oceanique de la France. The Authors.
Flower, W. H. Specimens illustrating the osteology and dentition of vertebrated animals, in the Museum of the Royal College of Surgeons of England. Pt. 1, Homo. The Author.
Foster-Firmin Gold and Silver Manufacturing Co. The Company.

Foster and Whitney's Lake Superior. Part 2, 2 Vols. Edw. Stroud.
Franklin Fire Insurance Company. Semi-centennial Celebration, 1879. The Company.
Gegenbauer, C. Comparative Anatomy. Transl. by T. Jeffrey Bell, 1879. I. V. Williamson Fund.
Geikie, A. Elementary lessons in physical geology.
Field Geology. I. V. Williamson Fund.
Genth, F. A. North Carolina Uranium minerals. The Author.
Geological Record, 1874–76. The Editor.
Geological Survey of Canada. Report of progress for 1877–78. The Survey.
Geological Survey of India. Records, Vol. XI., Pt. 1; Vol. XII., Pt. 1.
Memoirs, 8vo., Vol. XIV. and Vol. XV., Pt. 1.
Memoirs, 4to. Palæontologia Indica. Ser. IV., Vol. I., Pt. 3; Ser. XII. 1.
Contents and index of the first ten volumes of the Records of the Geological Survey of India, 1868–1877. The Survey.
Geological Survey of Pennsylvania. Reports D^2, E, F, G, O, P. V. & M^2. The Survey.
Gilbert, G. K. Report of the geology of the Henry Mountains. Department of the Interior.
Goette, A. Gliedmassen-Skelets der Molche. I. V. Williamson Fund.
Gorringe, H. H. Coast of Brazil, I.
West Coast of Africa, I. In Exchange.
Gosselet, M. J. Le calcaire devonien supérieur dans le N. E. de l'arrondissement d'Avesnes.
Le calcaire de Givet, 3me et 4me partie.
Gosselet, M. J. and Henri Rigaux. Mouvement du sol de la Flandre depuis les temps géologiques. The Author.
Grandidier, A. Histoire physique, etc. de Madagascar. Vols. XII. XIII. and XIV. I. V. Williamson Fund.
Gratiolet, P. Plis cérébraux de l'homme et des primates. I. V. Williamson Fund.
Gray, Asa. Botanical text-book. 6th Ed., Pt. 1. Structural Botany. I. V. Williamson Fund.
Gray, A. State Board of Agriculture, Kansas, 1st biennial report.
Monthly reports, Sept.–Dec. 1878.
Quarterly report, March 31, 1879. June 30, 1879. The Author.
Gray, J. H. China. 2 Vols. 1878. I. V. Williamson Fund.
Green, Miall, etc. Coal. 1878. I. V. Williamson Fund.
Grenacher, H. Sehorgan der Arthropoden. I. V. Williamson Fund.
Grisebach, A. H. R. Genera et species Gentianearum. 1839. J. H. Redfield.
Gronovius, J. Historia Indica. 1706. In Exchange.
Gross, S. D. Obituary notice of Isaac Hays, M.D. The Author.
Grote, A. R. On Lithophane and new Noctuidæ. The Author.
Gscheidlen. Physiologische Methodic. 4e Lief.
Guppy, R. J. L. . West Indian tertiary fossils. Henry Vendryes.
Habel, S. Sculpture of Santa Lucia Cosumalwhuapa in Guatemala. Smithsonian Institution.
Haeckel, E. Evolution of Man. 2 Vols. 1879.
Generelle Morphologie der Organismen. 2 Vols.
Populäre Vortrage. 1st Heft. 1878. I. V. Williamson Fund.
Halsted, B. D. American species of Characeæ. The Author.
Harpe, P. de la. Nummulites appertenant à la zone superièure des Falaises de Biarritz.
Nummulites du Conté de Nice.
Nummulites des environs de Nice et de Menton. The Author.

Hayden. Sun pictures of the Rocky Mountains.
The so-called Two-Ocean Pass. The Author.
Hayes, I. I. Land of desolation, 1872. In Exchange.
Hébert, Edm. Fossiles de la craie du nord de l'Europe.
Observations sur le terrain quaternaire. The Author.
Hector, J. Colonial Museum and Geological Survey of New Zealand. 13th report. The Author.
Geological Survey of New Zealand. Meteorological report, 1877. Reports of geological explorations, 1877-78. The Director.
Heer, O. Flora fossilis artica. 5 Bd. 1878. I. V. Williamson Fund.
Henle, J. Handbuch der systematischen Anatomie des Menschen. 2 Bd. 3 Lf., 3 Bd. 1 and 2 Abth. Wilson Fund.
Zur anatomie der Crystallinse. The Author.
Henry, J. Æneidea. 1873–78. Vol. II., continued. The Author.
Herman, L. Handbuch der physiologie. 1er Bd., 1er Th. 2 Bd., 1 Th. I. V. Williamson Fund.
Heude, R. P. Conchyliologie fluviatile de la Province de Nanking et de la Chine centrale. 4me F. I. V. Williamson Fund.
Hewitson, Wm. C. Illustrations of Diurnal Lepidoptera. Pts. 2, 5 and 8. Wilson Fund.
Hidalgo, J. G. Moluscos marinos de Espana, etc. Ent. 13 y 14.
Mollusques terrestres des Iles Baléares.
Coquilles terrestres de l'Amérique meridionale. The Author.
Hieroglyphic history of the City of Mexico. T. R. Peale.
Higgins, H. H. Mollusca of the Argo Expedition to the West Indies, 1876. The Author.
Hildebrand, F. Die Farben der Blüthen in ihrer jetzigen Variation und früheren Entwicklung. I. V. Williamson Fund.
Hilgard, E. W., and Dr. F. V. Hopkins. Report upon specimens obtained from borings, 1878. War Department.
Hjelt, O. E. A. Carl von Linne. The Author.
Hockstetter, F. v. Neuen geologischen Aufschluss in Gebiete der Karlsbader Thermen, 1878. Dr. F. V. Hayden.
Hoffmann, C. A. S. Handbuch der mineralogie. 2 a, 2 b, 3, 3 b, 4 a, b. Dr. F. V. Hayden.
Hoffman, W. J. "Turtle-Back" celts in the District of Columbia.
Mineralogy of Nevada. The Author.
Hofmann, K. B. Lehrbuch der Zoochemie. 3e. H. I. V. Williamson Fund.
Holst, E. Om Poncelet's Betydning for Geometrien. The Author.
Hooker, J. D., and J. Bell. Tour in Marocco, 1878. I. V. Williamson Fund.
Hooker, J. D. Flora of British India. Pt. VI. The Author.
Hoppe-Seyler, F. Physiologische Chemie. 3 Th. I. V. Willianson Fund.
Humphreys, J. T. Natural History notes in Burke and Catawba Counties, N. C. The Author.
International Exhibition, Fairmount Park, official bulletin, 1869.
Issel, A., and C. Tapparone Canefri. Strombidi del Mar Rosso. The Authors.
Jacquin, N. J. Observationum botanicarum, 1764. In Exchange.
James, T. P. New species of North American mosses. Catalogue, Musci. The Author.
Jan, Prof. Iconographie générale des Ophidiens. 49c. Livr. Wilson Fund.
Jeffreys, J. G. Reply to Prof. Verrill.
Mollusca procured during the Lightning and Porcupine Expeditions, 1868–70. Pt. 1. The Author.
Jekel, K. Catalogue of Insects, 1879. The Author.
Jellett, J. H. Address before the Royal Irish Academy, 1870. The Author.

Jensen, O. S. Turbellaria ad Litora Norvegiæ occidentalis. Bergen Museum.
Jhering, H. von. Peripherische Nervensystem der Wirbelthiere, 1878. I. V. Williamson Fund.
Jimenez, F. and L. Fernandez. Determination de la longitud del pendulo de segundos y de la gravidad en Mexico á 2283m. sobre et nivel del mar. Dr. F. V. Hayden.
Johns Hopkins University. Chesapeake Zoological Laboratory. Scientific results of the session of 1878.
Jordan, D. S. Manual of the vertebrates of the northern United States. 2d Ed., 1878. I. V. Williamson Fund.
Julien, A. A. Fissure-inclusions in the fibrolitic gneiss of New Rochelle, N. Y. The Author.
Just, L. Botanischer Jahresbericht. 5er Jahrg., 1er und 2e Abth. I. V. Williamson Fund.
Kempf, M. The wandering Cainidæ. The Author.
Kessler, H. F. Lebensgeschichte der auf Ulmus campestris L. vorkommenden Aphiden-Arten. The Author.
King, C. U. S. Geol. Expl. of 40th par. Vol. I. Systematic geology. Engineer Department, U. S. A.
Kjerulf, T. Om Stratifikationés Spor. The Author.
Klapp, W. H. Effects of strychnia. The Author.
Klein, E., and E. N. Smith. Atlas of Histology. Parts I.–VIII. I. V. Williamson Fund.
Klunzinger, C. B. Koralthiere des Rothen Meeres. 2es Th. I. V. Williamson Fund.
Kobelt, W. Synopsis novorum generum, specierum et varietatum molluscorum viventium Testaceorum. The Author.
Illustrirtes Conchylienbuch. 6e and 7e, Lief. I. V. Williamson Fund.
Catalogue der Gattung Cominella. The Author.
Koch, L. Entwicklung der Crassulaceen. I. V. Williamson Fund.
Kœnig, Geo. A. Preliminary notice on Chromometry. The Author.
Kokscharow, N. v. Mineralogie Russlands, 8er Bd. Lfr. 1–32. I. V. Williamson Fund.
Kölliker, A. Entwickl. des Menschen und der höheren Thiere. 2e Aufl., 2e Halfte. I. V. Williamson Fund.
Icones Histiological. 1e Abth. Wilson Fund.
Lawrence, G. N. Birds of Grenada, collection made by F. A. Ober.
Birds collected at Martinique by F. W. Ober.
Birds noted from the Islands of the Lesser Antilles, visited by Mr. Fred. A. Ober.
Birds obtained in Guadeloupe by Mr. Fred. A. Ober.
Birds of Antigua and Bermuda. New species of Cypselidæ. The Author.
Laws, J. B. Is higher farming a remedy for lower prices?
Field and other experiments conducted in the laboratory of. The Author.
Ledoux, A. R. Silica *v.* ammonia.
Analyses of Fertilizers, 1877–78. Dep. of Agriculture, N. C.
Lenhossek, J. von. Die künstlichen Schädelverbildungen ein allgemeinen und zwei künstlich verbildete Makrocephale Schädel aus Ungarn. 1878. I. V. Williamson Fund.
Letter from Secretary of War on lines of communication between Colorado and Mexico. Lieut. C. A. H. McCauley.
Leuckart, R. Menschlichen Parasiten. 2 Bd., 1–3 Lief. I. V. Williamson Fund.
Levy, P. Notas geograficas y economicas sobre la Republica de Nicaragua. I. V. Williamson Fund.

Lewes, G. H. Problems of life and mind. 3d Series. I. V. Williamson Fund.
Librarian of Congress, report, 1878. The Author.
Light-house Board, report, 1878. The Treasury Dep.
Lister, M. Historiæ animalium Angliæ tres tactatus, 1678. Dr. F. Hayden.
Locard, A. Museum d'histoire naturelle de Lyon, Guide aux collections de zoologie, geologie et mineralogie.
Des ravages causes par le Liparis dispar. Dr. F. V. Hayden.
Low, D. Domesticated animals of the British Islands, 1853. I. V. Williamson Fund.
Lockington, W. N. Flounders of our market. The Author.
Lubbock, J. Scientific lectures. I. V. Williamson Fund.
Lyman, B. S. Geological survey of Japan. Report of second year's progress of the survey of the Oil Lands of Japan. The Author.
Macalister, Alex. Introduction to the systematic zoology and morphology of vertebrate animals. I. V. Williamson Fund.
Zoology of vertebrate animals, 1878. I. V. Williamson Fund.
McCauley, C. A. H. Ornithology of the region about the source of the Red River of Texas. The Author.
Explorations in and about Pagosa Springs, Colorado, 1879. The Author.
McCook, H. C. Natural history of the agricultural ant of Texas. The Author.
McDonald, M. Semi-annual report of Virginia Military Institute, 1879. The Author.
Macfarlane, Jas. American geological railway guide. I. V. Williamson Fund.
McLachlan, R. Trichoptera of the European fauna. Pt. 8. I. V. Williamson Fund.
Mallet, L. Reciprocity. Cobden Club.
Mangin, A. Desert World, 1872. In Exchange.
Mantell, G. A. Petrefactions and their teachings, 1851. I. V. Williamson Fund.
Atlas of fossil remains, 1850. In Exchange.
Manual of the principal instruments used in American engineering and surveying. I. V. Williamson Fund.
Maps of Guatemala, Salvador, Nicaragua, Costa Rica, and Santa Domingo. I. V. Williamson Fund.
Marratt, F. P. Variations of sculpture in shells of the genus Nassa.
New form of Gladius, Klein.
Forty proposed new forms of the genus Nassa. The author.
Marsh, O. C. Vertebræ of recent birds.
Additional characters of the Sauropoda.
A new order of extinct reptiles (Sauranodonta). Pt. II.
Polydactyle horses.
History and methods of palæontological discovery. The Author.
Matheron, Ph. Recherches paléontologiques dans le Midi de la France. Livr. 5 and 6. Dr. F. V. Hayden.
Martin, Ch. Temperature de l'air, de la terre et de l'eau au Jardin des Plantes de Montpellier. Dr. F. V. Hayden.
Martin, K. Die Tertiärschichten auf Java. Palæontologischer Theil. I. Lief. I. V. Williamson Fund.
Martini und Chemnitz. Systematisches Conchylien Cabinet. Lief. 274–283. Wilson Fund.
Martindale, J. C. Colorado plants. The Author.
Maury, M. F. Physical geography of the sea, 1859. In exchange.
Medical and surgical history of the war of the rebellion. Part 2, Vol. 1. Medical History. Second issue. Surgeon-General U. S. A.

Meddicott, H. B. Manual of the geology of India. 2 vols. and atlas. Geological Survey of India.
Meehan, Thomas. Native flowers and ferns of the United States. Vol. 2, Pts. 13–24. The Publishers.
Pinus pungens. The Author.
Production of seed in Wistaria sinensis. The Author.
Mercantile Library Association, Philadelphia. 26th report. The Authors.
Mercantile Library Association, New York. 58th report. The Authors.
Message of the President upon negotiations with the Ute Indians. Lieut. C. A. H. McCauley.
Message of the President of United States Pts. 1–4, 1861–2. Edw. Stroud.
Message of the President of the United States on the subject of sheep husbandry, 1878. Dep. of Agriculture.
Miall, L. C. and F. Greenwood. Studies in comparative anatomy. No. II. Anatomy of the Indian elephant. Philosophical and Literary Soc. of Leeds.
Mickleborough, J. and A. G. Wetherby. Lower Silurian fossils. Cincinnati Group. 1878. J. Mickleborough.
Miller, S. H. Prize essay on evaporation. Utrecht Society of Arts and Sciences.
Milne Edwards, H. Leçons sur la physiologie et l'anatomie comparée. T. 9, Fasc. 1, T. 10, T. 13me, 1re and 2e P. I. V. Williamson Fund.
Ministère des travaux publiques. Direction des Mines. Statistique de l'industrie minérale et des appareils a vapeur en France et en Algérie. Dr. F. V. Hayden.
Mission scientifique au Mexique et dans l'Amérique Centrale. Recherches zool. 3me Partie, 4me et 7me Partie. I. V. Williamson Fund.
Modern meteorology. I. V. Williamson Fund.
Möller, V. v. Spiral-Gewundenen Foraminiferen des Russischen Kohlenkalks.
Paläontologische Beitrage. The Author.
Moleschott, Jac. Untersuchungen zur Naturlehre des Menschen und der Thiere. 10 Bd. 4 H.–11 Bd. 2 H. Wilson Fund.
Molina, F. Bosquejo de la Republica de Costa Rica. I. V. Williamson Fund.
Moncel, Count du. Telephone, microphone, and phonograph. I. V. Williamson Fund.
Morren, Ch. Fleurs nationales de Belgique.
Mouvement et l'anatomie du labellum du Megalinium falcatum.
Mouvement et l'anatomie du style du Goldfussia anisophylla. The Author.
Morren, Ed. L'energie de la végétation.
Plantes carnivores et irritables. The Author.
Moseley, H. N. Notes of a Naturalist on the "Challenger." I. V. Williamson Fund.
Moulton, M. M. Meteorological Reports, 1878. The Author.
Mueller, F. von. Native plates of Victoria. Pt. 1.
Fragmenta phytographiæ Australiæ. Vols. 1, 3, 4, 5, and 6. Dr. F. V. Hayden.
Münster, George Graf zu. Petrefactenkunde. H. 1–7. I. V. Williamson Fund.
Mulsant, E. and Cl. Rey. Histoire naturelles des coléoptères de France. Six parts. E. Mulsant.
Muséum d'histoire naturelle, rapports, 1878. The Museum.
Museum Godeffroy, Journal. Heft. XIV. I. V. Williamson Fund.
Museum of practical geology, catalogue of library, 1878. The British Government.
Nachtigal, G. Sahara und Sudan. 1er Th. I. V. Williamson Fund.

Nanaur, A. Tables de logarithmes. The Author.
Napp, R. La Republica Argentina, 1876. Argentine Centennial Commission.
Nathorst, A. G. Om Floran i Skänes Kolförande Bildningar. I. Floran vid Bjuf. 1a Haftet. Geological Survey of Sweden.
National Academy of Sciences, Report on Scientific Surveys. The Academy.
Nevill, G. Mollusca in the Indian Museum, Calcutta. Pt. I. Gastropoda. Trustees of Museum.
Newberry, J. S. Geographical Survey of the Fortieth Parallel.
New palæozoic fishes. The Author.
New Jersey, Geological Survey of, Report, 1878. G. H. Cook.
New York State Library, 58th–61st annual reports. The Trustees.
New York State Museum of Natural History, 27th, 29th, and 30th annual reports. The Trustees
Nusslin, O. Anatomie und Physiologie der Pulmonaten. I. V. Williamson Fund.
Observations météorologiques des Stations du second ordre dans les Pays-Bas, 1876. The Utrecht Observatory.
Ochsenius and Chaper, MM. Rapport sur les mines et founderies d'argent de Bingham. 3 pamphlets. Dr. F. V. Hayden.
Owen's Geological Survey of Wisconsin, Iowa, and Minnesota. Edw. Stroud.
Palæontographica, 25er Bd. 6e Lief., Suppl. III., Lief. I. Heft. 3, Lief. II. H. 2; Lief. III. H. 3, 26er Bd., 1 und 2 Lief. Wilson Fund.
Palæontographical Society's Publications. Vol. 33. Wilson Fund.
Paléontologie française, 1e Ser., An. Inv., Ter. Juras. Livr. 28, 40, 41. 2e Serie, Vegetaux Ter. Jur. Livr. 26, 27, 28. Wilson Fund.
Paulucci, M. Faune malacologique de l'Italie, 1878. I. V. Williamson Fund.
Pavesi, F., de Insubrum agricolarum in Transatlanticas regiones demigratione. Academy of Sciences of Amsterdam.
Peale, A. C. The Laramie Group of Western Wyoming and adjacent regions.
Jura-trias section of Southeastern Idaho and Western Wyoming. The Author.
Pennsylvania Hospital, report of Managers, 1879. The Authors.
Pfaff, F. Naturkrafte in den Alpen. Dr. F. V. Hayden.
Novitates Conchologicæ. I. Abth., Lief. 55, Schluss. Wilson Fund.
Nomenclator heliceorum viventium. 1, 2, 3, and 4 Lief. I. V. Williamson Fund.
Pickering, Chas. Chronological history of plants. Mrs. Chas. Pickering.
Pihl, O. A. L. On magnets. The Author.
Plateau, F. Circulation chez les animaux articules, 1878. The Author.
Polar Colonization. Memorial to Congress. H. W. Howgate.
Polk, L. L. Fish Culture in North Carolina. The Author.
Report, 1877–78. Dep. of Agriculture, N. C.
Portugal, geological map of. The Geological Survey.
Powell, J. W. Report on the lands of the arid regions of the United States. Department of the Interior.
Prime, F., Jr. Catalogue of official reports upon Geological Surveys of the United States and Territories and of British North America. The Author.
Quædvlieg, L. Entomologie pratique. The Author.
Quatrefages, A. De. The human species. I. V. Williamson Fund.
Radcliffe, C. B. Proteus, 1877. 2d Ed. I. V. Williamson Fund.
Rae, J. Railways of New South Wales. Government of New South Wales.

Rand, E. S. Rhododendon and American plants, 1871. In exchange.
Ranvier, L. Traité technique d'histologie. 5me Fasc. I. V. Williamson Fund.
Rathbun, R. Brazilian corals and coral reefs.
Brazilian echinoderms, with notes on their distribution. The Author.
Raulin, V. Description physique et naturelle de l'Ile de Crète. 2 vols. and atlas. Dr. F. V. Hayden.
Regel, E. Descriptiones plantarum novarum et minus cognitarum. Fasc. VI. The Author.
Reid, M. C. Inscribed stone of Grave Creek Mound. The Author.
Reinhardt, J. Beskrivelse af Hovedskallen af et Kæmpedovendyr, Grypotherium darwinii. Dr F. V. Hayden.
Reinsch, P. F. Fresh water algæ collected by Rev. A. C. Eaton. The Author.
Rhees, Wm. J. Smithsonian Institution; Documents relative to its origin and history. The Institution.
Rodwell, G. F. Etna, 1878. I. V. Williamson Fund.
Rogers, H. R. Theories of the great physical forces. The Author.
Rossmassler's Iconographie der europaischen Land and Susswasser Mollusker. 6 Bd. 4–6 Lf. Wilson Fund.
Rothrock, J. T. U. S. Geogr. Surv. west of the 100th Mer. Report. Vol. IV. Botany. Engineer Department, U. S. A.
Royal Society of scientific papers. Vol. 8. The Society.
Ruffner, E. H. Annual report upon explorations and surveys in the Dep. of the Missouri. Lieut. C. A. H. McCauley.
Russ, K. Fremdlandischen Stubenvögel. 3 Bd. 1–6 L. I. V. Williamson Fund.
Russell, I. C. Geological Museum of the School of Mines, Columbia College.
A new form of compass-clinometer. The Author.
Rutgers Scientific School Report, 1878. G. H. Cook.
Rutley, F. Study of rocks. I. V. Williamson Fund.
Ryder, J. A. Remarkable new genus of giant sloths (review).
New genus of minute Pauropod Myriapod.
Successive appearance of Chirocephalus and Streptocephalus in the same pond, etc. The Author.
Saporta, Comte de. Le monde des plantes avant l'apparition de l'homme, 1879. I. V. Williamson Fund.
Sars, G. O. Bidrag til kundskaben om Norges arkteske Fauna, I. Mollusca. I. V. Williamson Fund.
Mollusca regionis Arcticæ Norwegiæ. The Author.
Scheffler, H. Wärme und Elastizität. The Author.
Scheler, Aug. Histoire de la maison de Saxe-Cobourg-Gotha. The Author.
Scherzer, C. Wanderungen durch die Mittel-Amerikanischen Freistaaten Nicaragua, Honduras und San Salvador, 1857. I. V. Williamson Fund.
Schiodte, J. C. Zoologia Danica. 1e Hefte. I. V. Williamson Fund.
Schlagintweit-Sakünlünski, H. von. Auftreten von Bor-Verbindungen in Tibet, 1874. The Author.
Schlüter, Wm. Preis-Verzeichniss verkäuflicher europaischer und exotischer Vogeleier. The Author.
Schmidt, A. Atlas der Diatomaceen-Kunde. 15es and 16es H. I. V. Williamson Fund.
Schmidt, O. Spongien des Meerbusen von Mexico. 1es H. Alex. Agassiz.
Spongien des adriatischen Meeres. 2es, 3es Supplement. I. V. Williamson Fund.
Schneider, A. Vergleichenden Anatomie und Entwicklungsgeschichte der Wirbelthiere, 1879. I. V. Williamson Fund.

Schneider, O. Der Kaukasusländer, 1878. The Author.
Schwann, Th. Manifestations en l'honneur de, 1878. The Committee.
Schwartz, O. Flora Indiæ occidentalis. T. 1, 2, 3. 1797–1806. I. V. Williamson Fund.
Scudder, S. H. Catalogue of scientific serials. I. V. Williamson Fund.
Secchi, P. A. L'Astronomia in Roma nel Pontificato di Pio IX. Collegio Romano.
Second Yarkand Mission, Scientific results. Geology, mollusca, hymenoptera, ichthyology, reptilia and amphibia, neuroptera, 1878. East Indian Government.
Selle, A. de. Course de mineralogie et de geologie. T. 1er, text and atlas. Dr. F. V. Hayden.
Semper, C. Reisen im Archipel der Philippinen. 2er Th., 2er Bd. XIV. Heft. Wilson Fund.
Sharp, R. B. Catalogue of the birds in the British Museum. Vol. IV. The British Museum.
Short, Prof. The North Americans of antiquity. Appendix A. Lit. and Scient. Soc. of Madisonville, Ohio.
Shuttleworth, R. J. Notitiæ malacologicæ. II. Heft. Wilson Fund.
Siebe, H. Conquest of the sea. In exchange.
Simmonds, P. L. Commercial products of the sea, 1879. I. V. Williamson Fund.
Simpson, Lieut. Report and map of the route from Fort Smith, Arkansas, to Santa Fe, N. M. T. R. Peale.
Smith, E. F. Calculus found in a deer. Detection of iron by means of salicylic acid.
On a new base. The Author.
Smith, E. F., and Gertrude K. Peirce. Products obtained by nitration of Metachlorsalicylic Acid. The Authors.
Smith, Lawrence. Fer natif du Groenland et sur la Dolérite qui la renferme. The Author.
Smith, W. H. Practical mode of studying the heart.
Catalogue of reptilia and amphibia of Michigan. The Author.
Smithsonian Institution, Annual Report, 1877.
Miscellaneous Collections. Vols. 13, 14, 15.
List of publications, 1879. The Institution.
Snellen, M. Le telemeteorographe d'Olland. The Author.
Snow, F. H. Birds of Kansas. 3d Ed. 1875. Kansas Academy of Sciences.
Société Royale d'Horticulture de Liège. Projet du créer un Jardin d'Acclimatation, 1863. The Society.
South African Museum, report, 1878. The Trustees.
Souverbie, S. M., et R. P. Montrouzier. Description d'espèces nouvelles de l'Archipel Caledonien. S. M. Souverbie.
Sowerby, G. B. Thesaurus Conchyliorum. Pts. 33 and 34. Murex. I. V. Williamson Fund.
Spencer, H. Data of ethics. I. V. Williamson Fund.
Spratt, T. A. B. Travels in Crete. 2 Vols. 1865. Dr. F. V. Hayden.
Stanley, H. M. Through the Dark Continent. I. V. Williamson Fund.
Stansbury's Expedition to the Great Salt Lake. 2 Vols. Edw. Stroud.
Stearns, R. E. C. Certain badly-treated mollusks.
Fossil shells from the Colorado Desert.
Forms of seeds as a factor in natural selection in plants. The Author.
Stein, Fr. R. v. Organismus der Infusionsthiere. 3 Abth. 1 Hälfte. Wilson Fund.
Steiner, L. H. Changes required by the present state of medicine. The Author.
Stinson, J. H. Organon of science, 1879. The Author.
Stuart, A. B. Kawi Oorkonden. Batavian Natural History Society.

Svedmark, E. Halle-och Hunnebergs Trapp. Geological Survey of Sweden.
Sveriges Geologiska Undersökning. Ser. Aa. Nos. 63–67. Ser. C. Nos. 26 and 28. 8vo. Maps 63–67.
Malmfyndigheter Inom Norrbottens Län. The Geological Survey of Sweden.
Tate, R. Adelaide Philosophical Society, Address, 1878.
Correlation of the coral-bearing strata of S. Australia.
Recent Marginellidæ of S. Australia. The Author.
Thompson, D. A. W. Hydroid zoophytes from Australia and New Zealand. The Author.
Thomson, C. G. Hymenoptera Scandinaviæ. T. 5. I. V. Williamson Fund.
Thirmen, F. von. Fungi Pomicoli. 1879. I. V. Williamson Fund.
Thomas, C. Seventh report of State Entomologist, Illinois. The Author.
Todaro, A. Cultura dei cotoni in Italia. The Author.
Toula, F. Geologisch-paläont. Material zur Entwickelungsgeschichte der Säugethiere, 1879. Dr. F. V. Hayden.
Trautschold, H. Kalkbrüche von Mjatschkowa. 1e Hälfte, Fortsetzung und Schluss. The Author.
Trinchese, S. Struttura del sistema nervosa dei Molluschi gasteropodi, 1871. I. V. Williamson Fund.
Troschel, F. H. Das Gebiss der Schnecken. 2m. Bd., 6e Lief. Wilson Fund.
Tryon, Geo. W., Jr. Manual of Conchology. Pts. 1–4. The Author.
Tyndall, J. Fragments of science. 5th Ed.
Forms of water in clouds and rivers, ice and glaciers. I. V. Williamson Fund.
United States National Museum, Bulletin No. 12. Department of the Interior.
U. S. Geol. and Geogr. Surv. of Territories. Miscellaneous publications, Nos. 10, 11, and supplement.
Bulletin, Vol. IV. No. 4; Vol. V. Nos. 1 and 2.
Tenth annual report.
Report of Field Work, 1877, 1878.
Catalogue of publications, 3d Ed. Department of Interior.
University Convocation of the State of New York. 12th, 13th, and 14th anniversaries. The Trustees of State Library.
Vest, W. v. Ueber Margaritana Bonellii, Fer. 1866.
Werth der Mollusken-Gehäuse für die Wissenschaften im Allgemeinen.
Nachtrag zu Margaritana Bonellii, 1867.
Schliess-Apparat der Clausilien, 1867.
Myocardia, Klaff-Herzmuschel.
Arbreibung der Wirbel bei den Susswassermuscheln insbesondere den Unionen.
Genera Adacna, Monodacna und Didacna, Eich. 2. The Author.
Victoria, Mineral statistics, 1878. Reports of the mining surveyors and registrars. 1878 and 1879. Dr. F. V. Hayden.
Vollenhoven, S. C. Snellen van. Pinacographia. Pts. 7 and 8. I. V. Williamson Fund.
Wachsmuth, C. and F. Springer. Transition forms in Crinoids. The Authors.
Wagner, M. Naturwissenschaftliche Reisen im tropischen Amerika, 1870. I. V. Williamson Fund,
Ward, H. A. Notice of the Megatherium Cuvieri in the University of Rochester.
Notice of the Ward Cabinets, 1863.
Eighteen catalogues. The Author.
Watson, R. B. Mollusca of H. M. S. "Challenger" Expedition. Pts. 1, 2, and 3, and Trochidæ, continued. The Author.

Watson, S. Contributions to American botany, IX. The Author.
Webster, H. E. Annelida Chætopoda of the Virginian Coast. The Author.
Wetherby, A. G. New family and genus of lower Silurian Crustacea. The Author.
White, C. A., and H. A. Nicholson. Supplement to bibliography of North American invertebrate paleontology. The Author.
Whiteaves, J. F. Geological Survey of Canada. Mesozoic fossils, Vol. I. The Survey.
Whitney, J. D. Earthquakes, volcanoes, and mountain-building. I. V. Williamson Fund.
Wiedersheim, R. Anatomie der Gymnophionen. I. V. Williamson Fund.
Williamson, J. Fern etchings. I. V. Williamson Fund.
Williamson, R. S. Use of the barometer on surveys and reconnoissances. War Department.
Willshire, W. H. The principles of botany, 1839. Dr. F. V. Hayden.
Wilson, Jos. Naval Hygiene. 2d Ed. The Author.
Woman's Medical College of Pennsylvania. 13th announcement, 1879–80. The Trustees.
Yarrell, Wm. A history of British birds. 4th Ed. Part XII. I. V. Williamson Fund.
Young Men's Mercantile Library Association of Cincinnati, 44th annual report. The Directors.
Zoological Record, Vol. XIV. Wilson Fund.
Zittel, K. A. Handbuch der Palæontologie. 1 Bd. 2 H.; 2 Bd. 1. I. V. Williamson Fund.
Studien über fossile Spongien. 3e Abth. The Author.

JOURNALS AND PERIODICALS.

Adelaide. Philosophical Society. Transactions, etc., 1877–8. The Society.
Amsterdam. K. Akademie van Wetenschappen. Verslagen en Mededeelingen, Afd. Letterkunde, 2e Reeks, 7 Deel. Afd. Naturkunde, 2e Reeks, 12 and 13 Deel.
Jaarboek, 1877.
Processen-Verbaal. Afd. Natuur. Mai 1877–Apr. 1878.
Verhandlingen, Deel 18. The Society.
Atco. Our Rush Light. May, 1879. The Editor.
Auxerre. Société des Sciences historiques et naturelles de l'Yonne. Bulletin, 33e vol. The Society.
Baltimore. American Chemical Journal. Vol. I. No. 1. The Editor.
American Journal of Mathematics. Vol. I., No. 4.–Vol. II., No. 2. The Editor.
Peabody Institute, 12th annual report. The Institute.
Batavia. Genootschap van Kunsten en Wetenschappen. Verhandelingen, Deel 37, 38, and Deel 39, 1e Stuk. Tijdschrift, Deel 21, Afl. 3-6; D. 22, Afl. 1–6; D. 23, Afl. 1–4; D. 24, Afl. 4 and 5. Notulen, D. 12, Nos. 1–4; D. 13, Nos. 1–4; D. 14, No. 1; D. 15, No. 1. The Society.
Natuurkundig Vereen in Nederlandsch Indie. Tijdscrift. Deel 14, 15, 16. The Society.
Belfast. Naturalist's Field Club. Annual Report, 1876–77; Ser. 2, Vol. I. Pt. 4. The Society.
Natural History and Philosophical Society. Proceedings, Session 1877-1878. The Society.
Berlin. Archiv für Naturgeschichte, 42e Jahrg. 6 Heft; 43e Jahrg. 5 H.; 44 Jahrg. 4 H.; 45 Jahrg. 1–3 H. The Editor.

Botanischer Verein der Provinz Brandenberg. Verhandlungen, 19er Jahrg. The Society.
Deutsche geologische Gesellschaft. Zeitschrift, 30 Bd. 3 H.–31 Bd. 1 H The Society.
Entomologische Verein. Zeitschrift 22er Jahrg. 2 H.; 23er Jahrg. 1es H. The Society.
Gesellschaft Naturforschender Freunde. Sitzungs-berichte, 1878. The Society.
K. Preussischen Akademie der Wissenschaften. Monatsbericht, 1878, Sept.–1879, Juni.
Abhandlungen, mathematische, 1877, 1878; physikalische, 1877, 1878. The Society.
Naturæ Novitates, 1879, Nos. 1–18. The Publishers.
Der Naturforscher. 11 Jahrg. 40–12 Jahrg. 26. The Editor
Verein zur Beförderung des Gartenbaues. Monatsschrift, 21 Jahrg., Jan.–Dec. The Society.
Zeitschrift für die gesammten Naturwissenschaften. 3e Folge, Bd. 3. The Society.
Bern. Naturforschende Gesellschaft. Mittheilungen, Nos. 923–936. The Society.
Bologna. Accademia delle Scienze. Memorie, Ser. 3, S. 7 and 8; and S. 9, Fasc. 1 and 2.
Rendiconti, 1876–77, 1877–78. The Society.
Bonn. Archiv für mikroskopische Anatomie. 16es Bd. 1es H.–17er Bd., 2es H. I. V. Williamson Fund.
Naturhistorische Verein. Verhandlungen, 33er Jahrg. 2e H.–35er Jahrg. 1 H. The Author.
Bordeaux. Académie Nationale des Sciences, Belles Lettres et Arts. Actes, 3e Ser. 35e–39e, Annee. Table Hist. etc. The Society.
Société Linnéenne. Actes T. 32, Livr. 1–T. 33, Livr. 2. The Society.
Société des Sceinces physiques et naturelles. Memoires, 2e Ser. T. 2, 3e Cahier–T. 2, 2e Cah. The Society.
Boston. Society of Natural History. Proceedings, Vol. 19, Pt. 4.–Vol. 20, page 272.
Memoirs, Vol. 3, Pt. 1, Nos. 2 and 3. The Society.
Braunschweig. Archiv für Anthropologie, 11 Bd. 3es Viertelj.–12 Bd. 1es Viertelj. I. V. Williamson Fund.
Bremen. Naturwissenschaftliche Verein. Abhandlungen, 6 Bd., 1. The Society,
Bristol. Naturalists' Society. Proceedings, Vol. 2, Pt. 3. The Society.
Brooklyn. Entomological Society. Bulletin, Vol. 1, No. 7–Vol. 2, No. 3. The Society.
Brünn. Naturforschenden Verein. Verhandlungen, 15 and 16. The Society.
Bruxelles. Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique. Annales, 1877–1878.
Bulletin, 2me Ser. T. 41–44.
Memoires couronnés, 8vo. T. 27.
Memoires couronnés, 4to. T. 40. The Society.
Société Belge de Microscopie. Bulletin, 31 Oct. 1878–25 Sept. 1879.
Annales, T. 3. The Society.
Société Entomologique de Belgique. Compte-Rendu, Ser. 2, Nos. 58, 59, and 64.
Annales, T. 21. The Society.
Société Malacologique. Annales, T. 11. Procès-Verbaux, T. 6 and 7. The Society.
Société Royale de Botanique. Bulletin, T. 1–15. The Society.
Budapest. Ungarische National Museum. Termeszetrajzi Füzetek, 2 Kötet, 4. The Society.

Buenos Ayres. Sociedad Cientifica Argentina. Anales, Nov. 1878, May, 1879. See Cordoba. The Society.
Buffalo. North American Entomologist. Vol. 1, Nos. 1–5. The Editor.
Caen. Académie nationale des Sciences, Arts et Belles-Lettres. Mémoires, 1878, 1879. The Society.
Association des Instituteurs. Bulletin, 1876. The Society.
Calcutta. Asiatic Society of Bengal. Journal, Vols. 46, Pt. 1, Nos. 2, 3, and 4; Pt. 2, No. 3; Vol. 47, Pt. 1, Nos. 2 and 3; Pt. 2, No. 3.
Proceedings, 1877, No. 10; 1878, Nos. 6, 7, 9, and 10; 1879, No. 1. The Society and Isaac Lea.
Stray Feathers. Vol. 7, No. 1–Vol. 8, No. 1. I. V. Williamson Fund.
Cambridge. Harvard University. Library Bulletin, Nos. 11, 12, and 13.
Bibliographical Contributions, No. 1. The University.
Museum of Comparative Zoology. Memoirs, Vol. 6, No. 1.
Bulletin, Vol. 5, Nos. 10–15. The Director.
Nuttall Ornithological Club. Bulletin, Jan.–Oct. 1879. The Society.
Psyche, Nos. 53–57, 59–64, 69. The Editor.
Cap Rouge. Le Naturaliste Canadien. Jan.–Nov. 1879. The Editor.
Cassel. Malakozoologische Blätter. Bd. 25, Bg. 8 et seq. Neue Folge, 1er Bd. Bg. 1 et seq.
Cherbourg. Société Nationale des Sciences Naturelles. Memoires, T. 21. The Society.
Chicago. American Antiquarian, Vol. 1, Nos. 3 and 4; Vol. 2, No. 1. The Editor.
Christiania. Archiv für Mathematik og Naturvidenskab. 3 Bd. 3e H.–4 Bd. 2 H. The Editor.
K. N. Frederiks Universitet. Aarsberetning, 1876–'77. The University.
Norwegischen Meteorologischen Institut. Jahrbuch, 1874, 1875, and 1876. The Institute.
Nyt Magazin für Naturvidenskaberne. 23 Bds. 1 H.–24e Bds. 3 H. The Editor.
Videnskab-Selskab. Forhandlinger, 1875, 1877, and 1878. Skrifter, Ottende Bind, 4 and 5. The Society.
Cincinnati. The Paleontologist, Nos. 3 and 4. The Editor.
Society of Natural History. Journal, Jan. 1879; Vol. 2, No. 1. The Society.
Copenhagen. K. D. Videnskabernes Selskab. Oversigt, 1878, No. 2; 1879, Nos. 1 and 2.
Skrifter, 5te Raekke XII. 3 and 4. The Society.
Naturhistorisk Tidsskrift. 3e Raekke, 11 Bd. 3 H. I. V. Williamson Fund.
Société Royale des Antiquaires du Nord. Memoires, Nouvelle Serie, 1877.
Tillaeg, 1876. The Society.
Danzig. Naturforschende Gesellschaft. Schriften, Neue Folge, 4en B., 2es H. The Society.
Davenport. Academy of Natural Sciences. Report, 1879. The Society.
Dresden. K. Zoologische Museum. Mittheilungen. 3es H. The Director.
K. Sammlung für Kunst und Wissenschaft. Ergebnisse von Funfzigjahrigen Beobachtungen der Witterung, 1879. Bericht, 1876-1877. The Council.
Naturwissenschaftliche Gesellschaft Isis. 1878, Juli–Dec. The Society.
Verein für Erdkunde. Jahresbericht, 15. The Society.
Dublin. Royal Geographical Society of Ireland. Journal, Vol. 15, No. 1. The Society.
Royal Irish Academy. Proceedings, Ser. 2, Vol. 1, Nos. 12, 13; Vol. 2, Nos. 2, 7; Vol. 3, Nos. 1–3.
Transactions. Science, Vol. 26, Nos. 6–17. Polite Literature and Antiquities, Vol. 27, Pts. 1 and 2. The Society.

Dürkheim a. d. Haardt. Pollichia. Jahresbericht 33-35. The Society.
Edinburgh. Royal Botanic Garden. Report, 1878. The Director.
Geological Society. Transactions. Vol. 3, No. 2. The Society.
Royal Society. Proceedings, No. 100.
Transactions. Vol. 18, Pt. 2. The Society.
Scottish Naturalist. Nos. 33–36. The Editor.
Emden. Naturforschende Gesellschaft. 63er Jahresbericht. The Society.
Erlangen. Physikalisch-medicinische Societät. Sitzungs-berichte, 10 Heft. The Society.
Florence. R. Istituto di Studi Superiori practici e di perfezionamenta. Publicazione, Sezione di Medicina e Chirurgia, Vol. 1. Sezione di Scienze fisiche et naturali, Vol. 1. The Society.
Frankfurt a. M. Deutschen malakozoologische Gesellschaft. Jahrbucher, 6er Jahrg., 2, 3, and 4 H.
Nachrichtsblatt, 11er Jahrg. 1–5. The Society.
Senkenbergischen Naturforschenden Gesellschaft. Abhandlungen, 11er Bd., 2 and 3 H.
Bericht, 1876–77, 1877–78. The Society.
Der Zoologische Garten, 19 Jahrg. 7–20 Jahrg. 6. The Editors.
Freiburg i. B. Naturforschende Gesellschaft. Bericht, Bd. 7, H. 3. The Society.
Geneva. Congres periodique international des Sciences Medicales. Comptes Rendu, 1877. Dr. Wm. H. Jones.
Schweizerische palaontologische Gesellschaft. Abhandlungen, Vol. 5. I. V. Williamson Fund.
Société de Physique et d'Histoire Naturelle. Mémoires. Vol. 25, No. 2; Vol. 26, No. 1. The Society.
Genoa. Museo civico di Storia Naturale. Vols. 7 and 8. The Director.
Società di Letture e Conversazioni scientifiche. Effemeridi, 1875, Disp. 1–6.
Giornale, Anno 2, Fasc. 10–Anno 3, Fasc. 9. The Society.
Giessen. Oberhessiche Gesellschaft für Natur- und Heilkunde, 17er Bericht. The Society.
Glasgow. Natural History Society. Proceedings, Vol. 3, Pt. 3. The Society.
Gottingen. K. Gesellschaft der Wissenschaften. Nachrichten. 1878. The Society.
Graz. Naturwissenschaftliche Verein für Steiermark. Jahrg. 1878. The Society.
Halifax. Nova Scotian Institute of Natural Science. Proceedings and Transactions, Vol. 5, Pt. 1. The Society.
Halle. Naturforschende Gesellschaft. Abhandlungen, 14en Bd., 1–3 H., Festschrift, 1879. The Society.
Hamburg. Naturwissenschaftliche Verein. Verhandlungen, Neue Folge, Vols. 2 and 3. The Society.
Hannover. Naturhistorische Gesellschaft. 27 and 28 Jahrb. The Society.
Hanover. Botanical Gazette. Vol. 3, No. 12–Vol. 4, No. 8. The Editor.
Harlem. Hollandische Maatschappij der Wetenschappen. Natuurkundige Verhandelingen, 3e Verz. Deel 11. The Society.
Société Hollandaise des Sciences. Archives, T. 11, 4e Livr.–14 Livr. 2. The Society.
Heidelberg. Physiologische Institute der Universität. Bd. 1, H. 1–Bd. 2, H. 3. The Society.
Helsingfors. Finska Vetenskaps-Societeten. Ofversigt 18, 19, and 20.
Bidrag, 24–31.
Observations Météorologiques, 1874-1876. The Society.
Innsbruck. Ferdinandeum. Zeitschrift, 3e Folge, 22es and 23es H. The Society.

Jena. Medicinisch-naturwissenschaftliche Gesellschaft. Zeitschrift, 12er Bd. 4 H.–13er Bd. 2es H. The Society.
Kansas City. The Western Review of Science and Industry. Dec. 1878–Nov. 1879. The Editor.
Klagenfurt. Landesmuseum von Kärten. Jahrbuch 1–7, 10, 13. The Society.
Königsberg. Physikalisch-ökonomische Gesellschaft. Schriften, 17 Jahrg. 1, 2; 18er Jahrg. 1. The Society.
Lausanne. Société Helvétique des Sciences Naturelles. Actes, 60e Ses. The Society.
Société Vaudoise des Sciences Naturelles. Bulletin, Nos. 81 and 82. The Society.
Leeds. Philosophical and Literary Society. Annual reports, 1877–'78, 1878–'79. The Society.
Leiden. Nederlandsche Dierkundige Vereeniging. Tijdschrift, Deel 4. The Society.
Leipzig. Archiv für Anatomie und Physiologie. Anatomische Abth., 4 H. 1878–4 H. 1879. Physiologische Abth., 5 H. 1878–4 H. 1879. I. V. Williamson Fund.
Fürstlich Jablonowski-sche Gesellschaft. Preisschriften, 21.
Jahresbericht, 1878, 1879. The Society.
Journal für Ornithologie, 26 Jahrg. H. 3–27 Jahrg. H. 2. I. V. Williamson Fund.
K. Sächsischen Gesellschaft der Wissenschaften. Abhandlungen XI. 6–8; XII. 1.
Berichte, 1875–1878. The Society.
Kosmos. 2 Jahrg. 8–3 Jahrg. 6. I. V. Williamson Fund.
Morphologische Jahrbuch. 4er Bd. 3es H.–5er Bd. 2es H. I. V. Williamson Fund.
Naturforschende Gesellschaft. Sitzungsberichte, 1878, 1–3. The Society.
Zeitschrift für Krystallography und Mineralogie, 2 Bd. 6 H.–4 Bd. 1 H. I. V. Williamson Fund.
Zeitschrift für wissenschaftliche Zoologie, 31 Bd.–3 H.–32 Bd. 4 H. I. V. Williamson Fund.
Zoologischer Anzeiger. 1 Jahrg. 9–2 Jahrg. 41. The Editor.
Liege. Société Royale des Sciences. Mémoires, 2me Serie, T. 6.
Lille. Bulletin scientifique du Departement du Nord. Oct. 1878–Oct. 1879. The Editor.
Lisbon. Associacao des Engenheiros Civis Portuguezas. Revista de Obras publicas e minas, T. 10, Nos. 109–115. The Society.
Liverpool. Free Public Library, Museum, and Walker Art Gallery, 26th annual report. The Directors.
Literary and Philosophical Society. Proceedings. No. 32. The Society.
London. Annals and Magazine of Natural History. Dec. 1878–Nov. 1879. I. V. Williamson Fund.
Astronomical Register. Nov. 1878–Sept. 1879. I. V. Williamson Fund.
British Association for the Advancement of Science. Reports 47th and 48th Meeting. I. V. Williamson Fund.
Curtis's Botanical Magazine. Nos. 1100–1111. I. V. Williamson Fund.
Entomological Society. Transactions, 1878. The Society.
Floricultural Cabinet, 1833–1858. I. V. Williamson Fund.
Gardener's Chronicle. Nos. 259–306. The Editor.
Geological Magazine. Nov. 1878–Sept. 1879. I. V. Williamson Fund.
Geological Society. Quarterly Journal, Nos. 132, 136–139. The Society.
Hardwicke's Science Gossip. Nov. 1878–Sept. 1879. I. V. Williamson Fund.

Ibis. Oct. 1878–July, 1879. I. V. Williamson Fund.
Journal of Anatomy and Physiology. Vol. 12, Pt. 2–Vol. 13, Pts. 2, 3, and 4; Vol. 14, Pt. 1. I. V. Williamson Fund.
Journal of Botany, British and Foreign. Oct. 1878–Sept. 1879. I. V. Williamson Fund.
Journal of Physiology. Vol. 1, No. 4; Vol. 2, No. 2. I. V. Williamson Fund.
Quarterly Journal of Science. Oct. 1878–Sept. 1879. I. V. Williamson Fund.
London, Edinburgh, and Dublin Philosophical Magazine. Dec. 1878–Nov. 1879. I. V. Williamson Fund.
Mineralogical Society of Great Britain and Ireland. Mineralogical Magazine. Vol. 2, Nos. 11–14. The Society.
Nature. Nos. 472–523. The Editor.
Notes and Queries. Nov. 1878–Oct. 1879. The Editor.
Popular Science Review. Oct. 1878–July, 1879. I. V. Williamson Fund.
Quarterly Journal of Microscopical Science. Oct.–July, 1879. I. V. Williamson Fund.
Royal Asiatic Society of Great Britain and Ireland. Journal, new series. Vol. 11, Pts. 1 and 2. The Society.
Royal Geographical Society. Proceedings, new series. Vol. 1, Nos. 1–8, 11. Journal. Vol. 48. The Society.
Royal Institution of Great Britain. Journal, Vol. 8, Pts. 5 and 6. I. V. Williamson Fund.
Royal Microscopical Society. Journal. Vol. 2, Nos. 2–6. The Society.
Royal Society. Proceedings. Nos. 184–196. Philosophical Transactions, Vol. 167, Pt. 2, Vol. 168 and Vol. 169, Nos. 1 and 2. The Society.
Society of Arts. Journal. Vol. 26. The Society.
Trübner's American and Oriental Literary Record. Nos. 135–142. The Publishers.
Zoological Society. Proceedings. 1878, Pt. 3–1879, Pt. 2. Transactions. Vol. 10, Pts. 10, 11, 12. The Society.
Zoologist. Nov. 1878–Sept. 1879. I. V. Williamson Fund.

London, Ca. Canadian Entomologist. Vol. 10, No. 12–Vol. 11, No. 10. The Editor.

Louvain. Université Catholique. Annuaire, Anne 43me, and seventeen theses.

Lucca. Reale Accademia Lucchese di Scienze, Lettere ed Arti. Atti. T. 20. The Seciety.

Lübeck. Naturhistorische Museum. Jahresbericht, 1877–78. The Director.

Lüneburg. Naturwissenschaftliche Verein. Jahreshefte VII. The Society.

Lund. University, Acta, T. 9–14. The University.

Lyon. Société d'Agriculture, Histoire Naturelle et Arts utiles. Annales, 4me Série, T. 9me. The Society.
Société Linneenne. Annales, n. s. T. 23me. The Society.

Madison. Botanical Gazette, Vol. 4, No. 11–Vol. 5, No. 1. The Editor.
Wisconsin Academy of Sciences, Arts, and Letters. Transactions. Vol. 4. The Society.

Madrid. Memorial de Ingenieros y revista cientifico-militar. Ano 33, No. 22–Anno 34, 21. The Editor.
Observatorio, Anuario, 1877, 1878, 1879.
Resumen de las Observaciones, 1873–74, 1874–75.
Observaciones meteorologicas, 1873–74, 1874–75. The Observatory.

Manchester. Scientific Students' Association. Annual Report, 1877. The Society.
Metz. Académie. Memoires, 78e Année. The Society.
Verein für Erdkunde: Jahresbericht, 1er. The Society.
Mexico. Museo Nacional. Anales I. 7. The Director.
Sociedad "Andres del Rio." Boletin, Cuaderno 1 and 2. The Society.
Sociedad de Geografia y Estadistica de la Republica Mexicana. Boletin, T. 4, Nos. 2–5. The Society.
Sociedad Mexicana de Historia Natural. La Naturaleza, T. 4, Nos. 8–15. The Society.
Milan. R. Istituto Lombardo di Scienze e Lettere, Rendiconti. Serie 2, Vols. 9 and 10. Memorie. Vol. 13, Fasc. 3; Vol. 14, Fasc. 1. The Society.
Regio Istituto technico superiore. Programma, 1878–79. The Society.
Milwaukee. Naturhistorische Verein von Wisconsin. Jahresbericht, 1878–79. The Society.
Minneapolis. Minnesota Academy of Natural Sciences. Bulletin, pp. 325–352. The Society.
Modena. Societa dei Naturalisti. Annuario, XII., Disp. 1 and 2. The Society.
Mons. Société des Sciences, des Arts et des Lettres du Hainaut. Memoires, Ser. 4, T. 3me. The Society.
Montpellier. Academie des Sciences et Lettres. Memoires de la Section des Sciences. T. 9, 2e Fasc. 1; Section de Médecine, Memoires, T. 5, 1e Fasc. The Society.
Montreal. The Canadian Naturalist. N. S. Vol. 9, Nos. 1 and 3. The Editor.
Moscow. Société Impériale des Naturalistes. Bulletin, 1876, Nos. 1–4, 1878, Nos. 2.
Nouveau Memoires, T. 13, Livr. 5. The Society.
Münster. Westfälischen Provinzial Verein für Wissenschaft und Kunst. 7er Jahresb. The Society.
Munich. Gesellschaft für Anthropologie, Ethnologie und Urgeschichte. Beitrage, Vol. 2, Nos. 3 and 4. The Society.
K. Sternwart. Beobachtungen, 1877, 1878. The Observatory.
K. B. Akademie der Wissenschaften. Sitzungsberichte der math.-phys. Classe. 1878, 1–4.
Abhandlungen, historische Classe, 13er Bd., 1 and 2 Abth.
Nancy. Société des Sciences. Bulletin, Serie 2, T. 3, Fasc. 8 and 9. The Society.
Naples. R. Accademia delle Scienze fisiche e mathematiche. Atti, VI.
Rendiconti, Anni, 11–13. The Society.
R. Istituto d'Incorraggiamento alle Scienze Naturali, economiche e technologische, Programma, 1878. The Society.
Neubrandenburg. Verein der Freunde der Naturgeschichte in Mecklenburg, 32 Jahrg. The Society.
Neuchatel. Société des Sciences Naturelles. Bulletin, T. 11, 2er Cahier. The Society.
New Berlin. Entomologist's Exchange. Vol. 1, No. 5. The Editor.
Newcastle-upon-Tyne. Natural History Society of Northumberland and Durham, and Newcastle-upon-Tyne. Transactions. Vol. 8, Pt. 1. The Society.
New Haven. The American Journal of Science and Arts. Dec. 1878–Nov. 1879. The Editor.
New York. Academy of Sciences. Annals. Vol. 1, Nos. 1–8. The Society.
American Bookseller. Vol. 7, No. 1–Vol. 8, No. 10. The Editor.
American Chemical Society. Vol. 2, Nos. 1–4. Journal, Vol. 1, Nos. 1–3, 5–9. The Society.

American Geographical Society. Bulletin, 1878, No. 2–1879, No. 2. Journal, Vol. 9. The Society.
American Journal of Microscopy. Vol. 3, No. 11–Vol. 4, No. 1. The Editor.
American Quarterly Microscopical Journal. Vol. 1, Nos. 2, 3, and 4. The Editor.
Engineering and Mining Journal. Vol. 28, Nos. 10 and 12. The Editor.
Library Journal. Vol. 3, No. 9–Vol. 4, No. 10. Titleslip Register. Vol. 1, Nos. 1–10. I. V. Williamson Fund.
Medical Eclectic. Nov. 1878–Oct. 1879. The Editor.
Medical Journal. Dec. 1878–Oct. 1879. The Editor.
Popular Science Monthly. No. 81–Dec. 1879. Supplement, Nos. 19 and 20. The Editor.
Princeton Review. March, 1879. The Editor.
Torrey Botanical Club. Bulletin, Nos. 48–58. The Society.
Offenbach am Main. Verein für Naturkunde. Bericht, 17 and 18. The Society.
Orleans. Société d'Agriculture, Sciences, Belles-Lettres et Arts. Mémoires, 2e Ser. T. 19, No. 3–T. 21, No. 1. The Society.
Palermo. Società di Scienze Naturali ed economiche. Bulletino, No. 9–14. Giornale, Vol. 13. The Society.
Paris Académie des Sciences. Comptes Rendus, Vols. 77–86. The Society.
Annales des Mines. T. 14, 5me Livr.–T. 15, 4me Livr. Minister of Public Works, France.
Annales des Science Geologique. T. 10, Nos. 1–4. The Editor.
Annales des Science Naturelles. Zoologie et Paleontologie. T. 7, No. 5–T. 8, No. 3. Botanique. T. 6, No. 5–T. 8, No. 2. I. V. Williamson Fund.
Archives de Zoologie, experimentale et générale. 1877, No. 3–1878, No. 4. I. V. Williamson Fund.
Guide du Naturaliste. 1re Année, No. 4. The Editor.
Journal de Conchyliologie. T. 18, No. 2–T. 19, No. 3. The Editor.
Muséum d'Histoire Naturelle. Nouvelle Archives, 2me Serie, T. 1, 2me and 3me Fasc., T. 2, 1er Fasc. I. V. Williamson Fund.
Revue et Magasin de Zoologie. 1870-1873 ; 1874 wanting No. 6 ; 1875 wanting Nos. 4, 5, and 8 ; 1876 wanting Nos. 1 and 5 ; 1877 and 1878 wanting Nos. 7–12. I. V. Williamson Fund.
Revue Internationale des Sciences. Nos. 4, 6–1879, No. 10. The Editor.
Revue Scientifique de la France et de l'Étranger. 8me Année, No. 19. The Editor.
Société d'Acclimatation. Bulletin, 1878, Sept.–1879, Aout. The Society.
Société de Biologie. Compte Rendu des Sciences, 6me Série, T. 1–4. The Society.
Société Botanique de France. Bulletin, T. 24, p. 241 et seq. The Society.
Société Geologique de France. Bulletin, 3me Ser. T. 5me No. 11–T. 6, No. 7. The Society.
Passau. Naturhistorische Verein. Bericht, 11er. The Society.
Philadelphia. Academy of Natural Sciences. Proceedings, 1878, Pt. 3 ; 1879, Pts. 1 and 2. The Publication Committee.
American Entomological Society. Transactions, Vol. 7, Nos. 1 and 2. Proceedings, Nos. 1–4. The Society.
American Journal of the Medical Sciences, Jan.–Oct. 1879. The Editor.
American Journal of Pharmacy. Dec. 1878–Nov. 1879. The Editor.

American Naturalist. Dec. 1878–Nov. 1879. The Editor.
American Pharmaceutical Association. Proceedings, 26th Meeting. The Society.
American Philosophical Society. Proceedings, No. 102. List of Members. The Society.
Dental Cosmos. Dec. 1878–Nov. 1879. The Editor.
Franklin Institute. Journal, Dec. 1878–Nov. 1879. The Society.
Gardeners' Monthly. Dec. 1878–Nov. 1879. The Editor.
Historical Society of Pennsylvania. Pennsylvania Magazine of History and Biography. Vol. 2, No. 4–Vol. 3, No. 3. The Society.
The Librarian. Vol. 2, Nos. 1–21. The Editor.
Medical News and Library. Nos. 432–443. The Editor.
Monthly Review of Medicine and Pharmacy. Vol. 2, Nos. 3, 4, and 5. The Editor.
Naturalist's Leisure Hour. Vol. 2, No. 4–Oct. 1879. The Editor.
Robinson's Epitome of Literature. Vol. 3, Nos. 3–13. The Editor.
Zoological Society. 7th Annual Report. The Society.

Pisa. Nuova Giornale Botanico Italiano. Vols. 4–9; Vol. 11, Nos. 1–4. The Editor.
Societa Malacologica Italiana. Bulletino, Vol. 4, Nos. 15–20; Vol. 5, Nos. 1–10.
Societa Toscana di Scienze Naturali. Processi Verbali, 12 Gennaio, 1879–Luglio 6, 1879. The Society.

Prag, K. B. Gesellschaft der Wissenschaften. Sitzungsberichte, 1877–1878. Jahresbericht, 1877, 1878. Abhandlungen, 6e Folge, 9er Bd. The Society.

Quebec. Literary and Historical Society. Session of 1877–8. The Society.

Regensburg. Zoologisch-mineralogishe Verein. Correspondenz-Blatt. 32er Jahrg. Abhandlungen, 11es H. The Society.

Riga. Naturforscher-Verein. Correspondenzblatt. 32er Jahrg. The Society.

Rome. R. Accademia dei Lincei. Atti, Serie Terza, Transunti, Vol. 3, Nos. 1–7. The Society.
Accademia Pontificia de Nuovi Lincei. Atti, Anni 24–29. The Society.

St. Gallen. Naturwissenschaftliche Gesellschaft. Bericht, 77–78. The Society.

St. Petersburg. Académie Impériale des Sciences. Memoires, Vol. 25, No. 5; Vol. 26, No. 4.
Bulletin. T. 24, No. 4–T. 25, No. 2. The Society.
Repertorium für Méteorologie, Bd. VI. 1.
Hortus Petropolitanus. Acta. T. 3, 4, 5; Vol. 6. The Society.
Physikalische Central-Observatorium. Annalen, 1877. The Observatory.
Societas Entomologicæ Rossicæ. Horæ, T. XI. Nos. 1–4; T. XIII. The Society.

Salem. American Association for the Advancement of Science. Proceedings, Vol. 27. The Society.
Essex Institute. Bulletin, Vol. 10, No. 7–Vol. 11, No. 9. The Society.
Science News. Vol. 1, Nos. 3 and 4. The Editor.

San Francisco. California Academy of Sciences. Proceedings, Vol. 3, Pt. 4; Vol. 4, pp. 1–40. The Society.
California Horticulturist. Vol. 9, No. 3. The Editor.

Santiago de Chile. Revista Médica de Chili. Ano 6, Nos. 1–12. The Editor.
Universidad de Chile. Anales, 1877, 1e and 2e sec. The University.

Springfield. Familiar Science and Fanciers' Journal. Dec. 1878–Sept. 1879. The Editor.

Stuttgart. Neues Jahrbuch für Mineralogie, Geologie, und Palæontologie. 1878, 7es H.–1879, 7es H. The Editor.

Verein für vaterlandische Naturkunde in Württemberg. Jahreshefte 35er Jahrg.

Sydney. Royal Society of New South Wales. Journal and Proceedings, Vol. XI. The Society.

Tasmania. Royal Society. Papers, Proceedings, and Reports, 1877. The Society.

Tokio University. Science Department. Memoires, Vol. 1, Pt. 1. The University.

Topeka. Kansas Academy of Sciences. Transactions, Vols. 4–6. The Society.

Toronto. Canadian Institute. Proceedings, n. s., Vol. 1, Pt. 1. The Society.

Toulouse. Académie des Sciences, Inscriptions et Belles-Lettres. Mémoires, 7me Série, T. 10. The Society.

Revue Mycologique. 1re Année. Nos. 1 and 4. The Editor.

Société d'Histoire Naturelle. Bulletin, 1876–77, pp. 217 et seq., 1877–78, 2me Fasc.; 11me Année, 1 and 2 Fasc. The Society.

Trieste. Societa Adriatica di Scienze Naturali. Bollettina, Vol. 4, No. 2; Vol. 5, No. 1. The Society.

Tromso. Museum. Aarshefter I. The Director.

Turin. Academia Reale delle Scienze. Atti, Vol. 11, Disp. 1–Vol. 12, Disp. 5.

Memoria, Serie 2a, T. 28. The Society.

Regio Osservatorio della Regia Universita. Bollettino, Anno 9–11. The Society.

Upsal. Observatoire de l'Université. Bulletin Météorologique, Vol. 10. The Observatory.

Urbana. Central Ohio Scientific Association. Proceedings, Vol. 1, Pt. 1. The Society.

Utrecht. Algemeene Vergadering van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen, gehouden den 26 Juni, 1877, 25 Juni, 1878.

Aanteekeningen, 1877–78. The Society.

K. Nederlandsch Meteorologisch Institute. Jaarboek, 1872, 1876, and 1878. The Institute.

Venice. R. Instituto Veneto di Scienze, Lettere ed Arti. Atti, T. 1, Ser. 5, Disp. 10; T. 2; T. 3, Disp. 1–7. The Society.

Vienna. Anthropologische Gessellschaft. Mittheilungen, 8 Bd. 10–9 Bd. 3. The Society.

Embryologische Institute der K. K. Universität. Mittheilungen, 2 and 3 H. I. V. Williamson Fund.

K. Akademie der Wissenschaften. Sitzungsberichte, Mathemat.-Naturw. Classe, 76 Bd. I., 1 H.–77 Bd. II. 3 H.

Denkschriften. Bd. 35 and 38. The Society.

K. K. geologische Reichsanstalt. Jahrbuch, 28 Bd. No. 3–29 Bd. No. 2.

Verhandlungen. 1878, No. 11–1879, No. 9. Abhandlungen. Bd. 12, H. 1. The Society.

K. K. zoologisch-botanische Gesellschaft. Verhandlungen, Bd. 28. The Society.

Verein zur Verbreitung naturwissenschaftlichen Kenntnisse. Schriften, 19er Bd. The Society.

Zoologische Institute. Arbeiten, T. 2, H. 2–T. 2, H. 1. I. V. Williamson Fund.

Washington. The American Botanical Register, No. 3. Rev. Dr. E. A. Dalrymple.

National Academy of Sciences. Report, 1879. The Society.

. National Institute. Constitution, 1840-1849.
Bulletin of Proceedings, 1-4.
Discourse on the objects of, 1841.
Introductory Address, by Hon. R. J. Walker.
Annual Address, by Levi Woodbury.
Report of Recording Secretary, 1850. T. R. Peale.

Wellington. New Zealand Institute. Transanctions, Vol. XI. The Society.

Würzburg. Botanische Institut. Arbeiten, 2er Bd. H. 2. The Institute.
Physikalisch-medicinische Gesellchaft. Verhandlungen, Neue Folge, 12er Bd. 1 H.-13er Bd. 4 H. The Society.
Zoologisch-zootomische Institut. Arbeiten, 5er Bd. 1 H. I. V. Williamson Fund.

Yokohama. Asiatic Society of Japan. Transactions, Vol. 6, No. 3-Vol. 7, No. 3. The Society.

Zurich. Naturforschende Gesellschaft. Vierteljahrsschrift, 23er Jahrg. 1-4 H. The Society.

INDEX TO GENERA.

1879.

Acanthochila 115
Acanthocystis 163
Acanthodoris 72
Achelous 398
Actæa 392
Actæon 212, 223
Actinocrinus 226, 240
Actinodorus 108
Adalaria 72
Ælurodon 175
Ælurogale 176
Æolidia 71, 73, 125
Æolidiella 87
Æolis 72
Æolus 72
Akiodoris 72, 128
Albunea 409
Alope 418
Alpheus 416
Amœba 163, 204
Amphicyon 178, 179
Amphiuma 14, 144
Amphizonella 163
Anacharis 204
Anchistia 423
Anisocrinus 260
Anomalocrinus 285, 295
Anthracopus 165
Arachnocrinus 285, 315
Aratus 402
Araujia 205, 206
Arcella 162
Archidoris 72, 106
Aretes 418
Arionta 16
Ascaris 145
Asclepias 205, 207
Assiminea 29
Assulina 163
Ateles 60
Athanas 418
Atta 33
Atya 414
Atyephryra 415
Atyoida 415
Autonomea 421, 422
Auxis 134
Avicula 219

Barycrinus 238, 285, 322
Batocrinus 234
Begonia 138
Belemnocrinus 240
Bellidia 418
Bicidium 198
Binneya 16
Blatta 204
Blastoidocrinus 236
Bopyrus 198
Bothriocephalus 40
Botryocrinus 285, 320
Botryosphæria 67
Bullimus 219
Bulla 222
Bursacrinus 285, 346
Bythocaris 419

Cadlina 72, 114, 129
Calappa 402
Calceocrinus 242
Calceola 43
Callianassa 410
Callinectes 398
Calpiocrinus 253, 261
Calyptræa 219, 222
Campaspe 89
Camponotus 140
Cancellaria 223
Cancer 391
Canis 178, 184, 186
Carabocrinus 286, 366
Caradina 415
Carcinus 398
Cardita 218, 219, 220
Cardium 219, 221
Caridion 419

Caryocrinus............43, 230, 233
Castanea 165
Catalpa 161
Catillocrinus 242
Catolynx 170
Caulurus.................... 426
Cebus 60
Centropomus................ 153
Centropyxis................. 163
Cercopithecus 146
Cerithioderma 215
Cervus 33
Chirocephalus 148, 201
Chlorodius 395
Chondrella.................. 28
Chorinus 385
Chriomitra...............133, 134
Chromodoris 72, 108
Chrysocyon 184
Clathrulina 163
Cleiocrinus 258
Codaster.................... 231
Codonites 231
Cœliocrinus 286, 354
Colocasia 33
Comatula 239, 244
Concordia 413
Conus 213
Coralliocaris 423
Corallium................... 209
Corbis 219, 221
Corbula 221
Coryphella 71, 73, 77, 126
Coryphodon 50
Coryrhynchus 384
Crangon 411
Crematogaster.... 137
Cristatella 203
Crotalocrinus.............235, 247
Cryphiops 426
Cryptocheles 419
Cryptoprocta 170
Cupressocrinus 235, 242, 247
Cyanea 198
Cyathocrinus.....226, 228, 239, 247, 285, 302
Cybium 134
Cylichna 222
Cynælurus 170
Cynips 198
Cynocephalus................ 60
Cynodictis 184
Cynodon 184
Cyphoderia 163
Cypræa 222
Cyprædia 222
Cyrtia 43
Cyrtidocrinus 286, 368
Cysticercus 11
Cytherea.................219, 222

Decadocrinus 285, 342
Delphinula.................. 211
Dendrocrinus 285, 298
Dendronotus 72, 89, 126
Diaulula 72
Dichocrinus 227, 240
Dieba 184
Difflugia 162, 203
Dinictis 169
Diplodia 68
Doriprismatica 108
Doris....................... 106
Dothidea 66, 67
Dromidia 404
Dysodus 179, 185, 188, 193

Edriocrinus................. 244
Enalocrinus.................. 247
Encrinites 226
Encrinus 286
Endamœba 205
Enhydrocyon 178, 185, 193
Eolia 72
Eolida..................... 73
Eolidia 72
Eolis 72
Epanthropos 194
Epialtus 385
Eriphia 397
Erisocrinus 286, 362
Eucalyptocrinus 43, 240
Euceramus 408
Eucladocrinus 234
Euglypha 163
Eupachycrinus 286, 356
Eupilumnus 397
Euryrhynchus 424
Eurypauropus 139, 164
Euryplax 399
Eurytium 394
Eusmilus 170
Euspirocrinus 286, 366
Evatya 415

Felis 168, 170
Fiona 72, 73, 85, 125
Fistulana 219
Flabellina 71, 73, 79, 126
Forbesiocrinus 274
Formica 142, 154
Freia 198
Fuchsia 137
Fusus 223

Garberia 379, 380
Gebia 410

Gelasimus 399
Gissocrinus 241, 285, 312
Glossodoris 108
Gnathophyllum 414
Gnorimocrinus 273
Goniobranchus 31
Goniopsis 400
Gonolobus 205
Gordius 10
Gorilla 53
Granatocrinus 231
Graphiocrinus 285, 344
Grapsus 401
Gymnocladus 166

Haplocrinus.................. 43
Harpilius 423
Helleopera 162
Helicina 29, 33
Helix 33
Helocyon 184
Hepatus 403
Hermissenda 71, 73, 81, 126
Heteractæa.................... 396
Heterocrinus 228, 242, 285, 291
Heterocrypta 391
Hippa 409
Hippocrenes 218
Hippolysmata 412
Hippolyte 418, 426
Homalocrinus 258
Homo 193
Homocrinus 285, 298
Hoplophoneus 170
Hoya 205
Hyæna 169
Hyalolampe.................... 163
Hyalosphenia 163
Hybocrinus 243, 285, 297
Hydractinia 209
Hydreionocrinus 286, 352
Hylobates 59
Hymenocera 425
Hypoconcha 404
Hyrax 12

Ichneumon 169
Ichthyocrinus 228, 256
Icticyon 178, 190, 193
Iocrinus 285, 293
Iris 163

Janthina 86
Jorunna 132

Krantzite 41

Lamellidoris 72
Lamellina 25
Lasius 140, 160
Latreutes 413
Lecanocrinus 262
Lecythocrinus.............285, 311
Leo 169
Leopardus 169
Lepidops 410
Leptoclinium 379
Leptopodia.................... 383
Liatris 379
Libinia 386
Lichinocrinus 229
Limnea 33
Limopsis 221
Linyphia 150
Lithadia 403
Lithocrinus 275
Lonas 163
Lophomonas 204
Lupus 184
Lycalopex 184
Lycaon 178, 179
Lyncus 170
Lynx.......................... 193
Lysmata....................... 412

Macacus 60, 146
Machærodus 168, 170
Macrocœloma.................. 387
Mactra 198
Marsenia 72
Marsupites 239, 245
Megalotis 178
Megistocrinus 238
Melampus 26
Melania..................214, 225
Melocrinus...............227, 240
Melogramma 66, 381
Menippe 393
Menobranchus 144
Menopoma...................... 144
Mesostoma 215, 225
Mespilocrinus 228, 264
Metanthropos 194
Metoporhapis 384
Microcystis 17
Microphrys 386
Miersia 416
Mithraculus................... 388
Mithrax 390
Muræenopsis 14
Mus 11
Myelodactylus 286, 368
Myrmecocystis 197
Myrmica 140
Myrtillocrinus 242

Nasalis 146
Nasua 169
Natica 212
Nebela 162
Nectocrangon 412
Neofelis 170
Neotoma 12
Neptunus 398
Nika 412
Nimravus 169
Nipterocrinus 278
Niso 219, 224
Nucleocrinus 231
Nycterentes 185
Nyctotherus 204

Ocypoda 400
Odostomia 212
Ogyris 419
Oliva 223
Ollacrinus 234
Omphalotropus 28
Onchidiopsis 72
Onoclea 163
Onustus 218
Onychocrinus 255, 276
Ophiocrinus 285, 320
Oplophorus 426
Opuntia 64
Orcynus 133
Orgyia 195
Orthis 43
Ostrea 218, 219, 220
Othonia 388
Oxyurus 204

Pachygrapsus 400
Pachylocrinus 285, 338
Pachyocrinus 286, 368
Palæmon 425
Palæmonella 425
Palæmonetes 198, 424
Palæocyon 178, 179
Palæosyops 50
Pandalus 422
Panopeus 393
Panulirus 410
Paracrangon 412
Parisocrinus 285, 338
Pasithea 219
Patula 18
Pauropus 139, 149
Pecten 220
Pectunculus 219
Pelia 385
Peneus 427
Pentamera 227
Pentamerus 43
Pentremites 231, 236
Persephone 403
Petrolisthes 405
Phialocrinus 285, 347
Phoma 68
Phorus 218
Physianthus 205
Pilumnus 396
Pinnixa 402
Pinnotheres 402
Pisania 213
Pisocrinus 242
Pisosoma 406
Pitys 18
Placocista 163
Plagusia 401
Platycrinus 226, 227, 239, 241
Platylambrus 390
Platyonichus 399
Pleurobranchus 72
Pleurotoma 213, 224
Polycera 72
Polyergus 140
Polymera 227
Polyonyx 408
Polyporus 198
Pontonella 422
Pontonia 422
Pontophilus 412, 422
Porcellana 406
Porocrinus 233
Poteriocrinus 226, 227, 228, 232, 285, 327
Primula 138
Protamœba 204
Proteus 144
Pseudælurus 170
Pseudodifflugia 163
Pterocaris 421
Pterodoris 108
Pupa 33
Pycnosaccus 264
Pyrula 219, 223

Quadrula 162
Quercus 34, 198, 381

Rangifer 32
Retinospora 209
Rhizocrinus 240
Rhodocrinus 226, 227, 241
Rhopalocrinus 280
Rhus 69
Rhynchocinetes 419
Rhynchocyclus 413
Rhynchonella 43
Rissoa 215
Rissoina 214
Rostellaria 216, 219

Sabinea 412
Sarda 133
Sauropus 165
Scaphiocrinus 285, 335
Scomber 133
Scytalocrinus 285, 339
Semnopithecus 60, 146
Sesarma 401
Sicyocrinus 285, 322
Sicyonia 426
Sigaretus 219, 224
Simenia 184
Siredon 144
Siren 144
Smilodon 170, 175, 193
Solarium 212, 218, 219, 224
Solen 219
Solidago 10
Speothus 178, 185
Sphæria 66, 381
Sphæropsis 68
Sphenoderia 163
Spirifer 43
Stalagmium 221
Stapelia 205
Steganocrinus 234
Stemmatocrinus 286, 364
Stenogyra 19
Streptocephalus 200
Strotocrinus 234
Succinea 26, 33
Succinellite 42
Succinite 41
Symbathocrynus 240, 247
Symborodon 50
Synagodus 179, 185, 186, 193

Tænia 11, 40
Taxocrinus 228, 266
Teinostoma 211
Temnocyon 178, 179
Termes 155
Tetramera 227
Tetramorium 142, 156
Thalassiocaris 426
Thor 421
Thous 178, 179
Thümenia 67
Thuja 209
Tigris 169
Titanotherium 50
Tomarctus 179, 185
Tornatella 212, 222
Tornatellina 21
Tozeuma 413
Trigonocœlia 221
Trimera 227
Trinema 163
Triopa 72
Triton 145
Tritonia 72, 93, 95, 97, 128
Trochita 219, 222
Troglocaris 415
Troglodytes 52
Turritella 219
Typton 422

Uncia 169, 170
Urocaris 424
Urocyon 185

Vaccinium 381
Valsa 67
Vasocrinus 285, 317
Venericardia 219
Vertigo 19
Virbius 421
Viverricula 169
Voluta 218, 223
Volutilithes 218
Vulpes 178, 185

Woodocrinus 286, 347

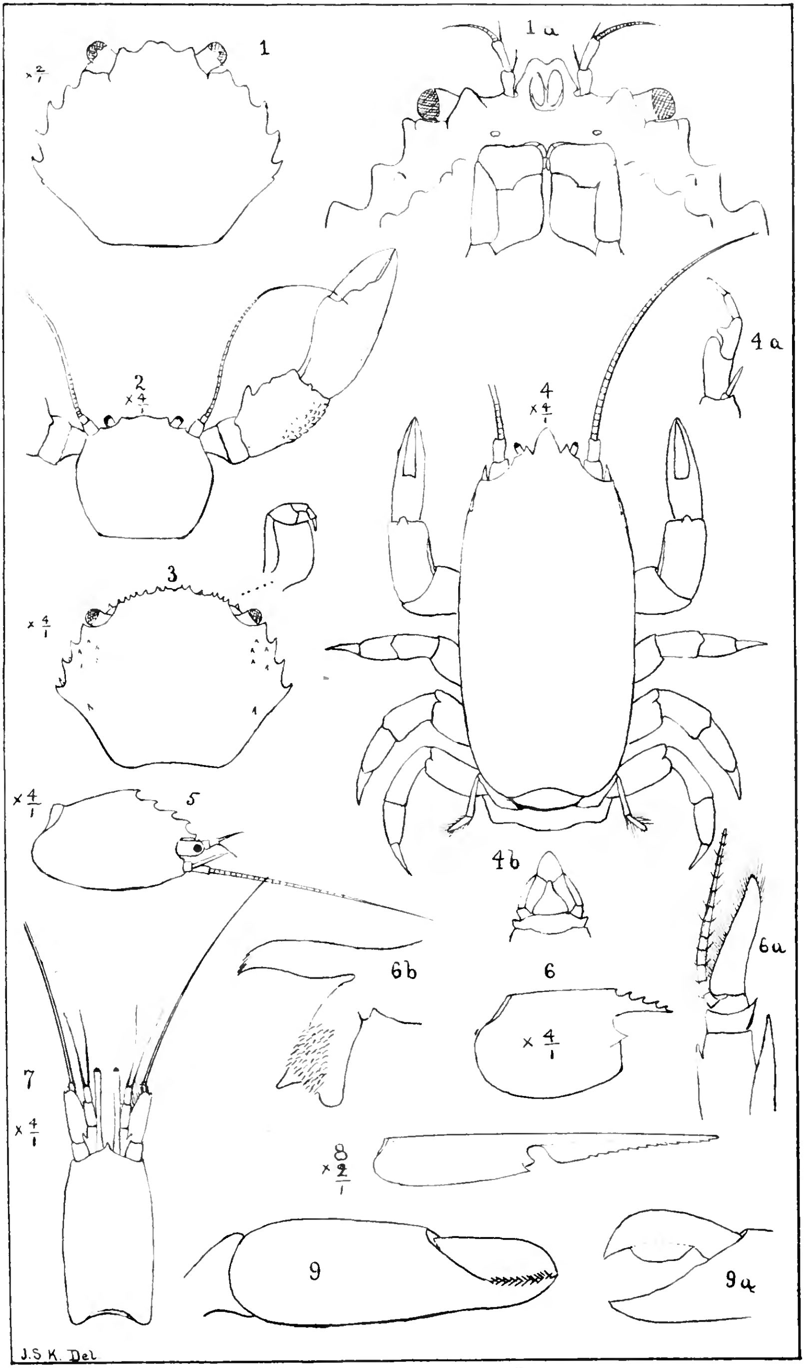
Xanthonyx 16
Xiphocaris 426

Zaphrentis 43
Zeacrinus 286, 348

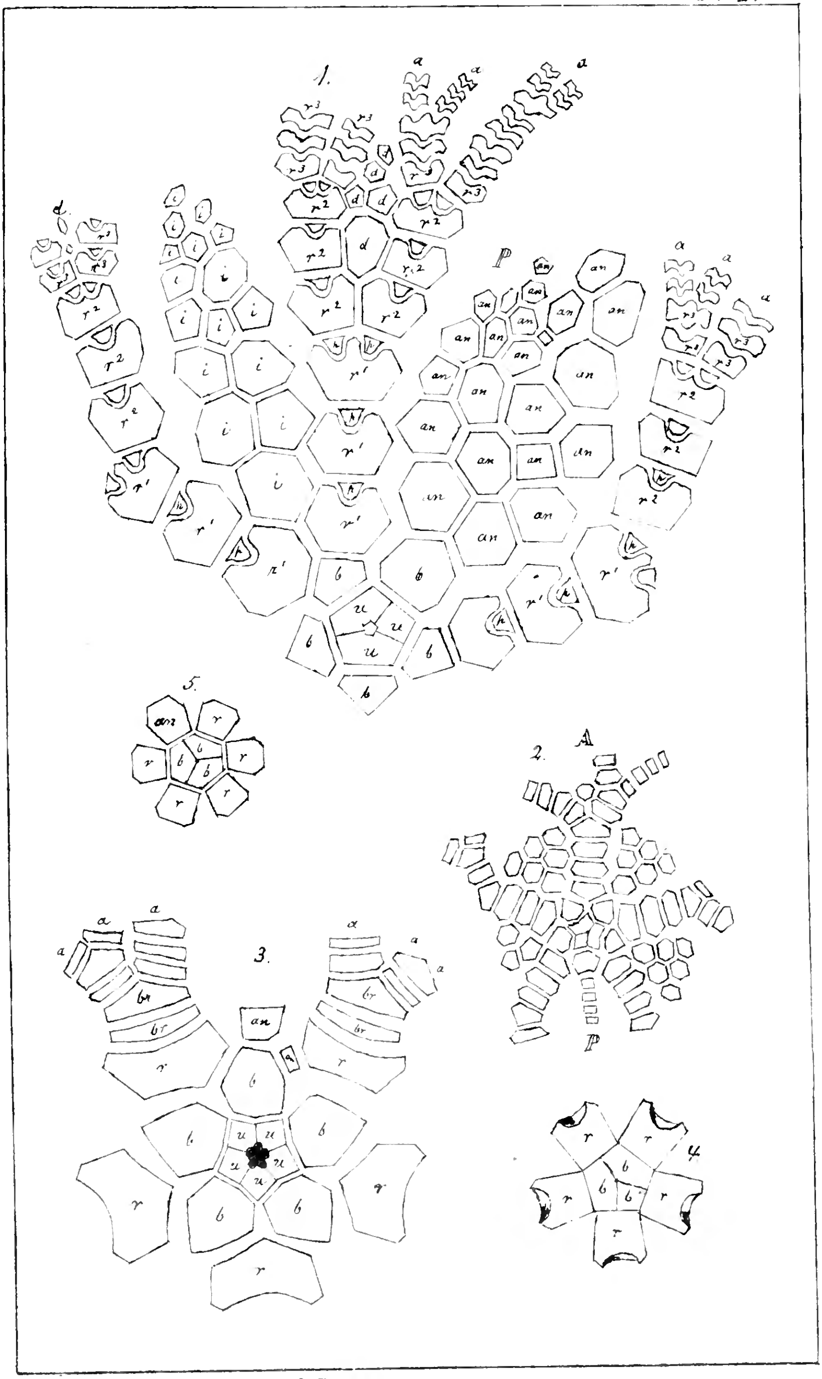
GENERAL INDEX.

Adamson, Wm., Announcement of death of, 162.
Additions to the Library, 459.
Allen, Harrison, Description of a Fœtal Walrus, 428.
Beadle, Rev. E. R., Announcement of death of, 9; Resolution upon death of, 9.
Bergh, R., On the Nudibranchiate Gasteropod Mollusca of the North Pacific Ocean, with special reference to those of Alaska, 71.
Biddle, Clement, Announcement of death of, 65.
Binney, W. G., On the Land Shells of the Mexican Island of Guadeloupe, collected by Dr. E. Palmer, 16.
Biological and Microscopical Section, Report of, 444.
Botanical Section, Report of, 450.
Chapman, H. C., On the Structure of the Chimpanzee, 40, 52; Notes on Amphiuma, 65, 144; Placenta of Macacus Cynomolgus, 138, 146.
Conchological Section, Report of, 445.
Cope, Edw. D., Election to fill vacancy in Council, 65; On the genera of Felidæ and Canidæ, 164, 168.
Corresponding Secretary, Report of, 439.
Curators, Report of, 441.
Dercum, F., The Lateral Sensory Apparatus of Fishes, 152.
Elections, 1879, 458.
Ellis, J. B., On the Variability of Sphæria Quercuum, Schw., 66; Reply to Dr. M. C. Cook's criticism of paper on Variability of Sphæria Quercuum, Sz., 379, 381.
Entomological Section, Report of, 448.
Garrett, Andrew, Description of a New Species of Goniobranchus, 9, 31; List of Land Shells inhabiting Rurutu, one of the Austral Islands, 9, 17.
Goldsmith, E., Asphaltum and Amber from Vincenttown, N. J., 40; On Amber containing Fossil Insects, 207.
Gray, Asa, On the Genus Garberia, 379.
Green, Wm. H., and A. J. Parker, Note on Hyraceum, 12; Correction to same, 379.
Gumbes, Wm. H., Announcement of death of, 209.
Hays, Isaac, Announcement of death of, 138.
Heilprin, Angelo, On some new Eocene Fossils from the Claiborne Marine Formation of Alabama, 208, 211; A comparison of the Eocene Mollusca of the Southeastern United States and Western Europe in relation to the determination of identical forms, 209, 217; On the Stratigraphical Evidence afforded by the Tertiary Fossils of the Peninsula of Maryland, 379.
Hess, R. J., Report of Biological and Microscopical Sections, 444.
Horn, Geo. H., Report of the Corresponding Secretary, 439; Report of Entomological Section, 448.
Index to Genera, 483.
Kingsley, J. S., On a collection of Crustacea from Virginia, North Carolina, and Florida, with a revision of the genera of Crangonidæ and Palæmonidæ, 379, 383; Carcinological Notes, No. 1, 380.
Knight, J. B., Announcement of death of, 65.

Leidy, Jos., On Gordius, and on some Parasites of the Rat, 10; Fossil remains of a Caribou, 32; On Bothriocephalus latus, 40; On Rhizopods occurring in Sphagnum, 162; Fossil foot tracts of the Anthracite Coal Measures, 164; Explosion of a Diamond, 195; Remarks on Orgyia, 195; Notice of some animals on the coast of New Jersey, 198; On Cristatella Idae, 203; On Amœba Blattæ, 204; Ward's Natural Science Eestablishment, 208; Report of the Curators, 441.
Librarian, Report of, 440.
Lockington, W. N., Notes on Pacific Coast Fishes, 10; On a new genus and species of Scombridæ, 133; On the Pacific species of Caulolatilus, 210.
Longstreth, Wm. W., Announcement of death of, 156.
Lyon, V. W., Description of three new species of Calceolidæ, from the Upper Silurian Rocks of Kentucky, 43.
McCook, Rev. H. C., Cutting or Parasol Ant, Atta fervens, Say, 33; Note on the Adoption of an Ant-Queen, 137; Mode of Depositing Ant Eggs, 140; Note on the Marriage Flights of Lasius flavus and Myrmica lobricornis, 140; Pairing of Spiders, 150; Notes on Mound-making Ants, 154; Combats and Nidification of the Pavement Ant, Tetramorium cæspitum, 156; On Myrmecocystus Mexicanus, Wesm., 197.
McCreary, J. B., Announcement of death of, 195.
Maury, F. F., Announcement of death of, 156.
Meehan, Thos., Solidago odora as a "Tea" plant, 10; Note on Opuntia prolifera, Eng., 64; On hybrid Fuchsias, 137; On special fecundity in plants, 138; Do snakes swallow their young? 139; Note on Lonas inodora, 163; On sex in Castanea Americana, 165; Variations in Thuja and Retinospora, 209; Report of Botanical Section, 450.
Meigs, J. Aitken, Announcement of death of, 279.
Miller, E. Spencer, Announcement of death of, 65.
Mineralogical Section, change of name, 380; Report of, 454.
Nolan, Edw. J., Report of the Recording Secretary, 438; Report of the Librarian, 440.
Officers for 1880, 457.
Parker, A. J., Complete connection of Fissura Centralis (Fiss. of Rolando) with the Fossa Sylvii, 428.
Peace, Ed., Announcement of death of, 203.
Potts, Ed., On the supposed sensitive character of glands of the Asclepiadacæ, 205.
President, Report of, 432.
Rand, T. D., Report of Mineralogical Section, 454.
Recording Secretary. Report of, 438.
Redfield, J. H., Report of Conservator of Botanical Section, 451.
Report of President, 432.
Report of Recording Secretary, 438.
Report of Corresponding Secretary, 439.
Report of Librarian, 440.
Report of Curators, 441.
Report of Biological and Microscopical Section, 444.
Report of Conchological Section, 445.
Report of Entomological Section, 448.
Report of Botanical Section, 450.
Report of Mineralogical Section, 454.
Roberts, S. R., Report of Conchological Section, 445.
Ruschenberger, W. S. W., Report of the President, 432.
Ryder, J. A., Further notes on the mechanical genesis of Tooth-forms, 10, 47; Morphological Notes on the limbs of the Amphiumidæ, as indicating a possible synonymy of the supposed genera, 14; Description of a new species of Chirocephalus, 138, 148; Notice of a new Pauropod, 139; Honey glands on Catalpa leaves, 161; The larva of Eurypauropus spinosus, 164; Description of a new Branchipod, 197, 200.
Siegfried, Chas. A., Natives of Botel Tobago, 33.
Smyth, Francis G., Announcement of death of, 195.
Wachsmuth, Chas., and Frank Springer, Revision of the Palæocrinoidea, Part I, the families Ichthyocrinidæ and Cyathocrinidæ, 209, 226.
Williams, H. J., Announcement of death of, 65.

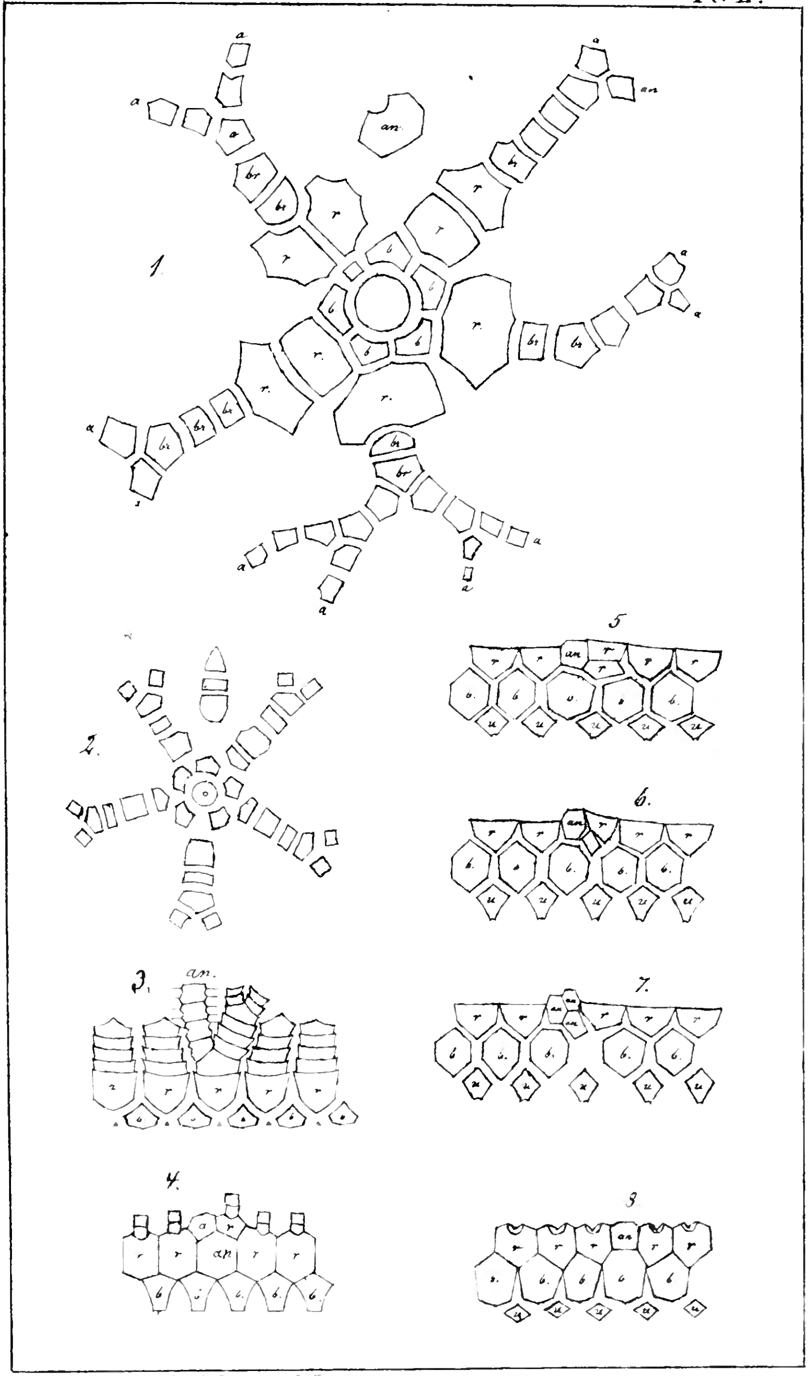


KINGSLEY ON CRUSTACEA.



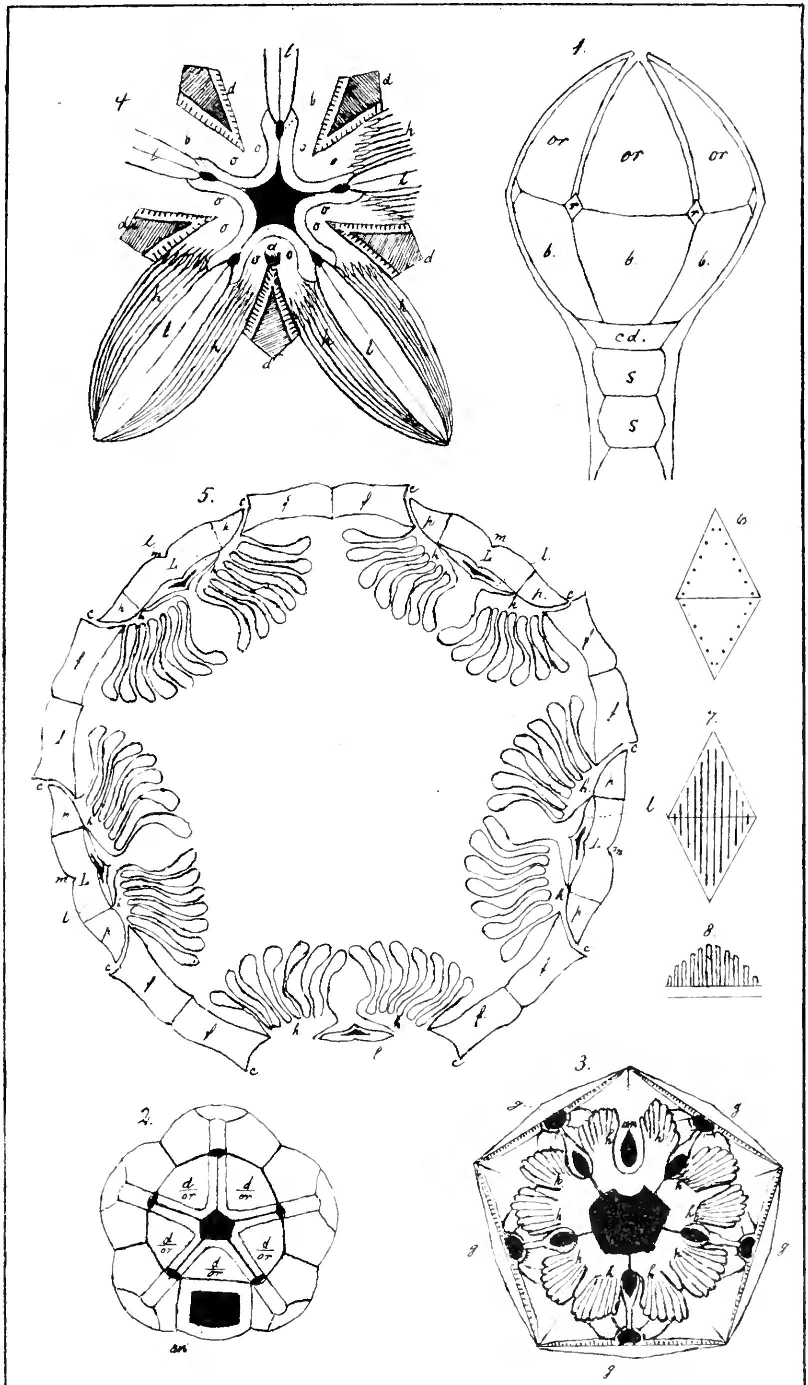
THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST BOSTON

WACHSMUTH AND SPRINGER ON CRINOIDEA.



THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST BOSTON

WACHSMUTH AND SPRINGER ON CRINOIDEA.



THE HELIOTYPE PRINTING CO. 220 DEVONSHIRE ST. BOSTON

WACHSMUTH AND SPRINGER ON CRINOIDEA.

PROCEEDINGS

OF THE

Academy of Natural Sciences

OF

PHILADELPHIA.

PART I.—January, February, and March, 1879.

PUBLICATION COMMITTEE.

JOSEPH LEIDY, M.D., GEO. H. HORN, M.D.,
WM. S. VAUX, THOMAS MEEHAN,
J. H. REDFIELD.

EDITOR: EDWARD J. NOLAN, M.D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
S. W. Corner of 19th and Race Streets.
1879.

PUBLICATIONS OF
THE ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA.

Seven volumes of the New Series of the JOURNAL, and Vol. VIII. Part III. (Quarto) have been issued—1847 to 1877. The price per volume of four parts is $10, or $3 per part, to subscribers; and to others, $12.50 per volume, or $3.75 per part. Vol. 7 contains "The Extinct Mammalian Fauna of Dakota and Nebraska, with a Synopsis of the Mammalian Remains of North America." Illustrated with thirty plates. By JOSEPH LEIDY, M.D., LL.D.

The FIRST SERIES OF THE JOURNAL, 1817 to 1842, in eight volumes octavo, may be obtained at $40 to members, and to the public, $48.

The FIRST SERIES OF THE PROCEEDINGS of the Society, published in octavo, 1841 to 1856, of which eight volumes were completed Dec. 31, 1856, may be obtained at $24 to members; and to the public, $30.

The SECOND SERIES OF THE PROCEEDINGS, commencing January 1, 1857 (of which fourteen volumes were completed Dec. 31, 1870), may be obtained at $42 to members, or $3 per volume separately; and to the public, $3.75 per volume.

The THIRD SERIES OF THE PROCEEDINGS, ILLUSTRATED, commencing January 1st, 1871, of which nine volumes were completed Dec. 31, 1879, is published at $5 per annum, payable in advance, to subscribers; single volumes, $6.25.

AMERICAN JOURNAL OF CONCHOLOGY, 1865–71. Seven vols. 8vo. Containing 2500 pages, illustrated by one hundred and fifty plates, many of them colored, besides about a thousand wood engravings. Published at $70. Price reduced to $42 for the set. Separate volumes $10 each.

BOOKS FOR SALE.

The ACADEMY has the following works for sale at the prices affixed:—

DESCRIPTION OF SHELLS OF NORTH AMERICA, with 68 colored plates. By THOMAS SAY, 1830–34. $10.50.

MONOGRAPH OF THE UNIONIDÆ OF NORTH AMERICA. By T. A. CONRAD. 60 uncolored plates, octavo, 1840. $8.

FOSSILS OF THE TERTIARY FORMATION OF THE UNITED STATES. By T. A. CONRAD. Complete, with 49 plates, octavo, 1838. $5.

MONOGRAPH OF THE TERRESTRIAL MOLLUSCA OF THE UNITED STATES. With Illustrations of all the Species. By GEORGE W. TRYON, Jr. Fine edition, plate paper, with duplicate plates, colored and tinted, $20; colored edition, $13.50; plain edition, $8.50. *Only* one hundred copies printed, which have been mostly sold.

MONOGRAPH OF THE FRESH WATER UNIVALVE MOLLUSCA OF THE UNITED STATES. By S. S. HALDEMAN, 1840–44. With CONTINUATION to 1871. By GEORGE W. TRYON, Jr. 2 vols., with many colored plates. Fine edition, duplicate plates, $40; with colored plates, $25; with plain plates, $18.

Either the original work or the continuation furnished separately, if desired.

SYNONYMY OF THE SPECIES OF STREPOMATIDÆ (Melanians) OF THE UNITED STATES. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

LIST OF AMERICAN WRITERS ON RECENT CONCHOLOGY, with the Titles of their Memoirs and Dates of Publication. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

MONOGRAPH OF THE ORDER PHOLADACEA and other Papers. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

COMPLETE WRITINGS ON RECENT AND FOSSIL CONCHOLOGY OF C. S. RAFINESQUE. Edited by WM. G. BINNEY and G. W. TRYON, Jr. $2.50.

OBSERVATIONS ON THE GENUS UNIO. By ISAAC LEA, LL.D. 4to., Vols. 1 to 13. With Index, Nos. 1, 2, and 3, complete. Illustrated with several hundred fine lithographic plates. $60.

Same, Vols. 2 to 13 inclusive, except Vols. 4 and 12. Each volume separately, $5.

SYNOPSIS OF GENUS UNIO. By ISAAC LEA, LL.D. Fourth edition. $3.

CONTRIBUTIONS TO GEOLOGY. By ISAAC LEA. $5.

FOSSIL FOOT-MARKS. By ISAAC LEA. Large folio, text and plate. $2.

Same, plate alone. 50 cents.

NOTICE TO BOOKSELLERS.—All the Publications of the Society will be supplied to Booksellers at a discount of 20 per cent. on the prices charged to the public.

Application to be made to WM. S. VAUX, Chairman of the Publication Committee, 1702 Arch Street, or to the Librarian, at the Hall of the Academy, corner of Nineteenth and Race Streets.

AGENTS, { *London*, TRUBNER & CO., No. 60 Paternoster Row.
Salem, Mass., NATURALIST'S AGENCY. }

May, 1879.

CONTENTS.

MEEHAN, THOMAS. Solidago odora as a "Tea" Plant . . 10
LEIDY, JOS., M.D. On Gordius, and on some Parasites of the Rat 10
GREENE, WM. H., M.D., and A. J. PARKER, M.D. Note on Hyraceum 12
RYDER, JNO. A. Morphological Notes on the limbs of the Amphiumidæ, as indicating a possible synonymy of the supposed genera 14
BINNEY, WM. G. On the land shells of the Mexican Island of Gaudelupe, collected by Dr. E. PALMER 16
GARRETT, ANDREW. List of land shells inhabiting Rurutu, one of the Austral Islands, with remarks on their synonymy, geographical range, and descriptions of new species . . 17
GARRETT, ANDREW. Description of a new species of Goniobranchus 31
LEIDY, JOS., M.D. Fossil remains of a Caribou 32
SEIGFRIED, Dr. CHAS. N., U. S. N. Natives of Botel Tobago . 33
McCOOK, Rev. H. C. Cutting, or Parasol Ant, Atta fervens, Say 33
LEIDY, JOS., M.D. On Bothriocephalus latus 40
GOLDSMITH, E. Asphaltum and Amber from Vincenttown, N. J. 40
LYON, VICTOR W. Descriptions of three new species of Calceolidæ from the Upper Silurian Rocks of Kentucky . 43
RYDER, JOHN A. Further notes on the Mechanical Genesis of Tooth-forms 47
CHAPMAN, H. C., M.D. On the structure of the Chimpanzee . 52
MEEHAN, THOS. Note on Opuntia prolifera 64
ELLIS, J. B. On the variability of Sphæria Quercuum, Schw. . 66
BERGH, Dr. R. On the Nudibranchiate Mollusca of the North Pacific Ocean, with special reference to those of Alaska . 71
LOCKINGTON, W. N. On a new genus and species of Scombridæ 133

COLLINS, PRINTER.

PROCEEDINGS

OF THE

Academy of Natural Sciences

OF

PHILADELPHIA.

PART II.—April—October, 1879.

PUBLICATION COMMITTEE.

JOSEPH LEIDY, M.D.,
WM. S. VAUX,
GEO. H. HORN, M.D.,
THOMAS MEEHAN,
J. H. REDFIELD.

EDITOR: EDWARD J. NOLAN, M.D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
S. W. Corner of 19th and Race Streets.
1879.

PUBLICATIONS OF
THE ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA.

Seven volumes of the New Series of the JOURNAL, and Vol. VIII. Part III (Quarto) have been issued—1847 to 1877. The price per volume of four parts is $10, or $3 per part, to subscribers; and to others, $12.50 per volume, or $3.75 per part. Vol. 7 contains "The Extinct Mammalian Fauna of Dakota and Nebraska, with a Synopsis of the Mammalian Remains of North America." Illustrated with thirty plates. By JOSEPH LEIDY, M.D., LL.D.

The FIRST SERIES OF THE JOURNAL, 1817 to 1842, in eight volumes octavo, may be obtained at $40 to members, and to the public, $48.

The FIRST SERIES OF THE PROCEEDINGS of the Society, published in octavo, 1841 to 1856, of which eight volumes were completed Dec. 31, 1856, may be obtained at $24 to members; and to the public, $30.

The SECOND SERIES OF THE PROCEEDINGS, commencing January 1, 1857 (of which fourteen volumes were completed Dec. 31, 1870), may be obtained at $42 to members, or $3 per volume separately; and to the public, $3.75 per volume.

The THIRD SERIES OF THE PROCEEDINGS, ILLUSTRATED, commencing January 1st, 1871, of which nine volumes were completed Dec. 31, 1879, is published at $5 per annum, payable in advance, to subscribers; single volumes, $6.25.

AMERICAN JOURNAL OF CONCHOLOGY, 1865–71. Seven vols. 8vo. Containing 2500 pages, illustrated by one hundred and fifty plates, many of them colored, besides about a thousand wood engravings. Published at $70. Price reduced to $42 for the set. Separate volumes $10 each.

BOOKS FOR SALE.

The ACADEMY has the following works for sale at the prices affixed:—

DESCRIPTION OF SHELLS OF NORTH AMERICA, with 68 colored plates. By THOMAS SAY, 1830–34. $10.50.

MONOGRAPH OF THE UNIONIDÆ OF NORTH AMERICA. By T. A. CONRAD. 60 uncolored plates, octavo, 1840. $8.

FOSSILS OF THE TERTIARY FORMATION OF THE UNITED STATES. By T A. CONRAD. Complete, with 49 plates, octavo, 1838. $5.

MONOGRAPH OF THE TERRESTRIAL MOLLUSCA OF THE UNITED STATES. With Illustrations of all the Species. By GEORGE W. TRYON, Jr. Fine edition, plate paper with duplicate plates, colored and tinted, $20; colored edition, $13.50; plain edition, $8.50. *Only* one hundred copies printed, which have been mostly sold.

MONOGRAPH OF THE FRESH WATER UNIVALVE MOLLUSCA OF THE UNITED STATES. By S. S. HALDEMAN, 1840–44. With CONTINUATION to 1871. By GEORGE W. TRYON, Jr. 2 vols., with many colored plates. Fine edition, duplicate plates, $40; with colored plates, $25; with plain plates, $18.

Either the original work or the continuation furnished separately, if desired.

SYNONYMY OF THE SPECIES OF STREPOMATIDÆ (Melanians) OF THE UNITED STATES. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

LIST OF AMERICAN WRITERS ON RECENT CONCHOLOGY, with the Titles of their Memoirs and Dates of Publication. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

MONOGRAPH OF THE ORDER PHOLADACEA and other Papers. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

COMPLETE WRITINGS ON RECENT AND FOSSIL CONCHOLOGY OF C. S. RAFINESQUE. Edited by WM. G. BINNEY and G. W. TRYON, Jr. $2.50.

OBSERVATIONS ON THE GENUS UNIO. By ISAAC LEA, LL.D. 4to., Vols. 1 to 13. With Index, Nos. 1, 2, and 3, complete. Illustrated with several hundred fine lithographic plates. $60.

Same, Vols. 2 to 13 inclusive, except Vols. 4 and 12. Each volume separately, $5.

SYNOPSIS OF GENUS UNIO. By ISAAC LEA, LL.D. Fourth edition. $3.

CONTRIBUTIONS TO GEOLOGY. By ISAAC LEA. $5.

FOSSIL FOOT-MARKS. By ISAAC LEA. Large folio, text and plate. $2.

Same, plate alone. 50 cents.

NOTICE TO BOOKSELLERS.—All the Publications of the Society will be supplied to Booksellers at a discount of 20 per cent. on the prices charged to the public.

Application to be made to WM. S. VAUX, Chairman of the Publication Committee, 1702 Arch Street, or to the Librarian, at the Hall of the Academy, corner of Nineteenth and Race Streets.

AGENTS, *London*, TRUBNER & CO., No. 60 Paternoster Row.
Salem, Mass., NATURALIST'S AGENCY.

Nov. 1879.

CONTENTS.

Meehan, Thomas. On Hybrid Fuchsias 137
McCook, Rev. H. C. Note on the Adoption of an Ant-Queen 137
Meehan, Thomas. On Special Fecundity in Plants . . 138
Ryder, John A. Notice of a new Pauropod 139
Meehan, Thomas. Do Snakes Swallow their Young? . . 139
McCook, Rev. H. C. Mode of Depositing Ant-eggs . . 140
McCook, Rev. H. C. Note on the Marriage-flights of Lasius flavus and Myrmica lobricornis 140
Chapman, H. C., M.D. Notes on the Amphiuma . . . 144
Chapman, H. C., M.D. Placenta of Macacus cynomologus . 146
Ryder, Jno. A. Description of a new Species of Chirocephalus 148
McCook, Rev. H. C. Pairing of Spiders, Linyphia marginata 150
Dercum, Francis, M.D. The Lateral Sensory Apparatus of Fishes 152
McCook, Rev. H. C. Note on Mound-making Ants . . 154
McCook, Rev. H. C. Combats and Nidification of the Pavement Ant, Tetramorium Cæspitum 156
Ryder, J. A. Honey Glands on Catalpa Leaves . . . 161
Leidy, Jos., M.D. On Rhizopods occurring in Sphagnum . 162
Meehan, Thomas. Note on Lonas inodora 163
Ryder, J. A. Larva of Eurypauropus spinosus . . . 164
Leidy, Jos., M.D. Fossil Foot Tracks of the Anthracite Coal Measures 164
Meehan, Thomas. On Sex in Castanea Americana . . 165
Cope, E. D. On the Genera of Felidæ and Canidæ . . . 168
Leidy, Jos., M.D. Explosion of a Diamond 195
Leidy, Jos., M.D. Remarks on Orgyia 195
McCook, Rev. H. C. On Myrmecocystus Mexicanus, Wesm. . 197
Leidy, Jos., M.D. Notices of some Animals on the Coast of New Jersey, ... 198
Ryder, J. A. Description of a new Branchipod . . . 200
Leidy, Jos., M.D. On Cristatella Idæ 203
Leidy, Jos., M.D. On Amœba Blattæ 204
Potts, E. On the Supposed Sensitive Character of the Glands of the Asclepiadaceæ 205
Goldsmith, E. On Amber containing Fossil Insects . . 207
Leidy, Jos., M.D. Ward's Natural Science Establishments . 208
Meehan, Thos. Variations in Thuja and Retinospora . . 209
Heilprin, Angelo. On some New Eocene Fossils from the Claiborne Marine Formation of Alabama. (Plate XIII.) . 211

COLLINS, PRINTER.

PROCEEDINGS

OF THE

Academy of Natural Sciences

OF

PHILADELPHIA.

PART III.—November and December, 1879.

PUBLICATION COMMITTEE.

JOSEPH LEIDY, M.D., GEO. H. HORN, M.D.,
WM. S. VAUX, THOMAS MEEHAN,
J. H. REDFIELD.

EDITOR: EDWARD J. NOLAN, M.D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
S. W. Corner of 19th and Race Streets.
1880.

PUBLICATIONS OF
THE ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA.

Seven volumes of the New Series of the JOURNAL, and Vol. VIII. Part III (Quarto) have been issued—1847 to 1877. The price per volume of four parts is $10, or $3 per part, to subscribers; and to others, $12.50 per volume, or $3.75 per part. Vol. 7 contains "The Extinct Mammalian Fauna of Dakota and Nebraska, with a Synopsis of the Mammalian Remains of North America." Illustrated with thirty plates. By JOSEPH LEIDY, M.D., LL.D.

The FIRST SERIES OF THE JOURNAL, 1817 to 1842, in eight volumes octavo, may be obtained at $40 to members, and to the public, $48.

The FIRST SERIES OF THE PROCEEDINGS of the Society, published in octavo, 1841 to 1856, of which eight volumes were completed Dec. 31, 1856, may be obtained at $24 to members; and to the public, $30.

The SECOND SERIES OF THE PROCEEDINGS, commencing January 1, 1857 (of which fourteen volumes were completed Dec. 31, 1870), may be obtained at $12 to members, or $3 per volume separately; and to the public, $3.75 per volume.

The THIRD SERIES OF THE PROCEEDINGS, ILLUSTRATED, commencing January 1st, 1871, of which nine volumes were completed Dec. 31, 1879, is published at $5 per annum, payable in advance, to subscribers; single volumes, $6.25.

AMERICAN JOURNAL OF CONCHOLOGY, 1865–71. Seven vols. 8vo. Containing 2500 pages, illustrated by one hundred and fifty plates, many of them colored, besides about a thousand wood engravings. Published at $70. Price reduced to $42 for the set. Separate volumes $10 each.

BOOKS FOR SALE.

The ACADEMY has the following works for sale at the prices affixed:—

DESCRIPTION OF SHELLS OF NORTH AMERICA, with 68 colored plates. By THOMAS SAY, 1830-34. $10.50.

MONOGRAPH OF THE UNIONIDÆ OF NORTH AMERICA. By T. A. CONRAD. 60 uncolored plates, octavo, 1840. $8.

MONOGRAPH OF THE TERRESTRIAL MOLLUSCA OF THE UNITED STATES. With Illustrations of all the Species. By GEORGE W. TRYON, Jr. Fine edition, plate paper with duplicate plates, colored and tinted, $20; colored edition, $13.50; plain edition, $8.50. *Only* one hundred copies printed, which have been mostly sold.

MONOGRAPH OF THE FRESH WATER UNIVALVE MOLLUSCA OF THE UNITED STATES. By S. S. HALDEMAN, 1840–44. With CONTINUATION to 1871. By GEORGE W. TRYON, Jr. 2 vols., with many colored plates. Fine edition, duplicate plates, $40; with colored plates, $25; with plain plates, $18.

Either the original work or the continuation furnished separately, if desired.

SYNONYMY OF THE SPECIES OF STREPOMATIDÆ (Melanians) OF THE UNITED STATES. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

LIST OF AMERICAN WRITERS ON RECENT CONCHOLOGY, with the Titles of their Memoirs and Dates of Publication. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

MONOGRAPH OF THE ORDER PHOLADACEA and other Papers. By GEO. W. TRYON, Jr. Cloth, $2; paper, $1.75.

COMPLETE WRITINGS ON RECENT AND FOSSIL CONCHOLOGY OF C. S. RAFINESQUE. Edited by WM. G. BINNEY and G. W. TRYON, Jr. $2.50.

OBSERVATIONS ON THE GENUS UNIO. By ISAAC LEA, LL.D. 4to., Vols. 1 to 13. With Index, Nos. 1, 2, and 3, complete. Illustrated with several hundred fine lithographic plates. $60.
Same, Vols. 2 to 13 inclusive, except Vols. 4 and 12. Each volume separately, $5.
SYNOPSIS OF GENUS UNIO. By ISAAC LEA, LL.D. Fourth edition. $3.
CONTRIBUTIONS TO GEOLOGY. By ISAAC LEA. $5.
FOSSIL FOOT-MARKS. By ISAAC LEA. Large folio, text and plate. $2.
Same, plate alone. 50 cents.

NOTICE TO BOOKSELLERS.—All the Publications of the Society will be supplied to Booksellers at a discount of 20 per cent. on the prices charged to the public.

Application to be made to WM. S. VAUX, Chairman of the Publication Committee, 1702 Arch Street, or to the Librarian, at the Hall of the Academy, corner of Nineteenth and Race Streets.

AGENTS, *London*, TRUBNER & CO., No. 60 Paternoster Row.
Salem, Mass., NATURALIST'S AGENCY.

March, 1880.

CONTENTS.

HEILPRIN, ANGELO. A Comparison of the Eocene Mollusca of the Southeastern United States and Western Europe in relation to the determination of identical forms . . . 217

WACHSMUTH, CHARLES, AND FRANK SPRINGER. Revision of the Palæocrinoidea. (Plates XV., XVI., and XVII.) . . . 226

GRAY, ASA. On the Genus Garberia 379

ELLIS, J. B. Reply to Dr. M. C. Cooke's Criticism on paper on "Variability of Sphæria Quercuum. Sz." 381

KINGSLEY, J. S. On a Collection of Crustacea from Virginia. North Carolina, and Florida, with a revision of the Genera of Crangonidæ and Palæmonidæ. (Plate XIV.) . . . 383

PARKER, A. J. Complete Connection of the Fissura Centralis (Fiss. of Rolando) with the Fossa Sylvii 428

Report of the President 432

Report of the Recording Secretary 438

Report of the Corresponding Secretary 439

Report of the Librarian 440

Report of the Curators 441

Report of Biological and Microscopical Section 444

Report of the Conchological Section 445

Report of the Entomological Section 448

Report of the Botanical Section 450

Report of the Mineralogical Section 454

Election of Officers for 1880 457

Index to Genera, 1879 483

COLLINS, PRINTER.

MBL WHOI LIBRARY
WH 18RD C