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BULLETIN OF THE UNIVERSITY OF IOWA.
NEW SERIES. Vol. 1. No. 6. PRICE 50 CENTS.

BULLETIN

FROM THE

LABORATORIES OF NATURAL HISTORY

OF THE

STATE UNIVERSITY OF IOWA.

VOL V. NO. I.

REPORT ON THE OPHIUROIDEA COLLECTED BY THE BAHAMA EXPEDITION IN 1893.

By PROFESSOR A. E. VERRILL.

PUBLISHED

BY AUTHORITY OF THE REGENTS.

IOWA CITY, IOWA:
SEPTEMBER, 1899.

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Secretary WM. J. HADDOCK:

I have the honor to submit herewith Bulletin No. 1, of Volume V, from the Laboratories of Natural History, of the State University of Iowa.

C. C. NUTTING, Editor.

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REPORT ON THE OPHIUROIDEA

COLLECTED BY THE BAHAMA EXPEDITION FROM THE UNIVERSITY OF IOWA IN 1893.

BY PROFESSOR A. E. VERRILL, OF YALE UNIVERSITY.

The Bahama Expedition obtained about 66 species of Ophiuroidea, among which there are many species of great interest and several that were previously unknown.

In former years the same region had been very extensively explored by the various dredging expeditions made by Mr. Alexander Agassiz, in the Coast Survey Steamer "Blake," and by other earlier government expeditions. The various collections thus obtained were very fully worked up and the numerous new species were described by Mr. Theodore Lyman in the publications of the Museum of Comparative Zoology.* The Challenger Expedition added a few species from the same region, which are included in Mr. Lyman's final report on the Challenger Ophiuroidea (Vol. V, 1882).

Therefore, it was not to have been expected that many new discoveries would be made, in that region, by a comparatively small number of dredgings, and with a far less elaborate equipment. Hence the number of new forms obtained by the Bahama Expedition is rather surprising.

*Bulletin of the Mus. Comp. Zoology, Vol. I, No. 10, p. 309, 1869; Vol. V, No. 9, p. 217, 1878; Vol. X, No. 6, 1883; also Vol. V, No. 7, p. 67, 1878, and Vol. VI, No. 2, 1879, (Challenger Coll.)

Illust. Catal. Mus. Comp. Zool., Vol. I, No. I. 1865; Vol. VI, 1871; Vol. VIII, No. II, 1875.

This collection is peculiar in lacking many common species which were taken at numerous stations and in large numbers by the "Blake Expedition". Such species belong largely to such genera as *Ophioglypha*, *Ophiomusium*, *Amphiura*, etc. These live, for the most part, on muddy or sandy bottoms, or buried just below the surface, and are only to be obtained by the use of the dredge or trawl. But as the Bahama Expedition worked largely upon the hard bottoms and used the tangles relatively much more than the dredge, the absence of many of the common species is easily understood.

On the other hand, and for the same reasons, the collection is relatively rich in those species and genera that live on hard bottoms and cling to the branches of gorgonian corals, hydroids, etc., by means of their long, coiled arms.

Such species are best obtained by the tangles. Some of these belong to the *Ophiuræ;* such as *Sigsbiea* and *Hemieuryale;* but most of them belong to the *Euryalæ*. Many of these are simple armed species of the genera *Ophiocreas*, *Astroschæma*, *Astroporpa*, *Astronyx*, *Astrogomphus;* others are of the general *Astrophyton* and *Gorgonocephalus*, in which the arms are many times forked.

Some of the long-spined genera, like *Ophiacantha*, *Ophiomitra*, *Ophiothrix*, etc., also live among the branches of gorgonian corals, or clinging to other organisms, so that they are easily captured by the tangles. Such genera are well represented in this collection.

Most of those species with long, coied arms, adapted for clinging to the branches of gorgonian corals, are remarkable for imitating closely, in various ways, the forms and colors of the corals on which they live. This must afford them a considerable degree of protection against predacious fishes, in addition to the direct protection due to the stinging powers of the corals themselves, which is sufficient to cause most fishes to avoid them.

I have observed that some of the northern plectognath fishes (file fishes) will feed upon hydroids. It is also well

known that our northern butter-fish, when young, lives with impunity beneath the disk and among the tentacles of the great red jelly-fish (*Cyanea arctica*), which is deadly to other fishes.

It is probable, therefore, that in tropical waters many fishes have acquired comparative immunity against the poisonous stinging organs (*cnidæ*) of coral animals. If so, the utility of the additional protection afforded by the imitative forms and colors of so many of the coral-inhabiting ophuiroids would be obvious.

Professor Nutting has already described the colors of some of these curious forms in his Narrative of the Expedition.

In this report I have followed, in general, the order of sequence adopted by Lyman, but in the case of the *Euryalæ* and in the families *Amphiuridæ*, *Ophiacanthidæ*, and some others, I have thought it desirable to alter his classification considerably.

I have also introduced the names and in some cases the characters of the family groups, and have changed the limits of several of them. Many of these were proposed by Lütken[1] and by Ljungman[2] many years ago.

Several new families are also now characterized.

In describing the genera and species, I have generally used, as a matter of convenience, the same terms, for the organs and parts, that were used by Mr. Lyman in his various works on this group, but have made a few obvious changes. I have preferred to use *oral shield* instead of "mouth-shield", and *adoral shield* instead of "side-mouth-shield". In the genera allied to *Amphiura*, I have usually called the "outer mouth-papillæ" or papillæ of the second oral tentacle, the distal oral tentacle-scales to indicate their homology with the ordinary

[1] Addit. ad Hist. Ophiur., Part III; Synop. gen. Ophiur. ver., p. 87, 1869.

[2] Ophiuroidea viv. hucusque cognita enumerat, Ofvers. Kgl. Vetenskaps-Akad. Forhandlingar, for 1866, 1867.

tentacle-scales. The same idea has been carried out in *Ophiacanthidæ*. In the latter group I have designated the apical "mouth-papillæ" as tooth-papillæ.

In the identification of the species, I have been very much aided by a pretty large series of typical specimens of the species obtained in the West Indies by the several "Blake" Expeditions and described by Mr. Lyman. They were sent to the Yale Museum, several years ago, by Mr. A. Agassiz. I have also used, for comparison, a collection sent to me by Dr. Lütken, from the University Museum of Copenhagen.

Order I. OPHIURÆ *Müller & Troschel*, 1842.

Ophiuræ Ljungman, Oph. Viv., p. 303, 1867.

Ophiuridæ Lyman, and many other authors.

Zygophiuræ and *Streptophiuræ* Bell, 1892.

Family, PECTINURIDÆ, nom. nov.

Ophiodermatidæ Ljung., Oph. Viv., p. 87, 1867. Lutk., Addit. Hist. Oph., III, p. 87, 1869.

Since the generic name, *Ophioderma*, is now recognized only as a synonym of *Ophiura*, I have changed the name of this family, as is customary in such cases. The name *Ophiuridæ* cannot properly be used for the small group here included, because Mr. Lyman and many others have always used it to designate the order *Ophiuræ*, or all the *Ophiuroidea* exclusive of the *Euryalæ*.

Ophiura brevispina *Say*.

Ophiura brevispina Say, Journ. Phil. Acad. Nat. Sci., V, p. 149, 1825.

Ophiura brevispina Lyman, Proc. Bost. Soc. Nat. Hist., VII, p. 258, Jan., 1860; Ill. Cat. Mus. Comp. Zool., I, p. 18. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868.

Ophioderma olivaceum Ayers, Proc. Bost. Soc. Nat. Hist., IV, p. 134, 1852.

Ophioderma serpens Lutken, Vid. Meddel., Jan., 1856, p. 7; Add. ad Hist. Ophiur., Pt. II, p. 96.

Ophiura olivacea Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 23, 1865; Lyman, Report Voy, Challenger, Zool. Ophiuroidea, V, p. 9, 1882;

Bull. Mus. Comp. Zool., X, p. 230. Verrill, Proc. Boston Soc. Nat. Hist., X, p. 339, 1866; Report on Invert. Vineyard Sound, etc., p. 719, [363], 1873.

A variety, taken at the Tortugas, has the oral plates wider than usual. Its disk is green and the arms are banded.

A variety from Bahia Honda has narrower oral plates. Its disk is white, the arms greenish.

Several other marked varieties of this species occur. The northern form (*O. olivacea*), formerly considered a distinct species, has been treated as a synonym by Lyman in his later works. It seems to be, at least, a well marked variety.

The variety *olivacea* ranges from the south side of Cape Cod and Vineyard Sound to Charleston, S. C. It is common at Fort Macon, N. C. It is usually found in sheltered localities among eel-grass (*Zostera*).

Tortugas and Bahia Honda.

If all the forms united under this species by Mr. Lyman belong together, it ranges from Cape Cod to Bahia, Brazil.

The typical variety is common at Key West and throughout the West Indies, and also occurs at the Bermudas.

OPHIURA BREVICAUDA (*Lütk.*) *Lyman.*

Ophioderma variegata Duch. & Mich., Rad. Antill., 1850 (*t.* Lyman *non* Ltk).

Ophioderma brevicauda Lutken, Vid. Meddel., Jan., 1856, p. 8; Add. ad. Hist. Ophiur., Pt. II, p. 94, pl. 1, fig. 3.

Ophiura brevicauda Lyman, Ill. Cat. Mus. Com. Zool., I, p. 16, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882.

The only specimen in the collection, referred to this species, has the arms longer and more slender than usual, with more slender arm-spines and finer granules.

Egg Key. One example.

Common at the Florida Keys and throughout the West Indies in shallow water. Colon (Bradley).

OPHIURA CINEREA (*Mull. & Troschel*). *Lyman.*

Ophiura cinerea Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 27, 1865; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882; Bulletin. Mus. Comp. Zool., X, p. 230. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 368, 1868. Nutting, Narrative Bahama Exp., p. 131.

Ophioderma cinereum Mull. & Trosch., Syst., Ast., p. 87, 1842.

Ophioderma saxatalis Duch & Mich., Rad. Antill., 1850, (*t.* Lyman).

Ophioderma antillarum Lutk., Vid. Meddel., p. 9, 1856; Add. ad Hist. Ophiur., Pt. II, p. 88, 1859.

Tortugas, twelve examples. Common in shallow water throughout the West Indies. It ranges to Colon and to the Abrolhos Reefs, Bahia, and Fernando de Noronha, Brazil.

OPHIURA RUBICUNDA (*Lutk.*) *Lyman.*

Ophiura rubicunda Lyman, Ill. Cat. Mus. Com. Zool., I, p. 30, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 10, 1882. Nutting, Narrative Bahama Exp., p. 131.

Ophioderma rubicunda Lutken, Vid. Meddel., Jan. 1856, p. 8; Add. ad Hist. Ophiur., Pt. II, p. 90, pl. I, fig. 2.

This species is conspicuously colored, even in alcohol. One example has the disk red, mottled with pale yellow; arms similar, but also with lighter and darker bands; others have the disk yellow with red mottlings on the interbrachial areas and oral shields; under arm-plates mottled; spines yellow.

In life, according to Prof. Nutting, the disk was lake-red, mottled with gray.

Tortugas, two examples.

It occurs at low water and in small depths at the Florida Keys and throughout the West Indies, and at Colon.

OPHIURA APPRESSA *Say.*

Ophiura appressa Say, Journ. Phil. Acad., V, p. 151, 1825.

Ophiura appressa Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 34, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882. Nutting, Narrative Bahama Exp., p. 131.

Oyhioderma virescens Lutken, Vid. Meddel., Jan. 1856, p. 9; Add. ad Hist. Ophiur., Pt. II, p. 92, pl. I, fig. 4.

One of the specimens belongs to a variety with unusually broad oral shields. The disk of this one is dark green, mottled with lighter, in alcohol.

Tortugas, fourteen examples.

Common at the Florida Keys and throughout the West Indies, in shallow water. It extends southward to Bahia and Pernambuco, Brazil; also to Colon, Bermuda, and Cumana.

OPHIURA PALLIDA *Verrill, sp. nov.*

PLATE II; FIGURE 4.

Arms five, long and slender, Remarkable for the large, broad, subcordate oral shields, crowded close to the bases of the oral papillæ; very small granulated lateral oral shields. Two very small tentacle-scales, the inner not elongated. Mouth-papillæ rather large, mostly flat or truncated, the three outer ones broadest.

Arm-spines nine, rather slender, round and pointed, the longest only little longer than the rest, equal to about one-half the length of a side arm-plate. Under arm-plates longer and narrower than in *O. rubicunda.* Upper ones short and broad, not broken, outer end slightly emarginate. Radial shields with a small, naked, distal portion, widely separated, regularly ovate. Notch at the bases of the arms angular, including three dorsal arm-plates. On the sides of the arms, at their bases and along the genital slits, are many small, naked scales. The disk is elsewhere covered with very minute granules.

The color of the arms, in alcohol, is pale brownish yellow or yellowish white, banded with a darker shade of yellowish brown; the disk is yellowish white; radial shields like the arms; beneath, the disk and arm-plates are white. The diameter of the disk of one of the larger specimens is 17 mm.; length of arms, from mouth, 90 mm.

Sta. 2 and sta. 15, off Havana, in 110 and 200 fathoms, four examples.

This species is allied to *O. rubicunda*. The latter has longer and larger oral plates, and smaller lateral oral plates; much larger and relatively stouter and more unequal arm-spines; larger and longer tentacle-scales; its color is also very different, being red or reddish brown. It also somewhat resembles some forms of O. *cinerea*, but differs in its larger radial and oral shields, and in other characters.

PECTINURA ANGULATA *Lyman.*

Pectinura angulata Lyman, Bull. Mus. Comp. Zool., X, p. 232, pl. III, figs. 7–9, 1883.

Bahama Banks, two examples. Taken by the Blake Exped., in the West Indies, in 88 to 248 fathoms.

OPHIOPEZA PETERSI *Lyman.*

Ophiopeza petersi Lyman, Mus. Comp. Zool., V, 9, p. 217, pl. II, figs. 22–24, 1878; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 13, 1882.

Sta. 19, in 1½ to 8 fathoms, off Fort Jefferson, one example. Taken by the Blake Exped. in 177 fath., in the West Indies.

OPHIOPÆPALE GOESIANA *Ljungman.*

Ophiopæpale goesiana Ljung., Dr. Goes, Oph., Ofv. Kong. Akad., 1871, p. 615. Lyman, Bull. Mus. Comp. Zool., V, 9, p. 228; op. cit. X, p. 233, 1883; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 18, pl. XXXVII, figs. 4–6, 1882, anatomy; Three Cruises of the Blake, II, p. 3, fig. 393, 1888. Nutting, Narrative, p. 81, (color).

According to Professor Nutting, the color of the disk in life, is brown, conspicuously spotted with white.

Sta. 2, off Havana, 110 fathoms, ten examples.

Taken by the Blake Exped., in 38 to 250 fathoms, in the West Indies.

Family, OPHIOLEPIDÆ *Ljung.*, 1866.

OPHIOZONA IMPRESSA *Lyman.*

Ophiozona impressa Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 64, fig. 4, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 21, pl. XXXVII, figs. 13–15, 1882, anatomy; Bull. Mus. Comp. Zool., X, p. 235, 1883.

Off Havana, 110 to 160 fathoms, 3 examples. It occurs from Florida to St. Thomas, in shallow water.

OPHIOZONA NIVEA *Lyman.*

Ophiozona nivea Lyman, Illust. Catal. Mus. Comp. Zool., vol. VIII, p. 9, figs. 85–86, 1875; Bull Mus. Comp. Zool., vol. V, p, 128, 221; Three Cruises of the Blake, II, p. 110, fig. 390, 1888.

Variety, COMPTA *Verrill.*

PLATE III; FIGURE 2, 3, 4.

The original description of this species does not apply well to a large number of specimens subsequently obtained, nor are the outline figures correct. Therefore, I have given new figures, part of them from specimens sent to me by Mr. Lyman, and have prepared the following more detailed description. The figures represent a variety with separated radial shields, which I have named *var. compta.*

Arms five, disk rather flat, rounded, covered with rather large, unequal, irregular flat plates; five larger ones, in line with the radial areas, surround a large central one, or sometimes a group of two or three or more smaller central ones; five large interradials, and five similar marginal interradials are also conspicuous, forming five interradial rows. Radial shields irregularly sub-triangular, with the broader outer ends nearly or quite in contact or separated by a row of two or three small plates; the inner ends divergent, separated by one large wedge-shaped plate and usually one or two small ones; a triangular plate which lies between their outer ends, is bordered on each side by a somewhat thickened, rather crescent-shaped plate, around which there are several small supplementary plates, and in the notch between them lie the first three small and short, dorsal arm-plates.

The oral side of the disk has, on each interradial area, four large, submarginal plates, of which the two median are larger, and usually oblong; between these and the oral shields there are usually five or six irregular and unequal plates.

The oral shields are large, oblong-oval or shield-shaped, longer than broad, the sides nearly parallel, indented, and the outer ends rounded, while the inner margins form a sharp angle. Lateral oral plates, large, elongated, curved, thickened and in contact proximally at their narrow ends.

Oral papillæ rather numerous, five to seven on each border; the next to the outer one is largest, flat, with the edge rounded; the others are mostly small, conical, and acute. Beyond the middle of the arm they become more triangular, with a slight median prominence on the outer end.

The under arm-plates are large, shield-shaped, widest distally, with the lateral edges incurved; proximal end rounded or truncate, and the outer end broadly rounded. On the basal joints they become wider and shorter, with the proximal end much narrower than the distal. Tentacle-scales on the proximal joints, two, rather large, flat, broad ovate; farther out there are often three, of which one is very small.

Arm-spines three (rarely four), small, conical, near together, well down on the sides of the arm; the upper one is usually a little smaller than the others. Upper arm-plates, except a few close to the base of the proximal half of the arm, broad-trapezoidal or triangular, with the outer lateral corners prominent and acute; the outer edge is broadly rounded; the sides nearly straight, or a little incurved, and strongly divergent; the inner end, on the proximal ones, is narrow and truncated; those beyond the middle of the arm are triangular.

The three basal plates are small and very short; the fourth is crescent-shaped; the fifth is much wider than long; farther out the ratio of the length to the breadth increases.

The diameter of the disk of the largest specimen is 16 mm.; length of longest arm, which is broken at the tip, 34 mm.

Off Havana, 110 to 263 fathoms; also from 200 fathoms, off Barbados, (Blake Exped.) Taken by the Blake Exped. in 56 to 424 fathoms.

A study of a series of specimens sent to me by Mr. Lyman (from sta. 291, 200 fath., Blake Exp.) shows considerable variation in the form of the oral shields. These are sometimes oblong, twice as long as broad, with the outer and inner portions of the same width; in other cases the outer part, beyond the lateral indentations caused by the end of the genital slit, is broader than the inner part; in other specimens the outer part is narrower than the inner. The number and arrangement of the large angular plates outside the oral shields are variable even on the same specimen. Usually there are three or four of the larger plates, of which two stand side by side, near the margin of the disk.

The radial shields are often separated distally by a row of two or three small angular plates and a large proximal plate as in our figure (pl. III, fig. 4), but in other specimens the radial shields are in contact distally, but separated proximally by a single large triangular plate, as in Mr. Lyman's type-specimen. The central disk-plate is usually closely surrounded by five large angular plates, but in many cases there are small plates intervening more or less irregularly. The variations in the scaling of the disk and in the radial shields are not coincident with the variations of the oral shields.

The varietel name is given to the variety with distinctly separated *radial shields*, regardless of the variations in the oral shields, which happen to be, in both the specimens figured, (pl. III, figs. 3 and 4) of the shorter and more ovate form.

This species is allied to *O. tessellata*. It is easily distinguished by the large, irregular disk-plates, wide, oblong, oral shields; three subequal arm-spines, low down on the sides. There are no marginal spinules outside the radial shields. The upper arm-plates also differ in form.

OPHIOTHYREUS GOESI *Ljungman.*

Ophiothyreus goesi Ljung., Dr. Goes, Ophi. Of. Kong. Akad., p. 619, 1871. Lyman, Bull. Mus. Comp. Zool., V, 9. p. 22; op cit. X, p. 235; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 28, 1882. Nutting, Narrative, p. 81.

Sta. 2, off Havana, 110 fathoms, six examples.

Taken in the West Indies by the Blake Exp. in 30 to 300 fath.

OPHIOGLYPHA ACERVATA *Lyman.*

Ophioglypha acervata Lyman, Bull. Mus. Comp. Zool., I, 10, p. 316, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. I, fig. 6; Bull. Mus. Comp. Zool., V, 7, p. 99; Bull. Mus. Comp. Zool., V, 9, p. 218; op. cit. X, p. 242. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 39, 1882.

Sta. 26, off Key West, 60 fathoms, thirty-two examples; Sta. 41, off Sand Key, 15 fathoms, fifty examples; Sta. 54, off American Shoal, 130 fathoms, twenty examples.

Taken by the Blake Exp. in 84 to 808 fathoms.

OPHIOMUSIUM EBURNEUM *Lyman.*

Ophiomusium eburneum Lyman, Bull. Mus. Comp. Zool., I, 10, p. 322, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. II, figs. 1, 2, 3; Bull. Mus. Comp, Zool., V, 7, p. 220; op. cit., X, p. 244; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 99, 1882.

Variety, ELEGANS *Verrill.*

PLATE III; FIGURES 1, 1*a*.

This species was the type of the genus. According to Mr. Lyman's original description and figures his type differs considerably from our specimens. I have, therefore, thought it desirable to give new figures of our examples, and to describe the differences, which do not, however, appear to be of specific value. But as our specimens are only a trifle larger than his type, which was 9 mm. across the disk, the differences are probably not due to age.

Our specimens have the radial shields, broad, ovate and not widely separated, only three rows of small plates intervening, of which the lateral are minute; their inner ends are not so divergent as in the type. According to Mr. Lyman all the side arm-plates meet above and below "from the very innermost joint." In ours they do not meet above on the two basal joints and barely touch on the third. The upper arm-plates at the base of the arms are quite unlike Mr. Lyman's figure and description. The first (preceded by a smaller transverse, supplementary radial) is transversely elliptical, large, much wider than long; the next is six-sided, large, longer than broad, truncated proximally, angulated distally and laterally; the third is also rather large, longer than broad, rhombic, with the inner half longer and more acute than the outer; beyond the third the plates are of similar shape, but rapidly decrease in size, as described by Lyman. The arm-spines are *three*, instead of two, and are not all "nearly equal." They are small, short, blunt, the lowest are longest; distally the lowest one becomes more decidedly longer and stouter than the others. The under arm-plates are not all "three-sided and very small," for the two basals are rather large for the genus, somewhat five-sided, or trapezoidal, with the corners rounded and the outer end either obtusely angulated or convex.

The oral shields are longer than figured by Mr. Lyman, much longer than wide, the distal half with nearly parallel or slightly curved sides, the outer end convex, the proximal sides convergent to an acute angle, so that the form is very acute-ovate. The adoral shields are long, triangular, with their very acute proximal ends touching. The mouth-papillæ are mostly flattened and thick; the next to the outer is broadest, the others decreasing in size successively. Diameter of disk of largest specimen figured, 12 mm., length of arms about 42 mm. Diameter of disk of the smaller one figured, 10 mm.

Off Havana, 110 to 260 fath., four examples. Taken by the Blake Exp. in 92 to 500 fath.

OPHIOMUSIUM TESTUDO *Lyman.*

Ophiomusium testudo Lyman, Ill. Cat. Mus. Comp. Zool., VIII, 2, p. 8, pl. I, fig. 6–8, 1875; Bull. Mus. Comp. Zool., V, 9, p. 219; Lyman. Report Voy. Challenger, Zool., Ophiuroidea, V, p. 99, 1882.

Sta. 2 and 13, off Havana, in 110 fathoms, thirteen examples; sta. 56, Pourtales Plateau, in 200 fathoms, four examples. Taken by the Blake Exp. in 73 to 400 fathoms.

OPHIOMUSIUM STELLATUM Verrill, sp. nov.

PLATE I; FIGURES 3, 3*a*.

Disk nearly round, rather thin and flat, with a ten-rayed grouping of small crowded plates. Arms five, of moderate length, slender, regularly tapered, with the joints rather prominent, owing to the projecting side arm-plates. Radial shields rather large, ovate, divergent, separated by about three crowded, irregular rows of unequal overlapping plates, those of the middle row larger. A large, thickened, supermarginal, interradial plate, nearly as large as the radial shields, occupies most of each interradial margin, between the radial shields with which it is in contact on each side, within the outer margin, but they are separated distally from it by a small, rounded marginal plate on each side. This large interradial plate is somewhat semicircular in form, with the convex edge turned toward the center of the disk, while its gently curved or nearly straight outer edge forms the interradial border of the disk. From each of the large interradial plates three or four crowded rows of small unequal plates extend inward to the central area, forming five rays, somewhat broader than the radial rays, but giving a distinctly ten rayed character to the disk-scaling. On the central area of the disk is a larger, round, central plate and ten similar primary plates can be distinguished among the small, unequal, crowded scales.

Just outside the distal end of each radial shield there is a small, thick, transversely elliptical plate, which rises prominently above the level of the radial shields and arm-plates. Distal to this there are two or three small supplementary basal arm-plates.

The under side of the disk is pretty uniformly covered by small rounded scales. Oral shields rather small, about as long as broad, somewhat heart-shaped or triangular, with curved edges; the outer end is usually slightly indented or incurved, the lateral edges a little convex, the inner end acute. Lateral oral shields oblong, a little wider distally. Mouth-papillæ squarish, about seven or eight on each side in a close row. Tentacle-pores occur on only two basal joints, each has a small rounded tentacle-scale. Under arm-plates, on the two joints having tentacle-pores, are shield-shaped or pentagonal, wider than long, broadest distally, with an obtuse inner angle; farther out they are very small, triangular or short wedge-shaped, but they are found well out on the arm.

Arm-spines three, very small, short, and nearly equal near the base of the arms, but beyond about the tenth joint the lower one is a little the longest. The upper ones becoming shorter and thicker, with a bent tip, which becomes claw-like farther out. The spines are scarcely one-third as long as a joint. Upper arm-plates very small, those beyond the basal are top-shaped or wedge-shaped, with the distal end rounded and the proximal end acute; they extend well out on the arms, or as far as the arms are preserved in our specimens.

Diameter of disk 7.5 mm.; length of longest arm (much broken at the end) 22 mm.

Off Havana, 110 to 260 fathoms, two examples.

This species is closely related to *O. cancellatum* Lyman. The latter differs in having three pairs of tentacle-pores and two tentacle-scales to each pore, smaller and shorter radial shields, more widely separated, less unequal and more numerous disk-scales; a much smaller super-marginal, interradial plate; upper arm-plates larger and less triangular. The prominent basal arm-plate, at the ends of the radial shields, is lacking.

The type of *O. cancellatum* Lym. was taken by the Challenger Exp., off the coast of Japan, in 420 to 470 fathoms (Voy.

Chall., p. 88, pl. II, figs. 16–18). Mr. Lyman also recorded it, with a mark of doubt, from off Bermudas, in 435 fathoms. Possibly the example from the latter place may have been identical with our species.

OPHIOMUSIUM SCULPTUM Verrill, sp. nov.

PLATE II; FIGURE 2. PLATE VIII; FIGURE 2.

Five arms. Disk flattened, ten-lobed, owing to two projecting tubercles on each interradial margin. Upper surface covered with large plates bearing clusters of coarse granules. Five interradial plates surround a larger central one; these are surrounded by a regular circle of ten angular plates, five of which are radial and five interradial; their acute ends are directed outward so that they form a ten-rayed star; the points of the five radial plates separate the inner ends of the radial shields. The latter are larger, irregularly polygonal, nearly or quite in contact at one point, but separated distally by a large sub-triangular plate, which, like the radial shields, is unevenly verrucose and rough and bears a cluster of granules. A very large, thick, rough, and swollen bilobed plate occupies the whole of each interradial margin and extends beneath to the oral shield. The upper arm-plates are small and become obsolete at about the twelfth joint; the first one is swollen, triangular, with rounded corners, and bears a central granule. The next is smaller and more sharply triangular; the following ones decrease regularly in size to the last. The radial shields are very large, longer than broad, with the inner part sub-triangular and the outer portion transversely oblong. The outer end is truncated; the outer lateral lobes are obliquely truncated, the sides strongly incurved, the inner end acute. The lateral oral shields are elongated, narrow, and irregular. The genital slits are very narrow and sinuous. The mouth slits are very narrow. The oral papillæ are all consolidated. Tentacle-pores exist on the first two joints, each with one or two minute tentacle-scales. Under arm-plates, on the first two joints, are small shield-shaped; on three or four following joints they are minute,

REPORT ON THE OPHIUROIDEA

COLLECTED BY THE BAHAMA EXPEDITION FROM THE UNIVERSITY OF IOWA IN 1893.

BY PROFESSOR A. E. VERRILL, OF YALE UNIVERSITY.

The Bahama Expedition obtained about 66 species of Ophiuroidea, among which there are many species of great interest and several that were previously unknown.

In former years the same region had been very extensively explored by the various dredging expeditions made by Mr. Alexander Agassiz, in the Coast Survey Steamer "Blake," and by other earlier government expeditions. The various collections thus obtained were very fully worked up and the numerous new species were described by Mr. Theodore Lyman in the publications of the Museum of Comparative Zoology.* The Challenger Expedition added a few species from the same region, which are included in Mr. Lyman's final report on the Challenger Ophiuroidea (Vol. V, 1882).

Therefore, it was not to have been expected that many new discoveries would be made, in that region, by a comparatively small number of dredgings, and with a far less elaborate equipment. Hence the number of new forms obtained by the Bahama Expedition is rather surprising.

*Bulletin of the Mus. Comp. Zoology, Vol. I, No. 10, p. 309, 1869; Vol. V, No. 9, p. 217, 1878; Vol. X, No. 6, 1883; also Vol. V, No. 7, p. 67, 1878, and Vol. VI, No. 2, 1879, (Challenger Coll.)

Illust. Catal. Mus. Comp. Zool., Vol. I, No. I. 1865; Vol. VI, 1871; Vol. VIII, No. II, 1875.

This collection is peculiar in lacking many common species which were taken at numerous stations and in large numbers by the "Blake Expedition". Such species belong largely to such genera as *Ophioglypha*, *Ophiomusium*, *Amphiura*, etc. These live, for the most part, on muddy or sandy bottoms, or buried just below the surface, and are only to be obtained by the use of the dredge or trawl. But as the Bahama Expedition worked largely upon the hard bottoms and used the tangles relatively much more than the dredge, the absence of many of the common species is easily understood.

On the other hand, and for the same reasons, the collection is relatively rich in those species and genera that live on hard bottoms and cling to the branches of gorgonian corals, hydroids, etc., by means of their long, coiled arms.

Such species are best obtained by the tangles. Some of these belong to the *Ophiuræ;* such as *Sigsbiea* and *Hemieuryale;* but most of them belong to the *Euryalæ*. Many of these are simple armed species of the genera *Ophiocreas*, *Astroschæma*, *Astroporpa*, *Astronyx*, *Astrogomphus;* others are of the general *Astrophyton* and *Gorgonocephalus*, in which the arms are many times forked.

Some of the long-spined genera, like *Ophiacantha*, *Ophiomitra*, *Ophiothrix*, etc., also live among the branches of gorgonian corals, or clinging to other organisms, so that they are easily captured by the tangles. Such genera are well represented in this collection.

Most of those species with long, coied arms, adapted for clinging to the branches of gorgonian corals, are remarkable for imitating closely, in various ways, the forms and colors of the corals on which they live. This must afford them a considerable degree of protection against predacious fishes, in addition to the direct protection due to the stinging powers of the corals themselves, which is sufficient to cause most fishes to avoid them.

I have observed that some of the northern plectognath fishes (file fishes) will feed upon hydroids. It is also well

known that our northern butter-fish, when young, lives with impunity beneath the disk and among the tentacles of the great red jelly-fish (*Cyanea arctica*), which is deadly to other fishes.

It is probable, therefore, that in tropical waters many fishes have acquired comparative immunity against the poisonous stinging organs (*cnidæ*) of coral animals. If so, the utility of the additional protection afforded by the imitative forms and colors of so many of the coral-inhabiting ophuiroids would be obvious.

Professor Nutting has already described the colors of some of these curious forms in his Narrative of the Expedition.

In this report I have followed, in general, the order of sequence adopted by Lyman, but in the case of the *Euryalæ* and in the families *Amphiuridæ*, *Ophiacanthidæ*, and some others, I have thought it desirable to alter his classification considerably.

I have also introduced the names and in some cases the characters of the family groups, and have changed the limits of several of them. Many of these were proposed by Lütken[1] and by Ljungman[2] many years ago.

Several new families are also now characterized.

In describing the genera and species, I have generally used, as a matter of convenience, the same terms, for the organs and parts, that were used by Mr. Lyman in his various works on this group, but have made a few obvious changes. I have preferred to use *oral shield* instead of "mouth-shield", and *adoral shield* instead of "side-mouth-shield". In the genera allied to *Amphiura*, I have usually called the "outer mouth-papillæ" or papillæ of the second oral tentacle, the distal oral tentacle-scales to indicate their homology with the ordinary

[1] Addit. ad Hist. Ophiur., Part III; Synop. gen. Ophiur. ver., p. 87, 1869.

[2] Ophiuroidea viv. hucusque cognita enumerat, Ofvers. Kgl. Vetenskaps-Akad. Forhandlingar, for 1866, 1867.

tentacle-scales. The same idea has been carried out in *Ophiacanthidæ*. In the latter group I have designated the apical "mouth-papillæ" as tooth-papillæ.

In the identification of the species, I have been very much aided by a pretty large series of typical specimens of the species obtained in the West Indies by the several "Blake" Expeditions and described by Mr. Lyman. They were sent to the Yale Museum, several years ago, by Mr. A. Agassiz. I have also used, for comparison, a collection sent to me by Dr. Lütken, from the University Museum of Copenhagen.

Order I. OPHIURÆ *Müller & Troschel*, 1842.

Ophiuræ Ljungman, Oph. Viv., p. 303, 1867.

Ophiuridæ Lyman, and many other authors.

Zygophiuræ and *Streptophiuræ* Bell, 1892.

Family, PECTINURIDÆ, nom. nov.

Ophiodermatidæ Ljung., Oph. Viv., p. 87, 1867. Lutk., Addit. Hist. Oph., III, p. 87, 1869.

Since the generic name, *Ophioderma*, is now recognized only as a synonym of *Ophiura*, I have changed the name of this family, as is customary in such cases. The name *Ophiuridæ* cannot properly be used for the small group here included, because Mr. Lyman and many others have always used it to designate the order *Ophiuræ*, or all the *Ophiuroidea* exclusive of the *Euryalæ*.

Ophiura brevispina *Say*.

Ophiura brevispina Say, Journ. Phil. Acad. Nat. Sci., V, p. 149, 1825.

Ophiura brevispina Lyman, Proc. Bost. Soc. Nat. Hist., VII, p. 258, Jan., 1860; Ill. Cat. Mus. Comp. Zool., I, p. 18. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868.

Ophioderma olivaceum Ayers, Proc. Bost. Soc. Nat. Hist., IV, p. 134, 1852.

Ophioderma serpens Lutken, Vid. Meddel., Jan., 1856, p. 7; Add. ad Hist. Ophiur., Pt. II, p. 96.

Ophiura olivacea Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 23, 1865; Lyman, Report Voy, Challenger, Zool. Ophiuroidea, V, p. 9, 1882;

Bull. Mus. Comp. Zool., X, p. 230. Verrill, Proc. Boston Soc. Nat. Hist., X, p. 339, 1866; Report on Invert. Vineyard Sound, etc., p. 719, [363], 1873.

A variety, taken at the Tortugas, has the oral plates wider than usual. Its disk is green and the arms are banded.

A variety from Bahia Honda has narrower oral plates. Its disk is white, the arms greenish.

Several other marked varieties of this species occur. The northern form (*O. olivacea*), formerly considered a distinct species, has been treated as a synonym by Lyman in his later works. It seems to be, at least, a well marked variety.

The variety *olivacea* ranges from the south side of Cape Cod and Vineyard Sound to Charleston, S. C. It is common at Fort Macon, N. C. It is usually found in sheltered localities among eel-grass (*Zostera*).

Tortugas and Bahia Honda.

If all the forms united under this species by Mr. Lyman belong together, it ranges from Cape Cod to Bahia, Brazil.

The typical variety is common at Key West and throughout the West Indies, and also occurs at the Bermudas.

OPHIURA BREVICAUDA (*Lütk.*) *Lyman.*

Ophioderma variegata Duch. & Mich., Rad. Antill., 1850 (*t.* Lyman *non* Ltk).

Ophioderma brevicauda Lutken, Vid. Meddel., Jan., 1856, p. 8; Add. ad. Hist. Ophiur., Pt. II, p. 94, pl. 1, fig. 3.

Ophiura brevicauda Lyman, Ill. Cat. Mus. Com. Zool., I, p. 16, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882.

The only specimen in the collection, referred to this species, has the arms longer and more slender than usual, with more slender arm-spines and finer granules.

Egg Key. One example.

Common at the Florida Keys and throughout the West Indies in shallow water. Colon (Bradley).

OPHIURA CINEREA (*Mull. & Troschel*). *Lyman.*

Ophiura cinerea Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 27, 1865; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882; Bulletin. Mus. Comp. Zool., X, p. 230. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 368, 1868. Nutting, Narrative Bahama Exp., p. 131.

Ophioderma cinereum Mull. & Trosch., Syst., Ast., p. 87, 1842.

Ophioderma saxatalis Duch & Mich., Rad. Antill., 1850, (*t.* Lyman).

Ophioderma antillarum Lutk., Vid. Meddel., p. 9, 1856; Add. ad Hist. Ophiur., Pt. II, p. 88, 1859.

Tortugas, twelve examples. Common in shallow water throughout the West Indies. It ranges to Colon and to the Abrolhos Reefs, Bahia, and Fernando de Noronha, Brazil.

OPHIURA RUBICUNDA (*Lutk.*) *Lyman.*

Ophiura rubicunda Lyman, Ill. Cat. Mus. Com. Zool., I, p. 30, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 10, 1882. Nutting, Narrative Bahama Exp., p. 131.

Ophioderma rubicunda Lutken, Vid. Meddel., Jan. 1856, p. 8; Add. ad Hist. Ophiur., Pt. II, p. 90, pl. I, fig. 2.

This species is conspicuously colored, even in alcohol. One example has the disk red, mottled with pale yellow; arms similar, but also with lighter and darker bands; others have the disk yellow with red mottlings on the interbrachial areas and oral shields; under arm-plates mottled; spines yellow.

In life, according to Prof. Nutting, the disk was lake-red, mottled with gray.

Tortugas, two examples.

It occurs at low water and in small depths at the Florida Keys and throughout the West Indies, and at Colon.

OPHIURA APPRESSA *Say.*

Ophiura appressa Say, Journ. Phil. Acad., V, p. 151, 1825.

Ophiura appressa Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 34, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882. Nutting, Narrative Bahama Exp., p. 131.

Oyhioderma virescens Lutken, Vid. Meddel., Jan. 1856, p. 9; Add. ad Hist. Ophiur., Pt. II, p. 92, pl. I, fig. 4.

One of the specimens belongs to a variety with unusually broad oral shields. The disk of this one is dark green, mottled with lighter, in alcohol.

Tortugas, fourteen examples.

Common at the Florida Keys and throughout the West Indies, in shallow water. It extends southward to Bahia and Pernambuco, Brazil; also to Colon, Bermuda, and Cumana.

OPHIURA PALLIDA *Verrill, sp. nov.*

PLATE II; FIGURE 4.

Arms five, long and slender, Remarkable for the large, broad, subcordate oral shields, crowded close to the bases of the oral papillæ; very small granulated lateral oral shields. Two very small tentacle-scales, the inner not elongated. Mouth-papillæ rather large, mostly flat or truncated, the three outer ones broadest.

Arm-spines nine, rather slender, round and pointed, the longest only little longer than the rest, equal to about one-half the length of a side arm-plate. Under arm-plates longer and narrower than in *O. rubicunda.* Upper ones short and broad, not broken, outer end slightly emarginate. Radial shields with a small, naked, distal portion, widely separated, regularly ovate. Notch at the bases of the arms angular, including three dorsal arm-plates. On the sides of the arms, at their bases and along the genital slits, are many small, naked scales. The disk is elsewhere covered with very minute granules.

The color of the arms, in alcohol, is pale brownish yellow or yellowish white, banded with a darker shade of yellowish brown; the disk is yellowish white; radial shields like the arms; beneath, the disk and arm-plates are white. The diameter of the disk of one of the larger specimens is 17 mm.; length of arms, from mouth, 90 mm.

Sta. 2 and sta. 15, off Havana, in 110 and 200 fathoms, four examples.

This species is allied to *O. rubicunda*. The latter has longer and larger oral plates, and smaller lateral oral plates; much larger and relatively stouter and more unequal arm-spines; larger and longer tentacle-scales; its color is also very different, being red or reddish brown. It also somewhat resembles some forms of O. *cinerea*, but differs in its larger radial and oral shields, and in other characters.

PECTINURA ANGULATA *Lyman.*

Pectinura angulata Lyman, Bull. Mus. Comp. Zool., X, p. 232, pl. III, figs. 7–9, 1883.

Bahama Banks, two examples. Taken by the Blake Exped., in the West Indies, in 88 to 248 fathoms.

OPHIOPEZA PETERSI *Lyman.*

Ophiopeza petersi Lyman, Mus. Comp. Zool., V, 9, p. 217, pl. II, figs. 22–24, 1878; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 13, 1882.

Sta. 19, in 1½ to 8 fathoms, off Fort Jefferson, one example. Taken by the Blake Exped. in 177 fath., in the West Indies.

OPHIOPÆPALE GOESIANA *Ljungman.*

Ophiopæpale goesiana Ljung., Dr. Goes, Oph., Ofv. Kong. Akad., 1871, p. 615. Lyman, Bull. Mus. Comp. Zool., V, 9, p. 228; op. cit. X, p. 233, 1883; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 18, pl. XXXVII, figs. 4–6, 1882, anatomy; Three Cruises of the Blake, II, p. 3, fig. 393, 1888. Nutting, Narrative, p. 81, (color).

According to Professor Nutting, the color of the disk in life, is brown, conspicuously spotted with white.

Sta. 2, off Havana, 110 fathoms, ten examples.

Taken by the Blake Exped., in 38 to 250 fathoms, in the West Indies.

Family, OPHIOLEPIDÆ *Ljung.*, 1866.

OPHIOZONA IMPRESSA *Lyman.*

Ophiozona impressa Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 64, fig. 4, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 21, pl. XXXVII, figs. 13–15, 1882, anatomy; Bull. Mus. Comp. Zool., X, p. 235, 1883.

Off Havana, 110 to 160 fathoms, 3 examples. It occurs from Florida to St. Thomas, in shallow water.

OPHIOZONA NIVEA *Lyman.*

Ophiozona nivea Lyman, Illust. Catal. Mus. Comp. Zool., vol. VIII, p. 9, figs. 85–86, 1875; Bull Mus. Comp. Zool., vol. V, p, 128, 221; Three Cruises of the Blake, II, p. 110, fig. 390, 1888.

Variety, COMPTA *Verrill.*

PLATE III; FIGURE 2, 3, 4.

The original description of this species does not apply well to a large number of specimens subsequently obtained, nor are the outline figures correct. Therefore, I have given new figures, part of them from specimens sent to me by Mr. Lyman, and have prepared the following more detailed description. The figures represent a variety with separated radial shields, which I have named *var. compta.*

Arms five, disk rather flat, rounded, covered with rather large, unequal, irregular flat plates; five larger ones, in line with the radial areas, surround a large central one, or sometimes a group of two or three or more smaller central ones; five large interradials, and five similar marginal interradials are also conspicuous, forming five interradial rows. Radial shields irregularly sub-triangular, with the broader outer ends nearly or quite in contact or separated by a row of two or three small plates; the inner ends divergent, separated by one large wedge-shaped plate and usually one or two small ones; a triangular plate which lies between their outer ends, is bordered on each side by a somewhat thickened, rather crescent-shaped plate, around which there are several small supplementary plates, and in the notch between them lie the first three small and short, dorsal arm-plates.

The oral side of the disk has, on each interradial area, four large, submarginal plates, of which the two median are larger, and usually oblong; between these and the oral shields there are usually five or six irregular and unequal plates.

The oral shields are large, oblong-oval or shield-shaped, longer than broad, the sides nearly parallel, indented, and the outer ends rounded, while the inner margins form a sharp angle. Lateral oral plates, large, elongated, curved, thickened and in contact proximally at their narrow ends.

Oral papillæ rather numerous, five to seven on each border; the next to the outer one is largest, flat, with the edge rounded; the others are mostly small, conical, and acute. Beyond the middle of the arm they become more triangular, with a slight median prominence on the outer end.

The under arm-plates are large, shield-shaped, widest distally, with the lateral edges incurved; proximal end rounded or truncate, and the outer end broadly rounded. On the basal joints they become wider and shorter, with the proximal end much narrower than the distal. Tentacle-scales on the proximal joints, two, rather large, flat, broad ovate; farther out there are often three, of which one is very small.

Arm-spines three (rarely four), small, conical, near together, well down on the sides of the arm; the upper one is usually a little smaller than the others. Upper arm-plates, except a few close to the base of the proximal half of the arm, broad-trapezoidal or triangular, with the outer lateral corners prominent and acute; the outer edge is broadly rounded; the sides nearly straight, or a little incurved, and strongly divergent; the inner end, on the proximal ones, is narrow and truncated; those beyond the middle of the arm are triangular.

The three basal plates are small and very short; the fourth is crescent-shaped; the fifth is much wider than long; farther out the ratio of the length to the breadth increases.

The diameter of the disk of the largest specimen is 16 mm.; length of longest arm, which is broken at the tip, 34 mm.

Off Havana, 110 to 263 fathoms; also from 200 fathoms, off Barbados, (Blake Exped.) Taken by the Blake Exped. in 56 to 424 fathoms.

A study of a series of specimens sent to me by Mr. Lyman (from sta. 291, 200 fath., Blake Exp.) shows considerable variation in the form of the oral shields. These are sometimes oblong, twice as long as broad, with the outer and inner portions of the same width; in other cases the outer part, beyond the lateral indentations caused by the end of the genital slit, is broader than the inner part; in other specimens the outer part is narrower than the inner. The number and arrangement of the large angular plates outside the oral shields are variable even on the same specimen. Usually there are three or four of the larger plates, of which two stand side by side, near the margin of the disk.

The radial shields are often separated distally by a row of two or three small angular plates and a large proximal plate as in our figure (pl. III, fig. 4), but in other specimens the radial shields are in contact distally, but separated proximally by a single large triangular plate, as in Mr. Lyman's type-specimen. The central disk-plate is usually closely surrounded by five large angular plates, but in many cases there are small plates intervening more or less irregularly. The variations in the scaling of the disk and in the radial shields are not coincident with the variations of the oral shields.

The varietel name is given to the variety with distinctly separated *radial shields*, regardless of the variations in the oral shields, which happen to be, in both the specimens figured, (pl. III, figs. 3 and 4) of the shorter and more ovate form.

This species is allied to *O. tessellata.* It is easily distinguished by the large, irregular disk-plates, wide, oblong, oral shields; three subequal arm-spines, low down on the sides. There are no marginal spinules outside the radial shields. The upper arm-plates also differ in form.

OPHIOTHYREUS GOESI *Ljungman.*

Ophiothyreus goesi Ljung., Dr. Goes, Ophi. Of. Kong. Akad., p. 619, 1871. Lyman, Bull. Mus. Comp. Zool., V, 9. p. 22; op cit. X, p. 235; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 28, 1882. Nutting, Narrative, p. 81.

Sta. 2, off Havana, 110 fathoms, six examples.

Taken in the West Indies by the Blake Exp. in 30 to 300 fath.

OPHIOGLYPHA ACERVATA *Lyman.*

Ophioglypha acervata Lyman, Bull. Mus. Comp. Zool., I, 10, p. 316, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. I, fig. 6; Bull. Mus. Comp. Zool., V, 7, p. 99; Bull. Mus. Comp. Zool., V, 9, p. 218; op. cit. X, p. 242. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 39, 1882.

Sta. 26, off Key West, 60 fathoms, thirty-two examples; Sta. 41, off Sand Key, 15 fathoms, fifty examples; Sta. 54, off American Shoal, 130 fathoms, twenty examples.

Taken by the Blake Exp. in 84 to 808 fathoms.

OPHIOMUSIUM EBURNEUM *Lyman.*

Ophiomusium eburneum Lyman, Bull. Mus. Comp. Zool., I, 10, p. 322, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. II, figs. 1, 2, 3; Bull. Mus. Comp, Zool., V, 7, p. 220; op. cit., X, p. 244; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 99, 1882.

Variety, ELEGANS *Verrill.*

PLATE III; FIGURES 1, 1*a*.

This species was the type of the genus. According to Mr. Lyman's original description and figures his type differs considerably from our specimens. I have, therefore, thought it desirable to give new figures of our examples, and to describe the differences, which do not, however, appear to be of specific value. But as our specimens are only a trifle larger than his type, which was 9 mm. across the disk, the differences are probably not due to age.

Our specimens have the radial shields, broad, ovate and not widely separated, only three rows of small plates intervening, of which the lateral are minute; their inner ends are not so divergent as in the type. According to Mr. Lyman all the side arm-plates meet above and below "from the very innermost joint." In ours they do not meet above on the two basal joints and barely touch on the third. The upper arm-plates at the base of the arms are quite unlike Mr. Lyman's figure and description. The first (preceded by a smaller transverse, supplementary radial) is transversely elliptical, large, much wider than long; the next is six-sided, large, longer than broad, truncated proximally, angulated distally and laterally; the third is also rather large, longer than broad, rhombic, with the inner half longer and more acute than the outer; beyond the third the plates are of similar shape, but rapidly decrease in size, as described by Lyman. The arm-spines are *three*, instead of two, and are not all "nearly equal." They are small, short, blunt, the lowest are longest; distally the lowest one becomes more decidedly longer and stouter than the others. The under arm-plates are not all "three-sided and very small," for the two basals are rather large for the genus, somewhat five-sided, or trapezoidal, with the corners rounded and the outer end either obtusely angulated or convex.

The oral shields are longer than figured by Mr. Lyman, much longer than wide, the distal half with nearly parallel or slightly curved sides, the outer end convex, the proximal sides convergent to an acute angle, so that the form is very acute-ovate. The adoral shields are long, triangular, with their very acute proximal ends touching. The mouth-papillæ are mostly flattened and thick; the next to the outer is broadest, the others decreasing in size successively. Diameter of disk of largest specimen figured, 12 mm., length of arms about 42 mm. Diameter of disk of the smaller one figured, 10 mm.

Off Havana, 110 to 260 fath., four examples. Taken by the Blake Exp. in 92 to 500 fath.

OPHIOMUSIUM TESTUDO *Lyman.*

Ophiomusium testudo Lyman, Ill. Cat. Mus. Comp. Zool., VIII, 2, p. 8, pl. I, fig. 6–8, 1875; Bull. Mus. Comp. Zool., V, 9, p. 219; Lyman. Report Voy. Challenger, Zool., Ophiuroidea, V, p. 99, 1882.

Sta. 2 and 13, off Havana, in 110 fathoms, thirteen examples; sta. 56, Pourtales Plateau, in 200 fathoms, four examples. Taken by the Blake Exp. in 73 to 400 fathoms.

OPHIOMUSIUM STELLATUM Verrill, sp. nov.

PLATE I; FIGURES 3, 3*a*.

Disk nearly round, rather thin and flat, with a ten-rayed grouping of small crowded plates. Arms five, of moderate length, slender, regularly tapered, with the joints rather prominent, owing to the projecting side arm-plates. Radial shields rather large, ovate, divergent, separated by about three crowded, irregular rows of unequal overlapping plates, those of the middle row larger. A large, thickened, supermarginal, interradial plate, nearly as large as the radial shields, occupies most of each interradial margin, between the radial shields with which it is in contact on each side, within the outer margin, but they are separated distally from it by a small, rounded marginal plate on each side. This large interradial plate is somewhat semicircular in form, with the convex edge turned toward the center of the disk, while its gently curved or nearly straight outer edge forms the interradial border of the disk. From each of the large interradial plates three or four crowded rows of small unequal plates extend inward to the central area, forming five rays, somewhat broader than the radial rays, but giving a distinctly ten rayed character to the disk-scaling. On the central area of the disk is a larger, round, central plate and ten similar primary plates can be distinguished among the small, unequal, crowded scales.

Just outside the distal end of each radial shield there is a small, thick, transversely elliptical plate, which rises prominently above the level of the radial shields and arm-plates. Distal to this there are two or three small supplementary basal arm-plates.

The under side of the disk is pretty uniformly covered by small rounded scales. Oral shields rather small, about as long as broad, somewhat heart-shaped or triangular, with curved edges; the outer end is usually slightly indented or incurved, the lateral edges a little convex, the inner end acute. Lateral oral shields oblong, a little wider distally. Mouth-papillæ squarish, about seven or eight on each side in a close row. Tentacle-pores occur on only two basal joints, each has a small rounded tentacle-scale. Under arm-plates, on the two joints having tentacle-pores, are shield-shaped or pentagonal, wider than long, broadest distally, with an obtuse inner angle; farther out they are very small, triangular or short wedge-shaped, but they are found well out on the arm.

Arm-spines three, very small, short, and nearly equal near the base of the arms, but beyond about the tenth joint the lower one is a little the longest. The upper ones becoming shorter and thicker, with a bent tip, which becomes claw-like farther out. The spines are scarcely one-third as long as a joint. Upper arm-plates very small, those beyond the basal are top-shaped or wedge-shaped, with the distal end rounded and the proximal end acute; they extend well out on the arms, or as far as the arms are preserved in our specimens.

Diameter of disk 7.5 mm.; length of longest arm (much broken at the end) 22 mm.

Off Havana, 110 to 260 fathoms, two examples.

This species is closely related to *O. cancellatum* Lyman. The latter differs in having three pairs of tentacle-pores and two tentacle-scales to each pore, smaller and shorter radial shields, more widely separated, less unequal and more numerous disk-scales; a much smaller super-marginal, interradial plate; upper arm-plates larger and less triangular. The prominent basal arm-plate, at the ends of the radial shields, is lacking.

The type of *O. cancellatum* Lym. was taken by the Challenger Exp., off the coast of Japan, in 420 to 470 fathoms (Voy.

Chall., p. 88, pl. II, figs. 16–18). Mr. Lyman also recorded it, with a mark of doubt, from off Bermudas, in 435 fathoms. Possibly the example from the latter place may have been identical with our species.

OPHIOMUSIUM SCULPTUM Verrill, sp. nov.

PLATE II; FIGURE 2. PLATE VIII; FIGURE 2.

Five arms. Disk flattened, ten-lobed, owing to two projecting tubercles on each interradial margin. Upper surface covered with large plates bearing clusters of coarse granules. Five interradial plates surround a larger central one; these are surrounded by a regular circle of ten angular plates, five of which are radial and five interradial; their acute ends are directed outward so that they form a ten-rayed star; the points of the five radial plates separate the inner ends of the radial shields. The latter are larger, irregularly polygonal, nearly or quite in contact at one point, but separated distally by a large sub-triangular plate, which, like the radial shields, is unevenly verrucose and rough and bears a cluster of granules. A very large, thick, rough, and swollen bilobed plate occupies the whole of each interradial margin and extends beneath to the oral shield. The upper arm-plates are small and become obsolete at about the twelfth joint; the first one is swollen, triangular, with rounded corners, and bears a central granule. The next is smaller and more sharply triangular; the following ones decrease regularly in size to the last. The radial shields are very large, longer than broad, with the inner part sub-triangular and the outer portion transversely oblong. The outer end is truncated; the outer lateral lobes are obliquely truncated, the sides strongly incurved, the inner end acute. The lateral oral shields are elongated, narrow, and irregular. The genital slits are very narrow and sinuous. The mouth slits are very narrow. The oral papillæ are all consolidated. Tentacle-pores exist on the first two joints, each with one or two minute tentacle-scales. Under arm-plates, on the first two joints, are small shield-shaped; on three or four following joints they are minute,

five-rayed variety of *O. mülleri*, but it was of small size and agreed in all other essential characters with the ordinary, small, six-rayed variety *O. mülleri*. At that time he gave it no varietal name.

The large specimens sent by Mr. Lyman differ from the types of *O. dispar* only in characters of small importance due, probably, to greater size.

The arm-spines are longer and the lower ones rather less differentiated from the upper ones; they are rather more slender and not so much flattened and increase a little more gradually in length from the lowest upward. The large radial shields are semielliptical, much as in our type. The upper arm-spines are regularly elliptical, and thickened. The under arm-plates are, as in our types, thickened and turned up at the distal and lateral margins, but many of them are slightly emarginate at the outer end, becoming truncate more distally. The oral shields are more rhombic, about as long as broad, with a small peak or acute angle on the outer end where it joins the genital scales; obtusely angled proximally. Adoral shields not touching proximally. Mouth papillæ three on most of the oral margins, small, flattened, the outer one (sometimes two) arises from the edge of the adoral shield above the outer oral tentacle and might be called an oral scale. The first oral scale is well developed, higher up in the mouth-slit.

Large clusters of minute eggs were attached around the mouth and between the groups of spines near the bases of the arms of our specimen.

Diameter of disk, 11.5 mm; length of arms, 70 mm.

It is not probable that the specimens above described are the adults of *O. mülleri*. They are much more like *O. krebsii*, and may, possibly, be the adults of the latter. It seems to me most probable that the specimens to which Mr. Lyman first applied his varietal name in 1878 were unlike those that he afterwards sent to me from another locality.

The former were very likely the real adults of *O. mülleri*, as he supposed. Therefore I think it best to apply a new name to the form above described. Whether it be a variety or the adult of *O. krebsii*, or a distinct species, can only be determined by a larger series of intermediate sizes.

OPHIACTIS KREBSII *Lütken.*

Ophiactis krebsii Lütken, Vid. Meddel., p. 12, 1856; Addit. ad Hist. Oph., Pt. II, p. 126. Lyman, Ill. Cat. I, p. 111, figs. 10, 11. Verrill, notes on Radiata, Trans. Conn. Acad., I, p. 341, 366, 1868.

Ophiactis savignyi (*pars*) Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 115, 1882.

Bahama Bank, 12 young. Common from Charleston, S. C. and Florida Reefs to the Abrolhos Reefs and Rio de Janeiro, Brazil. Bermuda (Coll. Goode). It lives in the interstices of sponges and corals, often gregariously while young.

Mr. Lyman considered it identical with *O. savignyi* and *O. virescens*, from the Indian and Pacific oceans respectively. With this opinion I am not prepared to agree.

O. dispar appears to me to be more nearly related to *O. krebsii* than to *O. mülleri*. The former has, even when of very small size, with six rays, two mouth papillæ, instead of one. Its ventral plates have also a thickened or raised margin as in *O. dispar* and the arm-spines are more unequal and more numerous than in *O. mülleri*. It is possible, therefore, that the ordinary specimens of *O. krebsii* are all very young and that when they grow to full size they may become regularly five-rayed, as do some other echinoderms that undergo spontaneous fission and have a variable number of arms while young. In that case it might, perhaps, develop into a species like *O. dispar*.

Family, OPHIACANTHIDÆ *Ver.*

Ophiacanthinæ (sub-family of *Amphiuridæ*) Ljungman, 1866; Lütken, 1869.

This family, as here understood, includes the following described genera: *Ophiacantha*, *Ophiomitra*, *Ophiotrema*, *Ophiocamax*, *Ophiolebes*, *Ophiothamnus*, *Ophiocopa*, *Ophiochiton*, *Ophiotoma*, and probably *Ophioblenna*. To these I have now added several others, separated from *Ophiacantha*, *Ophiomitra*, and *Ophiopsila*.

The first six of those named above have the disk covered with scales bearing spinules or thorny processes, or sometimes granules. *Ophiochiton* and *Ophiocopa* have naked or nearly naked scales. *Ophioblenna* and *Ophiotoma* are covered with naked skin. The radial shields may be large or small, naked or concealed.

The family is characterized by the prominent and highly developed side arm-plates, usually meeting above and below, and by the numerous, usually long, and more or less rough spines, which stand out at nearly right angles to the arm. The spines may be solid or hollow, glassy or opaque, terete or flat.

The mouth-papillæ are usually rather numerous, and form a continuous row along the side of the jaw, but the outer ones may be of larger size or different in form from the others, or clustered, and in such cases they are really the distal oral tentacle-scales. There may be only a single apical tooth-papilla, or there may be two or three, and sometimes there is a large cluster. In some cases the outer oral tentacle-pore is exposed to view on the outer margin of the jaw and then it has one, or sometimes several, special oral scales or papillæ by its outer side, or partly surrounding it. Some of its scales may be attached to the adoral plate, or even to the first under arm-plate. This plate is usually concave or somewhat bilobed, and has two inner, lateral, scale-like processes, which are sometimes movable and papilliform. There is generally a single acute tooth-papilla at the tip of the jaw, but there may be two or three, and in some cases (*Ophiocamax*, *Ophiomitra*, *Ophiotrema*), there may be a cluster of several spiniform tooth-papillæ. These were counted as mouth-papillæ

by Mr. Lyman, but when they stand on the dental plate they should be considered as true tooth-papillæ. The teeth are stout, flattened, obtuse; they vary from three to eight in number.

Dichotomous analytical table of the East Coast and West Indian species that have been referred to Ophiacantha, (sens. ext.)

[The species are grouped in this table as nearly in accordance with their structural relations as possible. Those marked with an asterisk are from the eastern coast of the United States north of Cape Hatteras. The others are from the West Indian region.]

A.—Oral shields join the first side arm-plates. Adoral shields entirely proximal to the oral shields.

B.—True *Ophiacantha.* Disk wholly, and radial shields mostly covered with small crotchets, thorny stumps, or short spinules or granules, or with a mixture of these forms.

C.—Disk covered with small crotchets, or short thorny stumps, or short spinules, with no elongated spines nor granules.

d.—Arm-spines finely serrulated, or nearly smooth under a simple lens, usually long and tapered, not glassy.

e.—Basal opposite rows of arm-spines, in the adults, approximate dorsally.

f.—Mouth-papillæ form a simple row.

* *O. bidentata* (Retz.)

* *O. aculeata* Ver.

* *O. fraterna* Ver.

* *O. abyssicola* Sars.

* *O. anomala* Sars.

f. f.—The distal oral papillæ, or oral tentacle-scales, are clustered or form a double row; all spiniform. Tentacle-scales spiniform.

* *O. enopla* Ver.

e. e.—Basal rows of spines not very closely approximate dorsally. Mouth-papillæ in a simple row.

* *O. fraterna* Ver.

O. cosmica Lym.

d. d.—Arm-spines decidedly thorny or prickly, and usually glassy, mostly long and slender.

g.—Basal rows of spines approximate dorsally. Side arm-plates very prominent. Disk with small slender crotchets or branched spinules.

O. aspera Lym.

* *O. millespina* Ver.

O. pentacrinus Ltk.

O. scutata Lym.

g. g.—Basal rows of spines not closely approximate dorsally. Disk with short thorny stumps.

O. stellata Lym.

C. C.—Disk entirely covered wlth tapered spinules or true spines, or having more or less of them mixed with granules or other structures, or else covered with granules only.

h.—Disk covered with spinules, only, or else having spinules mixed with other structures, not granulated.

i.—Disk with spinules only or mainly.

j.—Basal rows of spines approximate dorsally.

* *O. spectabilis* Sars.

j. j.—Basal rows of spines not approximate dorsally.

k.—Arm-spines finely serrulate, not glassy. Tooth-papillæ single. Mouth-papillæ in a simple row.

O. segesta Lym.

* *O. crassidens* Ver.

k. k.—Arm-spines thorny and glassy. Disk-spines slender, thorny, acute. Several tooth-papillæ.

O. pectinula Ver.

i. i.—Disk bearing few tapered spines mixed with other structures. Rows of spines approximate dorsally.

l.—Disk covered with granules, mixed with a few tapered spines. Arm-spines finely serrulate or nearly smooth.

O. vepratica Lym.

l. l.—Disk-spines elongated, mixed with crotchets or thorny stumps. Arm-spines more or less finely serrulate.

* *O. varispina* Ver.

h. h.—Disk covered with small close granules alone. Basal rows of spines not closely approximate dorsally. Arm-spines serrulate. Under arm-plates short and broad, well separated.

* *O. granulifera* Ver.

B. B.—Radial shields largely uncovered. Disk-scales either partially naked and easily visible, but bearing more or less granules or spines, or else entirely concealed.

m.—Disk-scales largely exposed.

n.—*Ophialcæa* V. Dorsal arm-plates largely in contact. Arm-spines nearly smooth, the opposite rows widely separated dorsally.

O. nuttingii Ver. sp. nov.

O. rubescens (Kœhl.) off Azores, 845 meters.

n. n.—*Ophiomitrella* Ver. Dorsal arm-plates separated by the side plates. Arm-spines slender, thorny, the basal rows approximate dorsally.

O. lævipellis (Lym.)

m. m.—Disk-scales mostly concealed, but radial shields naked.

o.—*Ophiacanthella* Ver. Basal rows of spines not approximate dorsally. Dorsal arm-plates largely in contact. Radial shields long, mostly naked, in contact by their edges. Arm-spines nearly smooth. Three tooth-papillæ; mouth-papillæ four, conical, all similar.

O. troscheli (Lym.)

o. o.—*Ophioscalus* (p. 42) Dorsal arm-plates separated. Basal rows of spines closely approximate dorsally. Radial shields large, broad, naked, in contact for nearly their whole length. Two or three tooth-papillæ. Arm-spines thorny and glassy.

O. echinulata (Lym.)

A. A.—The oral shield is separated from the side arm-plates by the distal lobe of the elongated adoral shields.

D.—*Ophiopristis* Ver. Adoral shields narrow, trilobed, the narrow distal lobe separating the oral shield from the side arm-plate. Disk-scales usually concealed by cuticle and spinules.

E.—*Ophiopora*, gen. nov. (See p. 43). No tentacle-scales, the pores are very large, spines small, usually smooth.

O. bartletti (Lym.) One spiniform distal oral papilla by the side of the oral tentacle-pore. Disk covered with acute spinules.

E. E.—One or two tentacle-scales.

p.—*Ophiolimna*, gen. nov. (See p. 44). Arm-spines seven or eight, nearly smooth, placed obliquely on the distal part of the plates, not strongly divaricate. Jaws more or less granulated. Disk-scales and radial shields concealed, bearing granules and spines.

* *O. Bairdii* (Lym.) Upper arm-plates separated. Rows of spines approximate dorsally. Tentacle-scale single.

O. mitra Lym. Upper arm-plates joined. Rows of spines wide apart dorsally. Two flat tentacle-scales.

p. p.—*Ophiopristis*, gen. nov. (see p. 44). Arm-spines serrulate, not obliquely placed. Strongly divaricate. Dorsal arm-plates separated. Tooth-papillæ usually three.

q.—Spines partly flattened, serrulate on the edges. A row or cluster of several distal oral papillæ at the large, oral tentacle-pore. Two tentacle-scales on the basal joints.

O. hirsuta (Lym.)

O. ensifera Ver. sp. nov.

O. cervicornis (Lym.)

q. q.—*Ophiotreta* Ver., subgen. nov. Only one or two, rarely three, oral tentacle papillæ, which are flat. Two to four or more tooth-papillæ. Arm-spines terete, or only a little flattened, slender, serrulate or nearly smooth.

O. lineolata (Lym.)

O. sertata (Lym.)

D. D.—*Ophiothamnus* Lym. Adoral shields large, wedge-shaped, with the broad distal end separating the narrow ovate oral shield from the side arm-plate. Disk-scales exposed. Radial shields more or less naked, close together.

O. gracilis (Ver.)

O. vicarius (Lym.)

O. exigua (Lym.)

From the old genus *Ophiacantha* several genera and subgenera may now be separated with characters that appear to be of as great morphological value as those that characterize, for instance, *Ophiomitra* or *Ophiochiton.*

The most important of these are here indicated.

SERIES I.

OPHIACANTHA (restricted).

Types, *O. setosa* and *O. bidentata.*

Section A.—Typical *Ophiacantha.*

To this section a large majority of all the described species belong.

Section B.—*Ophientodia*, subgenus nov.

Two, three, or four tooth-papillæ clustered at the tip of the jaws. Otherwise nearly as in section A. Distal oral papillæ not clustered.

The figures of several species show two paired papillæ, directed centrally, at the tip of the jaws. They may not always stand on the dental plate and in such cases should be counted as mouth-papillæ, but in some cases they have been determined as true tooth-papilla. Probably in this section there may be a central tooth-papillæ that has been over-looked in some species, by reason of its position, higher up on the jaw, or the smaller size. In some cases the central papilla is present on some jaws, but absent on others of the same specimen. It may have been accidentally lost in some examples. Therefore, I consider the presence of

three tooth-papillæ as the usual character of this division. The species need revision as to the tooth-papillæ.

a.—Radial shields rather small, narrow, mostly concealed.

O. scutata Lym.

O. cuspidata Ver.

O. pectinula Ver.

a. a.—*Ophioscalus*, nov. Radial shields large, wide, closely joined, naked. Disk-scales covered with rough spinules. Arm-spines approximate dorsally.

O. echinulatus (Lym.)

Section C.—*Ophiectodia*, subgenus nov.

Outer mouth-papillæ (oral tentacle-scales) several, forming a cluster or a double row, some often standing on the lower face of the jaw or adoral shield. Tooth-papillæ one to three, or more. The mouth-papillæ are clustered nearly as in typical *Ophiomitra*.

O. enopla Ver.

O. rosea (Lym.)

O. spectabilis (Sars.)

SERIES II.

Group D. *Ophialcæa*, (subgen. nov.) Types, *O. nuttingii* (Ver.) and *O. tuberculosa* (Lym.) (See p. 38).

The dorsal arm-plates are broadly in contact, at least on many of the proximal joints. Disk-scales bear spinules or granules. Radial shields separate, sometimes more or less exposed distally, sometimes covered. Arm-spines rather short, few, nearly smooth, the rows not approximate dorsally. Mouth-papillæ nearly as in typical *Ophiacantha* (group A).

O. nuttingii Ver., sp. nov. Arm-spines four, short. Oral shield very large, ovate. Disk-scales more or less exposed, bearing spinules.

Group F.—*Ophiomitrella* Ver., gen. nov. (See p. 39).

Type *O. lævipellis* (Lym.)

Disk-scales visible, bearing granules or spinules. Radial shields partly naked, not large, wide apart. Arm-spines slender, thorny or serrulate; the rows approximate dorsally in the type. One tooth-papilla. In the type-species a pair of special, distal, oral tentacle-papillæ, on the first under arm-plate, * directed into the mouth-slit. Adoral shields wide. Otherwise the mouth-parts are nearly as in typical *Ophiacantha*.

O. lævipellis (Lym. '83). Arm-spines eight, slender, thorny. Disk-scales naked or partly granulated. Upper arm-plates separated.

Group G.—*Ophiacanthella*, gen. nov. Type, *O. troscheli* (Lym.)

Radial shields naked, long, parallel, united by their edges. Dorsal arm-plates largely joined. Three tooth-papillæ. Arm-spines nearly smooth. (See p. 39.)

SERIES III.

In the following groups the oral shield is separated from the side arm-plates by the adoral shields:

Group H.—*Ophiopora*, gen. nov. Type. *O. bartletti* (Lym.)

Tentacle-pores all large and open. No tentacle-scales. (See p. 39.)

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*The two papilliform appendages of the first under arm-plate are here supposed to be movable, but with the published figures and descriptions it is not always possible to distinguish them from the solid, immovable crest-like lobes, which are present on these plates in the same position in many species, including *O. bidentata*. Among extra-limital species, these papillæ are found in some species, such as *O. serrata* Lym., that have the disk-scales and radial shields concealed.

Group I.—*Ophiolimna*, gen. nov. Type, *O. bairdii* (Lym.)

Spine-crest of the side arm-plates oblique and situated distally. Spines nearly smooth. Disk granulose and spinulose. Jaws more or less granulose. (See p. 40.)

Group J.—*Ophiopristis*, gen. nov. Type, *O. hirsuta* (Lym).

A row of distal oral papillæ alongside of the large, outer, oral tentacle-pore. Arm-spines partly flattened, with serrulate edges. (See p. 40.)

Group K.—*Ophiotreta*, subgen nov. Type, *O. lineolata* (Lym.)

One or two flat, distal oral papillæ by the side of the large oral tentacle-pore. Two or three tooth-papillæ. Spines mostly terete, sometimes flattened and serrulate on the edges. (See p. 40).

Description of Species.

OPHIACANTHA ASPERA *Lyman.*

Ophiacantha aspera Lyman, Bull. Mus. Comp. Zool., V, 9, p. 228, pl. I., figs. 10–12, 1878; op. cit., Vol. X, p. 263, 1883. Lyman, Report, Voy. Challenger, Zool., Ophiuroidea, V, p. 199, 1882.

The specimens collected show some minor variations among themselves and differ considerably in details from Mr. Lyman's figures.

The disk is densely covered with minute thorny spinules, terminating in two to five or more short divergent points; toward the margin they are longer, mostly with two or three points. The mouth papillæ are rather large and project downward; there are sometimes 4, but oftener 3; they are crowded and the innermost one is vertically compressed; the two outer ones are often longer and larger, somewhat enlarged and cuspidate at the end, and often rough with little prominences like incipient thorns, showing a tendency to the structure of the peculiar tentacle-scales; the two stand close

together and all arise from the buccal plate; one stout terminal tooth-papilla. The oral shield is nearly as figured, but the outer end is a little more prominent and the sides are a little incurved at the genital slit; the inner sides are also a little more incurved. The adoral plates are thickened and lunate, nearly as large at the oral shields. All these shields form together a rhombic figure and with the small concave first arm-plate they form a raised pantagon around the mouth. The tentacle-scale is more acute than figured, and has longer thorns, which are divergent like branches; distally it becomes slender and delicate, with few very acute branches. The arm-spines are very slender and very thorny, about ten in a row; they are so numerous and crowded as to conceal the arms above. The rows are closely approximate above, on six or more joints, and tubercles at the bases of the upper ones in opposite rows touch on the median line on the first two joints. The spine-ridges are so thick and prominent that they give a beaded appearance to the arm. Upper arm-plates are very small, quadrant-shaped, and widely separated. Under arm-plates are not just as figured; they are narrow, rather oblong, scarcely "shield-shaped" for the inner end is nearly truncate or slightly convex, without a distinct angle, and the outer end has a central lobe or prominence, which is a little roughened at the margin. The second plate differs from the rest; it is transversely lozenge-shaped, broader than long, but has the outer median lobe.

Diameter of disk, 5 to 6 mm.

Station 13, off Havana, 200 fathoms, five examples. Taken in various localities in the West Indies by the Blake Exp., in 73 to 262 fathoms.

OPHIACANTHA STELLATA *Lyman.*

Ophiacantha stellata Lyman, Ill. Cat. Mus. Comp. Zool., VIII, Pt. II, p. 11, pl. II, figs. 16–18, 1875; Ophiuroidea, V, p. 199, 1882; Bull. Mus. Comp. Zool., X, p. 262, 1883.

Sta. 13, off Havana, 200 fathoms, one example.

Taken by the "Blake" at many localities, in 56 to 262 fathoms.

OPHIALCÆA *Verrill*, subgen. nov. (See p. 42.)

OPHIACANTHA (OPHIALCÆA) NUTTINGII *Verrill*, sp. nov.

PLATE I; FIGURE 2. PLATE VIII; FIGURES 1—1*a*.

Five arms. Disk five-lobed, with strong interradial notches, covered, except on a portion of the radial shields, with small, exposed, imbricated scales, which usually bear a single short, conical, acute, nearly smooth spinule. The radial shields are rather small, separate, partly naked; the exposed part is narrow and elongated, somewhat crescent-shaped. The proximal sides are incurved and somewhat divergent, separated by several rows of small scales bearing conical, acute spinules. Scales bearing acute conical spinules, similar to those of the upper surface of the disk, but longer, cover the bases of the arms and the margin of the disk, toward the oral shields, the scales become much smaller and are usually without spinules.

The oral shields are large, broad, obovate, rather longer than broad, with rounded ends. The madreporic shield is larger and has a more prominent distal end. The buccal plates project but little beyond the oral shields. The adoral shields are very narrow, wedge-shaped, inconspicuous, and do not meet proximally.

The oral papillæ are about five on each edge of the jaw, besides a terminal tooth-papilla, the outer one is broad, ovate, obtuse, flat, and wider than the others, which are conical, pointed, and decrease proximally; tooth-papillæ small, spiniform, arising from the dental plate.

Under arm-plates are mostly broad, widest proximally, trapezoidal, with the distal end evenly curved and the inner end truncated, and broadly in contact. They are broader than long; those near to the base of the arms are narrower;

the first is very small, quadrant-shaped. One large, flat, elliptical or broad-ovate tentacle-scale, nearly as long as the under arm-plate, and usually a minute one in front of it. In a few cases the first tentacle-scale is bifid.

The arm-spines are about six, and are unusually short and smooth for this genus. Their length is about equal to the breadth of the under arm-plates. They are not very unequal; the lower ones are usually the largest; most of them are truncate or blunt, distinctly flattened, tapered, and curved backward; the lower ones are usually more tapered, nearly straight, subacute. They are dull and opaque, not thorny nor serrate, but microscopically roughened.

The proximal upper arm-plates are broadly in contact, broader than long, six-sided or subtrapezoidal, with the inner end truncate; the outer end, which is broadly convex or subtruncate with a median sinuosity, is much the widest. Distally they become relatively narrower and more nearly triangular, with rounded angles.

Color, in alcohol, light buff.

The larger specimens have a disk 11 mm. across; the arms are all broken.

Station 13, off Havana, in 200 fathoms, three examples.

OPHIOPRISTIS *Verrill.* (See p. 39.)

OPHIOPRISTIS ENSIFERA *Ver.*, sp. nov.

PLATE IV; FIGURES 1—1*d*.

Arms five, long and slender, with flat serrate spines. Disk flat, slightly ten-lobed, covered thickly, except on a part of the radial shields, with small obtuse and conical granules, mixed in some parts with minute, sharply conical spinules; all gradations in form, from the rounded granules to the conical spinules occur. Where the granules are partly rubbed off, in dry specimens, the surface is covered with small, distinct, imbricated scales. The radial shields are small; the naked

portions are ovate or elliptical, nearly parallel, and separated by several rows of scales and granules. They appear to extend but little beyond the exposed parts.

Upper arm-plates, except the basal ones, are rhombic or nearly lozenge-shaped, with a slightly angulated prominence in the middle of the outer margin, corresponding to a low median ridge; lateral margins slightly convex; proximal end angulated, slightly separated by the lateral plates. They are broader than long.

Under side of disk covered with minute, exposed scales, with few granules. Oral shields about as long as wide, rather rhombic, with rounded side angles, and a more prominent inner angle; the outer end projects slightly into the interradial area; the sides do not touch the side arm-plates. Adoral shields are long, narrow, irregularly trilobed, the distal end, embracing the lateral corners of the oral shield and touching the first under arm-plate, separates the latter from the oral shield.

Outer oral tentacle-pore large and exposed on the edge of the jaw, bordered by some small papillæ. Oral papillæ small, conical, acute, numerous, about seven to twelve on each side of a mouth-slit, of which four to seven form a proximal marginal row; others, in the largest specimens, lie within the slit, above and around the large tentacle-pore; those next the tip of the jaw are the largest. Several others (about 4 to 6 in the larger specimens) form an irregular row below the oral tentacle-pore, on the surface of the jaw. In the younger specimens there are about three in a regular row. Tooth-papillæ two, spiniform, situated at the edge of the dental plate. Teeth stout, flat, five or six.

Under arm-plates, except a few basal, irregularly traperzoidal or broad shield-shape, about as wide as long; the distal end broadly rounded; lateral edges strongly incurved; inner end very obtusely angled; scarcely separated by the lateral plates, except the two or three basals. Beyond the middle of the arm they become oblong, shield-shaped, and a little more

separated. The first one is small and deeply concave, or sheath-like, with two inner, vertical, flat crests. Tentacle-scales flat, ovate, of moderate size; on the first three or four joints there are, in large specimens, usually two; on the rest only one. The proximal tentacle-pores are not very distinctly larger than the rest.

Arm-spines unequal, rather long, scarcely translucent; the dorsal ones are not approximate in the basal rows; the upper spines on the basal joints are mostly long, rather slender, flat, tapered, subacute, roughened by minute, close denticles along each edge. Those lower down become a little shorter, stouter, and flatter, and are mostly somewhat bent, obtuse at tips, and with sharply serrulate edges. (See figs. 4–5). There are usually five spines in each row proximally.

Color in alcohol, yellowish white.

Diameter of disk 12 mm; length of longest arm, broken at tip, 65 mm.

Off Havana, 110 to 260 fathoms.

OPHIOPRISTIS HIRSUTA (*Lym*).

Ophiacantha hirsuta Lyman, Ill. Cat. Mus. Comp. Zool., VIII, Pt. II, p. 12, pl. II, figs. 21–23, 1875; Bull. Mus. Comp. Zool., V, 9, p. 230; op. cit. X, p. 261; Report Voy. Challenger, Zool., Ophiuroidea, V, p. 198, 1882.

The specimens in the collection differ considerably from Mr. Lyman's figures. In all, the spinules of the disk are much more numerous than figured. In some they are mostly very long and slender, as figured; in others they are much shorter, but slender and sharp. The radial shields are covered by the small scales and spines, except near their ends, which are sometimes in contact and sometimes separated by a few rows of minute scales. The under side of the disk is covered by naked, smooth, thin, rounded scales, with few spinules. Oral shields large, round-rhombic, about as long as wide, with a distinct, but small, distal lobe, (not evenly rounded, as figured); the inner angle is obtusely rounded; the in-

ner sides nearly straight, (as in the figure). The adoral shields are very incorrectly figured, the distal lobes being omitted. They are three-lobed; inner lobe is narrowed and tapered to the end; the distal end curves around the oral shield, one lobe touching the first under arm-plate and the other separating the oral shield from the side arm-plate (as in *O. ensifera*). The first under arm-plate is small, concave, with a thin, flat, vertical crest, near each inner angle, running inward and upward and forming part of the rim around the large, exposed, oral tentacle-pore, which is situated in a depression of the jaw-margin and gives exit to a large and long tentacle. Teeth four or five, stout; the uppermost longer and conical; the others flat and stout, obtuse. Tooth-papillæ two, conical, at the tip of the jaw on the small apex of the dental plate. Mouth-papillæ about seven, in a close row, small, spiniform, acute, the outer largest (all nearly as figured). Nearly all are attached to the buccal plate, but the two outer ones stand below the tentacle-pore like tentacle-scales. In some specimens there are two or three similar papillæ above the tentacle-pore, within the mouth-slit, (as in *O. ensifera*).

The under arm-plates are quite unlike Lyman's figure. The proximal ones are broad and short shield-shaped, slightly separated by the side plates; the distal edge is evenly curved; the outer angles prominent and acute, the sides much incurved at the tentacle-pores; the inner end very obtusely angulated. They have two faint diagonal lines crossing them; the outer edge is a little raised and thickened.

Tentacle-scales two on several joints, flat, ovate-lanceolate, acute. Arm-spines about five; the upper ones on the basal joints long, slender, tapered, acute; the middle ones, on the joints further out, are mostly flattened, with finely serrulate edges (as figured); the lower ones are usually the most slender. The spines are hollow, and glassy when wet. The upper arm-plates are rather small and considerably separated, shaped nearly as in Lyman's figure; they are slightly carinated and the middle field is whitish, so that a pale median line

runs the whole length of the arm; a narrow whitish transverse band marks the inner edge of the side arm-plates, and sometimes both edges are bordered with white. One example, from the Blake Expedition, in alcohol, has a very distinct white dorsal line on the arms, and they are also crossed by a few broad white bands. The ground-color of the arms and disk, above, is light chocolate-brown; beneath, nearly white. Diameter of the disk of the largest specimen described above, 11 mm.

Stations 13 and 15, off Havana, in 200 fathoms, two examples. Taken at many stations by the Blake, in 82 to 955 fathoms.

OPHIOTRETA Verrill, subgenus (See p. 44).

OPHIOPRISTIS (*Ophiotreta*) LINEOLATA (*Lym.*)

Ophiacantha lineolata Lyman, Bull. Mus. Comp. Zool., Vol. X, p. 258, pl. VI, figs. 79–81, 1883.
Ophiacantha, sp., Nutting, Narrative, p. 81, (color).

An excellent specimen of this rare and beautiful species is in the collection. Only a single specimen was taken by the Blake Expedition and described by Mr. Lyman. Although there can be no doubt as to the identity of our specimen with this species it differs in several particulars from Mr. Lyman's figures. These differences are, no doubt, partly individual variations, but others are probably due to errors in the figures, for the latter do not agree well with the description, especially as to the spines. Our specimen has, on some of the arms, two tentacle-scales to a pore, on at least ten joints, instead of only on one joint. The mouth-papillæ and tooth-papillæ are somewhat differently arranged. The under arm-plates and especially the adoral shields do not agree with the figures. The upper arm-plates are wider but of the same character. The six or seven arm-spines are nearly smooth and terete and evenly tapered, without any serrulations visible with a lens. They have a fine silky appearance quite unusual in this group, but they are figured as distinctly serrulate or thorny.

The disk is nearly round and evenly swollen, without any abrupt rise over the arms; the granulations, in fact, extend out a little on the arms. The whole surface, above and below, is uniformly covered with small, smooth, rounded granules. On some portions there are, also, a few scattered, slender, acute smooth spines, as figured. Radial shields are not even indicated by ridges. Under the granules are very small scales. The arms are narrow and high, with a slight dorsal carina. They are not beaded, for the side arm-plates project but little. The rows of spines do not approximate dorsally. The upper arm-plates are thick, elevated, about as wide as long, five-sided, or on some joints six-sided; the outer end is widest and is prominent, in the middle, where it is obtusely angulated, or often slightly truncated. The proximal sides are nearly straight and convergent; the inner end is narrow and truncated, and in contact with the preceding plate.

The oral shields are nearly broad "heart-shaped," but without any notch in the outer end, which is broadly rounded with a slight median angle, and has a row of twelve or more small granules along its margin; the inner sides are slightly incurved; the acute inner end extends far inward on the jaws.

The adoral plates are narrow and long, and do not meet proximally; they are three-lobed; one of the distal lobes joins the first arm-plate; the other is very narrow and extends out between the oral shield and the first side arm-plate, slightly separating them. In Mr. Lyman's figure these parts are left indefinite. The whole surface of the jaw, proximal to the oral shields, is covered with a close group of granules, some of which are conical and similar to the mouth-papillæ and tooth-papillæ alongside of them, so that they are liable to be confounded. Of true mouth-papillæ there are either five or six on different jaws, besides a more distal short oral scale. The two outer mouth-papillæ are larger and broader than the rest; they may be ovate or obovate, flat, obtuse, or sub-

truncate; sometimes the more distal is the larger, and sometimes the one next the distal. The three or four inner ones form a close row; they are rather slender conical, or compressed, acute. The tooth-papillæ (exclusive of the granules near them) seem to be ordinarily but three or four; in one case, perhaps, five; of these, two are usually above the rest, inside the mouth, and not visible from below. They are all small, conical, and variable in form. In Mr. Lyman's description, the jaw-granulations are probably confounded with the true tooth-papillæ, for he gives a large number;—"a cluster of a dozen." At the distal angles of the mouth-slits there is, on each side, a vertical, flat process, looking like a small mouth-papilla from below, but it extends far up into the slit and bears a spiniform papilla at the side of the inner oral tentacle. Its outer end is rounded and forms the distal boundary of the outer oral tentacle-pore; it does not seem to be movable, and arises at the suture of the adoral shield and first arm-plate, but seems to be attached more to the adoral plate.*

The first under arm-plate is small and concave. Four or five basal ones are scarcely separated by the side plates; they are about as long as broad, with an obtuse proximal angle; the distal end is prominent and strongly convex; farther out they become more nearly rhombic, with a distinct, obtuse, distal angle, and are then more separated.

The outer oral tentacles are very large and reach to the center of the mouth; they are not retracted, but have dried fully extended, as if they were more or less stiffened, in our specimen. Their pores are large, close to the edge of the jaw and partially exposed to view, when the outer papilla is removed. The tentacles of the two or three basal joints are rather large, those beyond decreasing rapidly. The basal

*It corresponds in position and use with a similar process, found in *O. ensifera*, *O. hirsuta* and other species, which in most cases seems to be developed on the angles of the first arm-plate. It is sometimes movable, but more frequently solid. (See also group F., p. 43).

tentacle-scales are two to a pore. The outer one is flat and ovate; the inner one is slender, spiniform, acute; both decrease rapidly in size and the inner one disappears at different joints on the several arms, from the fifth to the twelfth, while the other becomes lanceolate and acute.

Diameter of disk, 10 mm. The arms are all broken.

When living, according to Professor Nutting, the disk was light brown with five broad radial bands of white. This color still remains in alcohol. There are also traces of a median white line on the arms.

Off Havana, 110 to 200 fathoms. Off St. Kitts, 208 fathoms, Blake Exp.

OPHIOPRISTIS (*Ophiotreta*) SERTATA (*Lym.*)

Ophiacantha sertata Lyman, Bull. Mus. Comp. Zool., I, 10, p. 326, 1869; Bull. Mus. Comp. Zool., V, 9, p. 231; op. cit. X, p. 261; Report Voy. Challenger, Zool., Ophiuroidea, V, p. 198, 1882.

Our example differs in some respects from Mr. Lyman's description, but it agrees with specimens received from him. The species has not been figured.

The mouth-papillæ are usually six, not counting the pair of tooth-papillæ at the tip of the jaw; they form a close row; the two outer ones are broader and larger than the others, rather flat, ovate, obtuse, (not truncated as described by Lyman); they stand just below the outer oral tentacle. About four, placed more proximally, are more slender, elongated, compressed or spiniform. Tooth-papillæ usually three; close together on the edge of the jaw-tip, two are stouter than the mouth-papillæ, conical, acute; they appear to arise from the apex of the dental plate; just above these and below the first tooth, there is usually and odd median one, of similar form, but shorter, so that it is not visible from beneath.

Oral shield is usually wider and more lozenge-shaped than described, but in some of the smaller specimens it agrees fairly with the description, though by "heart-shaped" Lyman evidently did not mean "cordate" in the usual sense, for there

is no distal emargination, but rather an obtuse angle. The outer edge bears a row of five to seven small, conical grains.

The adoral plates are nearly as described; one of the narrow outer lobes separates the oral shield from the first side arm-plate; the other joins the first under arm-plate. The latter is small and emarginate on its inner end. The other under arm-plates differ a little from the description; they are nearly truncate on the inner end, or else very obtusely angulated, without any obvious "peak."

Upper arm-plates are small and nearly as described; they might be called narrow fan-shaped or quadrant-shaped, the outer end being well rounded. The arm-spines are as described, they are serrulated, but not rough for this genus; the flattened ones are finely serrulate on the edges; the basal rows are not closely approximate dorsally. The tentacle-scales are rather broad and flat, lanceolate or ovate, and do not rapidly change distally. One example has two pairs on several basal joints.

Diameter of disk, 6–9 mm.

Off Havana, Sta. 2, 110 fathoms, one example. Taken by the Blake Exp., in 123 to 411 fathoms.

AMPHIPSILA, gen. nov.

Type *A. fulva* (*Lym.*)

Disk rounded, covered with thin, naked scales, above and below. Radial shields narrow, separated, naked. Arm-plates distinct, above and below. Arm-spines of moderate length, numerous (five to twelve) serrulate. Oral shields clearly visible, at least when dry. A simple row of mouth-papillæ. Only two or three conical, apical papillæ in a marginal row; these may be considered as tooth-papillæ, but there is no distinct cluster of inner papillæ, below the teeth, as in *Ophiopsila*. Tentacle-scale spiniform.

AMPHIPSILA MACULATA, sp. nov.

PLATE III; FIGURES 4, 4*a*.

Disk swollen, covered with rather small, thin, flat, rounded, nearly smooth, naked, imbricated scales. Naked part of radial shields long and narrow, wide apart; the inner ends somewhat divergent; the outer ends a little wider or clavate. Arm-spines seven or eight, slender, of moderate length, the upper ones about as long as a joint, decidedly flattened and tapered distally, nearly opaque, hollow and slightly rough; the two lower ones are longer and larger than the rest, more terete, blunt or truncate, rough or thorny at the tip. The basal rows do not approximate dorsally.

Upper arm-plates obovate, longer than wide, rather large, outer ends thin, obtusely rounded, sides convex; inner ends obtuse, overlapped by the preceding plate; distally they become more nearly square, with rounded angles, and about as long as wide. Under arm-plates shield-shaped, longer than wide, the outer end widest and slightly emarginate in the middle, the lateral edges concave; the inner end angulated and slightly overlapped by the preceding plate. Tentacle-scales on several basal joints two, unequal, elongated, flat, rough, ribbed, and palmate at the end, as if composed of two or more divergent spinules united together; more distally the smaller or outer one becomes short, thorny, and acute, and then disappears, while the larger one becomes spiniform and thorny.

Oral shields very distinct, four-lobed, "spade-shaped," with the distal lobe narrow and extending into the interradial area; lateral lobes rounded; sides a little incurved; proximal end obtuse. Adoral shield long and narrow, extending back along the sides of the oral shield and slightly separating it from the side arm-plates.

Mouth-papillæ three or four in a regular row, besides three stouter conical ones that stand a little apart from the rest, in a row at the tip of the jaw, but of these only the middle one seems to be on the dental plate; the distal ones seem to be mostly attached to the adoral plates; they are rather large,

flat, lanceolate, the outer one largest. The first under arm-plate is small and bears a small process at each inner corner.

Color, in alcohol, yellowish white, with yellowish brown bars across the arms; disk with small dark brown spots.

Diameter of disk, 6 mm; arms badly broken.

Sta. 13, off Havana, 200 fathoms, one example.

AMPHIPSILA FULVA (*Lyman*).

Ophiopsila fulva Lyman, Bull. Mus. Comp. Zool., Vol. V, p. 227, pl. II, figs. 25–27, 1878; op. cit. Vol. X, p. 254, 1883.

This species was described and figured by Mr. Lyman from a single specimen.

The figure lacks many details and does not agree well with the description, but both differ so decidedly from our specimen of *O. maculata* that it seems useless to unite them. A direct comparison of specimens, however, might possibly show that they are varieties of one species.

West Indies, 13 to 175 fathoms, Blake Exped.

OPHIOMITRA Lyman.

Bull. Mus. Comp. Zool., Vol. I, p. 325, 1869; Voyage Challenger, V, pp. 202, 209, 1882, pl. XLV, figs. 4–6, (anatomy).

This genus is very closely allied to *Ophiacantha*. The only special distinctions given by Lyman are the larger size and nakedness of the radial shields, and the naked or nearly naked scales of the disk.

Mr. Lyman also described the disk of the type-species as rounded and cap-like—a character due, perhaps, to immaturity, for in large specimens of that species the interradial margins are incurved or emarginate.

When adult, the type-species (*O. valida* Lym.)* has numerous spiniform, clustered mouth-papillæ and tooth-papillæ.

*The specimens originally described and figured by Lyman were all immature, and had not developed the true characters of the mouth-parts.

The distal oral tentacle-pore is large and sub-marginal, partly sheathed by proximal processes from the concave first under arm-plate and inner side of the jaw.

The adoral shields are very broad, but wholly proximal to the small oral shields. The basal tentacle-pores are large and furnished with two prominent tentacle-scales.

The large, broad radial shields are largely in contact. The disk-scales are not large, of nearly uniform size, without specialized marginal ones, and bear short, coarse, clavate, thorny stumps.

The arm-spines are numerous, somewhat thorny and glassy. The dorsal arm-plates are slightly separated by the side-plates.

Most of the species, subsequently described by Mr. Lyman and others, differ much from the type in several characters.

They nearly all have a single odd tooth-papilla and a single row of mouth-papillæ, as in typical *Ophiacantha*. The interradial marginal scales are usually large and specialized. The radial shields are often entirely separate and in some cases not particularly large.

OPHIOMITRA VALIDA *Lyman.*

Ophiomitra valida Lyman, Bull. Mus. Comp. Zool., I, 10, p. 325, 1869; op. cit., X, p. 264, 1883; Lyman, Ill. Cat. Mus. Comp. Zool., VI, pl. II, figs. 4–6; Report Voy. Challenger, Zool., Ophiuroidea, V, p. 209, pl. XLI, figs. 4–6, 1882.

Station 35, off Key West, 90 fathoms, eight examples; Sta. 33, off Sand Key, 105 fathoms, two examples; Sta. 56, Pourtales Plateau, 200 fathoms, one example. Found throughout the Caribbæan Sea, at various depths, from 10 to 1105 fathfathoms. (Lyman).

OPHIOMITRA ORNATA *Ver.* sp. nov.

PLATE V; FIGURES 1, 1*a*.

Arms five, spines numerous and very long, tapered, acute, glassy, covered with small, rough prickles on all sides. Disk-

scales visible, not very large, of nearly uniform size, most of them bear a single, rather long tapered spine or shorter, acute, very thorny spinule. The central scales bear the shortest spinules, while the length increases toward the margin of the disk. Radial shields large, broad, irregular or roundish, partly naked, slightly bilobed distally. The under side of the disk is covered with flat, imbricated, subequal scales, bearing a few small, conical spines. The radial shields are partly separated by a narrow row of small scales, bearing short, conical, thorny spinules, similar to those on the central part of the disk; a few similar spinules arise directly from the radial shields. The interradial margins, in one dry specimen, were rather deeply emarginate; in another, equally dry, they were strongly convex.

The oral shields are small, broadly pelecoidal, wider than long, with the distal end evenly rounded, and the inner margins strongly incurved, and forming an acute proximal angle. The madreporic shield is much larger and more rounded (pl. V, fig. 1*a*). The adoral shields are very large and broad, rounded distally, with the adjacent edges joined extensively, along the median line. The mouth-papillæ and tooth-papillæ together, are about twelve to fifteen on each side of a jaw; they are nearly equal, large, spiniform, acute. Those along the distal part of the jaw may form two crowded rows; the tooth-papillæ form a crowded cluster of four or five or more at the tip; five or six, or more, serving as oral tentacle-scales, form a close distal cluster.

First under arm-plate small, concave, with a pair of processes on the inner angles. Under arm-plates, except on the basal joints, broadly triangular, with the distal side broadly rounded and slightly emarginate in the middle; lateral angles very prominent; inner margins nearly straight, forming a sharp median angle. The lateral plates meet along the median line and separate both the dorsal and ventral plates, more or less.

Tentacle-scales two on one or two basal joints; one of

these is much the larger, acute, lanceolate, concave, erect; farther out they rapidly decrease and become narrow, blunt or clavate and thorny at the tip.

The arm-spines are translucent, long, slender, terete, tapered, mostly acute, and roughly serrate or thorny; the upper ones are considerably longer and more slender than the lower ones. The rows are dorsally approximate. There are eight or nine spines in the larger rows.

The upper arm-plates, except the basal, are broadly rhomboidal; the outer margins form an obtusely rounded angle; side angles very acute; inner angle obtuse, but often with an acute tip. They are separated by the side plates. Basal plate short, transversely elliptical.

Diameter of disk of the type specimen, 11 mm; breadth of arm at base, without spines, 3 mm; length of longest spines, 4–6 mm.

Station 12, off Havana, 200 fathoms, one example; station 2, off Havana, 110 fathoms, one example.

OPHIOCAMAX AUSTERA *Verrill*, sp. nov.

PLATE VI; FIGURES 1, 1*a*. PLATE VII; FIGURE 2.

Rays five. Disk deeply five-lobed, covered with small polygonal scales and large naked radial shields. The small scales bear each a single, small, rough or thorny, tapered spine, some of which are elongated and others short-conical.

The radial shields are very large, acute-triangular, in contact throughout the length of the straight inner edges, but with a row of small spinules along the suture. Their inner ends are covered by small overlapping scales; their outer ends are separated by a small group of scales bearing spinules.

The under side of the disk is covered with small angular scales, bearing a few small conical spinules.

Oral shields thick, warty, small, and irregularly trilobed; the body or proximal part is transversely elliptical with an

obtuse proximal angle; the distal lobe is an elongated, narrow, oblong, blunt process, which extends out into the interradial area. Small, rough, granule-like and verruciform elevations occur on its proximal part, as well as on the distal. The madreporic shield is larger than the others, swollen, somewhat triangular, without a distinct distal lobe.

Adoral shields are very large, broad, quadrant-shaped, with the straight adjacent edges broadly joined.

The mouth-papillæ, tooth-papillæ, and oral tentacle-scales are all similar in form, long, acute, spiniform, and very numerous. The tooth-papillæ are about ten to a jaw, in four transverse rows, below the broader and flatter teeth; the two upper rows consist each of a pair of papillæ, side by side; the two lowest rows, near the margin of the jaw, usually consist of three each, of which the median ones are larger and like those above them. On the middle of each side of the jaw there is a crowded divergent group of 14 to 17 spiniform mouth-papillæ, some of which arise from the ventral surface of the oral plates and others from their margins; a few additional ones are situated along the inner margins, up to the tooth-papillæ. They are mostly acute, spiniform, and minutely serrulate or rough.

At the junction of the concave, first under arm-plate and the first lateral plate there is a prominence, bordering the oral tentacle-pore, and bearing a close cluster of about five or six large, acute, spiniform tentacle-scales directed inward; they are rather larger than the mouth-papillæ, but similar in form; two of these are borne on the under arm-plate and three on the corner of the side arm-plate. The first arm-plate is deeply hollowed out between the side lobes that bear spiniform tentacle-scales.

On the second and third joints there are four or five similar, but slightly smaller, tentacle-scales, in a conical group around each pore; on five or six succeeding joints there are three scales in a group, but they become thorny and more irregular and decrease rapidly in size distally; beyond the

ninth or tenth joint there are two small thorny ones, and farther out only one, which is very slender and rough.

The size of the tentacle-pores also decreases rapidly from the basal joints distally, so that even on the middle of the arm it becomes minute.

Along the basal half of the arm, beneath, there is a shallow, median groove, which increases in depth proximally; it is due to the concave form of the under arm-plates. The under arm-plates beyond the basal, are short, but transversely very wide, with the lateral angles extending far out between the side plates and up on the sides of the arms; the distal edge is distinctly three-lobed, the lobes being broadly rounded, the median a little more prominent than the lateral; the proximal end has a very obtuse median angle. They are slightly separated by the side arm-plates; on the middle of each under plate there is a slightly raised, small, rough elevation. The side arm-plates are short, but high and rather prominent; they meet both above and below.

Arm-spines seven or eight on the second and third joints beyond the disk. They increase regularly in length from the lowest, which are small and slender, to the two upper ones, which are large and long, or about as long as four arm-joints. They are slender, tapered, terete, translucent, and covered with small rough points on all sides.

The rows of spines do not approach very closely on the upper side of the arm, owing to the width of the arm-plates.

The upper arm-plates are strongly arched, rather thick and swollen, rough, with a transverse row of small verrucæ on a low ridge near the distal edge. These plates, except a few basal ones, are transversely subrhombic, or rudely elliptical, with the inner end obtusely angulated and the outer end broadly convex, and often obtusely angulated medially. They are much wider than long, and are separated by deep, narrow grooves in which the side plates meet.

The first four or five dorsal plates are smaller and narrow-

er; the third and fourth are nearly as wide as long, five-sided, with corners rounded. The first is a short, transverse plate, bearing a row of minute spinules, and separated from the radial shields by one or more supplementary plates.

Diameter of the disk of the largest, 14 mm.; the arms are broken at the ends.

Station 2, off Havana, 110 fathoms, two examples.

In one specimen, probably owing to repair after injury, two of the radial shields are replaced by a mosaic of small, irregular scales, bearing spinules, and the basal dorsal arm-plates, also, are each replaced by several small pieces.

This species is closely allied to *O. hystrix* Lyman, from the same region. The latter, as figured by Lyman,* has shorter and more irregular radial shields, separated for about half their length by a wedge of scales; the disk-plates larger and few, bearing much smaller, short, conical, thorny and sharp grains. The basal upper arm-plates are longer and more angular, trapezoidal, and more extensively in contact. The basal under arm-plates are shorter and less triangular; the under arm-plates have a less distinct central lobe; the eight arm-spines are shorter and more unequal. The mouth-papillæ, tentacle-scales, and oral shields are, however, very similar in the two forms.

O. fasciculata Lyman, also from the West Indies, is another similar species. It has smaller and very slender disk-spines, shorter and smaller radial shields, closely joined, and without the intervening row of spinules. The dorsal arm-plates are narrower and more widely separated; the six arm-spines are much shorter; the oral shield is broader and less lobed; the tentacle-scales fewer. The mouth-papillæ and under arm-plates are very similar.

*Three large specimens of this species are in the Yale Museum, sent by Mr. Lyman. Two of them agree well with Mr. Lyman's type, but the third is much like our type of *O. austera*. Mr. Lyman probably intended to include both forms under his species. But our species is really more nearly allied to *O. fasciculata L.*

OPHIOCHONDRUS GRACILIS *Verrill*, sp. nov.

Disk small; arms long and slender, tapering but little, coiled. Upper arm-plates small, thick, slightly in contact with each other, broad ovate, "top-shaped," or subtriangular with rounded angles, about as broad as long on the proximal half of the arm; outer end strongly convex, lateral angles rounded, obtuse; on the distal part of the arm they become more triangular or somewhat heart-shaped, and are separated by the side plates, under arm-plates small, thick, except the basal, broad-triangular, with rounded angles and convex outer edge, about as long as broad, separated by the side plates; the distal end is thick and raised. Tentacle-scale one, large for the genus, oblong-ovate or short spiniform, obtuse. Arm-spines eight, on the greater part of the arm short, stout, a little flattened, rather obtuse, slightly rough, nearly equal in length, or the uppermost a little longer than the others; distally they become more slender and tapered; near the base of the arm, on some of the joints, the upper spine is often twice as long as the others, tapered and acute.

Oral shield small, thick, pear-shaped, with an acute inner angle, as long as broad.

Adoral shields large, thick, and rough like the oral shields, pear-seed shaped, the inner ends prolonged, acute, and largely joined. Mouth-papillæ three on each side and an odd terminal one; they are relatively large, prominent, not crowded, obtuse, the outer one slightly flattened. The upper surface of the disk is destroyed.

Diameter of disk-scar, 3 mm; diameter of arm, without spines, 80 mm; length of arms, imperfect at tip, 20 mm.

Off Havana, 110 to 260 fathoms, on gorgonians, two examples.

This species, although the covering of the disk is unknown, differs very decidedly from all those hitherto described in the slenderness and length of the arms; elongated upper arm-spine on the proximal joints; form of arm-plates, tentacle-scales, mouth-papillæ, and oral shields.

Family, OPHIOMYXIDÆ *Ljung.* (restr.), 1866.

Ophioscolecidæ (*pars*) Lutk., 1869.

Ophiomyxinæ (sub-family) Ljung., 1871.

Ophiomyxidæ Carus, Faunæ Medit., p. 96, 1884.

Disk and arms covered with thick cuticle, and usually with only a row of marginal disk-scales, and a few scattered ones imbedded in the cuticle, but visible only when dried. Radial shields small, usually with a proximal series of small supplementary scales.

Teeth and mouth-papillæ stout, flat, with the end serrated. No tooth-papillæ. True tentacle-scales generally absent. Under arm-plates small. Side arm-plates sub-ventral, bearing several rough divergent spines. Upper arm-plates rudimentary or lacking; when present, composed of small pieces. Two large, triangular, peristomial plates on each mouth-angle.

Arm-bones peculiar, belonging to the modified "hour-glass-shaped" type; with well-formed condyles on both ends.

Ophiomyxa is the only genus described, but it evidently includes two generic groups. The second genus has the following characters:

OPHIODERA, gen. nov. Type, *O. serpentaria* (Lym.)

Marginal disk-scales, are rudimentary, and the disk-scales proximal to the radial shields are lacking. No upper arm-plates. Side arm-plates may be soldered to the under arm-plates; they are not contined upward by a row of supplementary plates. Three arm-spines, enclosed by cuticle.

OPHIOMYXA FLACCIDA (*Say*) *Lutk.*

Ophiura flaccida Say, Journ. Phil. Acad. Nat. Sci., V, p. 151, 1825.

Ophiomyxa caribæa Lütken, Vid. Meddel., p. 10, 1856.

Ophiomyxa flaccida Lütken, Add. ad. Hist. Ophiur., Pt. II, p. 138, pl. V, fig. 1, 1859.

Ophiomyxa flaccida Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 178, pl. II, figs. 18, 19. Verill, Trans. Conn. Acad., I, Pt. II, p. 341, 366, 1868.

Lyman, Bull. Mus. Comp. Zool., V, 9, p. 233; Lyman, Report, Voy. Challenger, Zool., Ophiuroidea, V, p. 246, pl. XLIII, fig. 1–3, 1882, anatomy. Nutting, Narrative, pp. 132, 170.

The specimens of this species show, in alcohol, considerable variation in color; most of them are dull yellowish green, or dark olive green on the disk, more or less mottled with yellow, and frequently with rings of yellow on the arms. In some examples the whole disk is covered with irregular rings of light yellow on an olive green ground-color. The colors are usually reddish or orange in life. In the larger specimens there are often, on alternate joints, four and five spines on each side; beyond the middle regularly five, or five and six on alternate joints more distally.

Tortugas, in shallow water, ten large examples, Egg Key, young.

Common in shallow water from the Florida Keys to the Abrolhos Reefs, Brazil, and throughout the West Indies. Bermuda (coll. Goode).

OPHIOMYXA BREVICAUDA *Verrill*, sp. nov.

PLATE III; FIGURE 3.

Arms relatively short and stout, rapidly tapered. Disk relatively large, tumid, five-lobed, extending out on the arms, covered with thick wrinkled cuticle, which contains few scales except along the margin and at base of arms, where there is a row of rather stout scales. Radial shields small, obscure, roundish. Arms covered above with smooth cuticle, without upper arm-plates or granules; the rhombic surfaces of the internal plates show a median groove and are nearly in contact. Under arm-plates small, rather shield-shaped, with a deep distal notch and angulated outer corners. Side-plates large, thick and prominent. Arm-spines three, webbed together, and covered by cuticle, slender, very acute, glassy, roughly serrulate. Tentacle-pores rather large.

Mouth-papillæ four, sometimes with a minute fifth distally; they are wide, flat, subtruncate or rounded and finely serrate at the end.

Oral shields small, broad-elliptical or sub-rhombic, with rounded corners, rather broader than long. Adoral shields trilobed, separating the oral shields from the side-plates, but not meeting within.

Diameter of disk, 13 mm. Length of arms, 45 mm.

Stations 4 and 13, off Havana, in 110 and 200 fathoms.

This species has arms shorter and much stouter at base than the preceding, and they taper very rapidly, instead of being of nearly uniform breadth and slender. The arm-spines are more slender, less tapered, rougher, and more glassy. The tentacle-pores are much larger; the under arm-plates are less heart-shaped or triangular; the mouth-papillæ stouter; the marginal disk-scales larger.

OPHIOMYXA TUMIDA *Lym.*

Ophiomyxa tumida Lym., Bull. Mus. Comp. Zool., vol. X, p. 272, pl. I, figs. 1–3, 1883.

PLATE III; FIGURE 5.

This species was taken at many stations in the West Indian region, in 13 to 300 fathoms by the Blake Expedition.

OPHIODERA, gen. nov. Type, *O. serpentaria* (Lym.)

Marginal disk-scales are rudimentary and concealed by thick cuticle; the disk-scales proximal to the radial shields, are lacking. No upper arm-plates. Side arm-plates may be soldered to the under arm-plates. They are not continued upward by a row of small plates. Three or four arm-spines enclosed in cuticle, the inner one is smaller and may serve as a tentacle scale; it is sometimes forked distally. Teeth and tooth-papillæ serrate, nearly as in *Ophiomyxa*, but with finer denticles.

OPHIODERA STIMPSONI *Verrill.*

? *Ophioscolex stimpsoni* Lyman, Illust. Cat. Mus. Comp. Zool., VIII, p. 23, pl. I, figs. 11-15, 1875.

PLATE II; FIGURES 4, 4*a*.

Arms very long and slender. Disk five-lobed, the lobes extending out a little on the base of the arms. Teeth three or four, upper one stout, spiniform, the others thicker, subtruncate.

Mouth-papillæ about five, partly slender, sub-spiniform, rough at tip, irregularly crowded in a row, nearly equal in length, but some are flattened and obtuse at tip.* Sometimes there is also a somewhat stouter tooth-papilla. Within mouth-slits, on each side, there are two (sometimes only one) slender papillæ, between the two oral tentacle-pores.

Oral-shields exposed when dry, small, transversely elliptical; adoral shields rather small, irregularly three or four-lobed, not meeting proximally, where there is a patch of naked cuticle between them, but distally separating the oral shields from the side arm-plates.

Genital slits wide and open near the oral shields, but narrow distally and not extending to the edge of the disk, bordered by narrow, naked scales.

Under arm-plates small, but somewhat thickened, angularly heart-shaped, with a deep distal notch or emargination, the outer corners angular. They are separated by the sunken side-plates, which leave central pits or indentations. No tentacle-scale. The pores are small and round. Arm-spines three or four, divaricate, small, very sharp, rough and glassy, nearly equal, more or less webbed together and covered by cuticle when in alcohol. They keep the same character to the ends of the arms, where there are but two, borne on prominent lobes of the side-plates.

Upper arm-plates lacking. The internal arm-plates show as transversely rhombic plates separated by wider intervals.

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*The irregularity of the papillæ may be due to some former injury and only partial restoration of these parts. Many of the papillæ lack the serrulate distal end, characteristic of the genus, and plainly seen in the other specimens described below.

Whole upper surface of disk and arms and lower surface of disk covered with thin, naked cuticle, wrinkled when dry, in which are imbedded microscopic scales, on the disk, and a row of small, but distinct, marginal scales. Sometimes there are a few minute, acute granules along the margin and on the bases of the arms. Radial shields narrow, very small, or concealed by cuticle.

Diameter of disk, 7 mm; length of arms, about 45 mm.

Another slightly larger specimen from the same station has the disk tumid, and the lobes extend out more on the bases of the arms. The cuticle is thicker and contains numerous microscopic scales, while on the lower side of the disk there are many very small, scattered, pointed granules. Similar granules are scattered on the sides and back of the arms. The lower side of the arms and disk is covered with thick cuticle that conceals the plates, even when dry, unless treated with potash.

The spines are usually four, but often three and four alternately, short, rather thick, acute, rough, the upper one largest, webbed together for half their length with cuticle.

Mouth-papillæ four or five, flattened, rounded at the end, and minutely serrate, except the outer one which is shorter and scarcely serrate. On some of the basal joints there is often a minute, slender, acute tentacle-scale, concealed by cuticle in the alcoholic specimens. Under arm-plates and oral shields as in the smaller one described above.

Another specimen, with disk 8 mm. in diameter, from station 15, has the oral shields more triangular, with rounded corners, their breadth being about equal to the length. The radial shields can be seen through the dried cuticle as very small, narrow, oblong plates, well apart.

Mouth-papillæ five, small, serrate, decreasing in size distally. Arm-plates and spines as in the others.

Station 4, off Havana, in 110 fathoms; station 15, off Havana, in 200 fathoms; station 24, off Key West, in 60 fathoms.

Family, HEMIEURYALIDÆ *Ver.*

In this family are included several genera of true Ophiuræ, which very much resemble, in form and habits, the simple-armed Euryalæ or Astrophytons. Like the latter, they coil their arms closely around the branches of gorgonian corals on which they dwell.

The disk is pentagonal and covered with thick plates or tubercles, which may be conical. The radial shields are large and prominent.

Upper arm-plates may be entire and accompanied by supplementary plates, or they may be replaced by a mosaic of small plates. They are thick or tubercular.

Under arm-plates well formed. Side-plates separated by extra plates. Oral and adoral shields normal. Spines few, short and stumpy. A row of mouth papillæ. Teeth, but no definite cluster of tooth-papillæ.

Genital pores small, situated near together at the outer end of the oral shield. Arm-bones have special forms approaching those of the *Astrophytons*. Mouth-frames strongly ossified.

The genera belonging to this family, are *Hemieuryale, Ophioplus, and Sigsbeia.*

OPHIOPLUS, gen. nov.

Type, *Hemieuryale tuberculosa* Lyman.

PLATE I; FIGURES 1, 1*a*, 1*b*.

Disk small, pentagonal, thick, covered with small, thickened or tubercular scales. Radial shields large, naked, separated. Oral shields and adoral shields well developed and naked. Mouth-papillæ in regular series. No tooth-papillæ. Under arm-plates rather large. Upper arm-plates entire, swollen and well formed, separated by a transverse row of small, tubercle-like plates. Side arm-plates prominent, separated above by a supplementary lateral plate. Arm-spines short, two or three in a row. Tentacle-scale single.

A pair of small, round genital pores under the outer end of the oral shields.

This genus differs decidely from *Hemieuryale*, to which it is allied, in having distinct and well formed dorsal arm-plates. It is also closely allied to *Sigsbeia*. In fact, it stands between these two genera in several characters.

OHPIOPLUS TUBERCULOSUS (*Lym.*) *Ver.*

Hemieuryale tuberculosa Lyman, Bull. Mus. Comp. Zool., vol. X, p. 276, pl. VIII, figs. 120–127, 1883.

Ophiomusium (?) Nutting, Narrative, p. 78.

PLATE 1; FIGURES 1, 1*a*, 1*b*.

Disk small, thick, pentagonal or five-lobed, convex, swollen over the bases of the arms, covered with rather large, mostly rounded, swollen and verruciform plates, among which a central plate and ten radiating rows of radial and interradial plates of larger size and greater elevation can be distinguished; the smaller plates are more irregular in form and less swollen. The radial shields are rough, rudely elliptical or ovate, rather long, widest in the middle, far apart, separated by a median row of about three high, verruciform plates and a row of smaller ones on each side. Upper arm-plates, except the basal, are broader than long, very thick and prominent, transversely elliptical or oblong, with all the corners rounded; outer end often a little emarginate, and inner end often truncated. They are usually separated by a single row of three, high, verruciform plates, of which the middle one is round and the laterals ovate; sometimes there is an additional row of two or three plates; at the base of the arms the median one may be lacking, and toward the tips, the laterals usually disappear, leaving only a small median one. A row of rounded prominent plates extends along each upper edge, alongside of the arm-plates, and alternating with the side-plates. Arm-spines generally two, sometimes three, small, short, stout, the lower one thickest, clavate or obtuse. Tentacle-scale rather large, ovate.

Under arm-plates, near the base of the arms, trapezoidal with convex outer edge and rounded corners, usually rather longer than broad; farther out they are nearly square, a little separated by the side plates.

Oral shields five-sided, broader than long, outer edge a little convex, angles rounded; inner edges concave, meeting in a broad angle. Adoral shields large, rudely ovate, the narrower inner ends broadly in contact. Mouth-papillæ about five, angular, acute, more or less flattened.

Genital pores very small, round, under the outer end of the oral shield.

Color deep brown, variously spotted with whitish, imitating the colors of *Gorgonella* to which it clings.

Usually many of the more prominent verruciform plates of the upper side of the arms and disk are white; under arm-plates dark brown.

Station 15 and 16, off Havana, 200 fathoms, two examples. Taken by the Blake Expedition in 96 and 115 fathoms.

SIGSBEIA MURRHINA *Lyman.*

Sigsbeia murrhina Lyman, Bull. Mus. Comp. Zool., V, 9, p. 234, 1878, pl. III, figs. 55, 58; op. cit. X, p. 277; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 250, pl. XLIII, figs. 4–6, 1882, anatomy; Three Cruises of the Blake, II, p. 114, fig. 399, 1888. Nutting, Narrative, p. 79.

PLATE II; FIGURES 1, 1*a*.

Station 13, off Havana, 200 fathoms, one adult and one young; station 73, Little Cat I., 3 to 15 fathoms, three young.

This species clings to gorgonians, which it imitates in form, and probably in color when living.

A young specimen, having a disk 3.5 mm. in diameter, appears to belong to this species. It is from station 73.

This specimen differs so much from Mr. Lyman's figures that it might almost be taken for a new species, but the differences may be due to age.

In our specimen the oral shields are broader and less ovate, the outer ends being more rounded than in Lyman's figure. The under arm-plates are longer, narrower, and more shield-shaped, the sides being strongly emarginate, and the proximal end narrower; they are all, even at the base of the arms, separated by the lateral plates. The tentacle-scale is very small. The arm-spines are minute, near together, short, obtuse, the lower one slightly larger.

The basal upper arm-plate is very small, short, transversely elliptical, partly concealed by three supplementary, thickened disk-scales outside the ends of the radial shields; the second plate is larger, thick, transversely elliptical; the succeeding ones are top-shaped with rounded outer, and very acute inner ends; sides incurved, usually not separated by the lateral plates. The two basal plates are, therefore quite unlike Mr. Lyman's figure.

The disk-plates are very different from Mr. Lyman's figure; the radial shields are narrower and at their inner ends there are five large, swollen, pear-shaped radial plates, their points inward, and separated by about three small scales, and with a small central scale. None of the disk plates bear tubercles or granules. The disk is high and swollen and the plates are not closely soldered together, as they are said to be by Mr. Lyman. Color of the dry specimen yellowish brown above, yellowish white below.

Order II. EURYALÆ *Müller & Troschel*, 1842.

Euryalidæ Gray, 1840.

Astrophytonidæ Norman, 1866.

Phytastra Hæckel, 1866.

Astrophytidæ Lyman, Ljungman and others.

Euryalæ Ljung., Oph. Viv., p. 334, 1867. Carus Fauna Medit., p. 97, 1884.

Cladophiuræ Bell, 1892.

Euryalida of several authors.

Family, ASTRONYCIDÆ, nov.

Astronycina, (*pars*) Ljung., Oph., Viv., 1867.

Arms undivided, long, slender, coiled, not annulated nor granulated. Disk with ten narrow radial ridges formed by long narrow radial shields, covered with thin, smooth scales or naked skin. Teeth stout, well formed, in a single row. Tooth-papillæ one or two, conical, sometimes absent. Mouth-papillæ small, like conical granules, placed above the margins of the jaw. Oral and adoral plates regularly formed.

Upper and under arm-plates rudimentary or absent. Side-arm-plates cover most of the lower side of the arm and project laterally, bearing two, three, or more spines or tentacle-scales, which may be either simple or hook-like. The genital slits are short, near together, in a depression near the oral shields.

Astronyx was the only described genus of this family, till recently, when I was able to add to it a new genus, *Astrodia*, (type *A. tennuispina* Ver.) from deep water off the U. S. coast.

This family includes only two genera, *Astronyx* M. & Tr., and *Astrodia*.

ASTRONYX LYMANI *Verrill*, sp. nov.

Astronyx loveni Lym., Bull. Mus. Comp. Zool., vol. X, p. 282, pl. VIII, figs. 136–138, young, (*non* Müll. & Troschel).

PLATE VIII; FIGURES 4—4*e*.

Arms five, long, slender, coiled. Disk pentagonal with incurved margins, and ten high, long radial shields, which are widely separated, curved outward in the middle and somewhat sinuous distally, the outer end a little clavate or knobbed; the edge is serrulate with small scales. The radial shields and disk are covered with a thin, smooth skin which extends out on the arms above and below. Interbrachial region below, in the dry specimen, concave or sunken, with the two short but wide genital openings close together, near the inner angle.

Tooth-papillæ about six, in a biserial group at the end of the jaw, small and conical; two or three similar mouth-papillæ on each jaw-margin, rather irregularly arranged, and others higher up in the slits. On the first joint the tentacle-pores are without scales or spines; on the second they sometimes have a single, very small one; on the third there are either two or three small spiniform ones; on the fourth usually three in each group, of which the inner is longest; on the fifth joint, opposite the edge of the disk, there are three, the inner or lower one being much longer and more spiniform than the others, which have claw-like hooks on the lower side. Farther out the number increases to four, and finally to six, beyond the middle of the arm. The large, lower one is about as long as a joint, blunt, and rough on the inside, on the basal joints, but farther out it becomes obtuse and its distal part bears ten, twelve or more small glassy hooks, in two or more rows (figs. 4, 4*a*, 4*e*); those of the upper series are all changed to claw-like hooks, the lower often with two or three glassy points; they are attached to a transverse row of prominent tubercles on the side arm-plates (figs. 4*a*, 4*b*, 4*c*). Still farther out the lower spine is reduced to a claw, with two or three points (fig. 4*d*). Near the tip of the arm there are only two or three hooks in each row.

Diameter of disk of type, 15 mm; of arm at base, 4 mm; length of arms, broken, 100+mm.

Station 16, off Havana, 200 fathoms.

This species resembles *A. loveni* in appearance. The latter has the smaller arm-spines more nearly equal, shorter and less strongly clawed; the lower one is more conical and the roughnesses are not so claw-like on the basal joints. Toward the base of the arm there may be four or five slender, tapered, nearly equal, divergent spines, but they all change to claws distally. The mouth and tooth-papillæ are fewer, smaller, and less acute.

A. locardi Kœhler,* from the eastern Atlantic, in 1710 m.

*Rev. Biol. du Nord de la France, vol. VII, p. 34, 1895.

is another similar species. It differs in having the proximal arm-spines, short, stout, obtuse, slightly bent, six or seven at the tenth joint, the length increasing gradually from the lowest to the upper ones, but showing no marked difference in length, even between the first and second.

Family, ASTROSCHEMIDÆ, nov.

Arms simple, long, slender, coiled. Disk five-lobed, with ten radial ribs; naked or granulated. Radial shields narrow, usually elongated.

Teeth large, stout, several in a vertical row. Mouth-papillæ small or wanting.

Under arm-plates small. Upper arm-plates poorly developed, often wanting, sometimes represented by two or more pieces, covered by naked skin or granulated.

Side arm-plates relatively large, covering a large part of the lower side of the arm, and usually bearing two elongated spines or tentacle-scales.

Oral and adoral plates regularly formed, but covered by cuticle.

Genital slits short, situated near the outer margin of the disk.

Mouth-frames strong, well developed, but without wing-like processes.

This family includes *Astroschema*, *Astrocreas*, and *Ophiocreas*.

ASTROSCHEMA OLIGACTES *Lütken.*

Asterias oligactes Pallas, Acad. Caes. Leop. Nova. Acta., II, p. 239, pl. VI, fig. 23.

Astroschema oligactes Lutken, Vid. Meddel., p. 16, 1856; Add. ad. Hist. Oph., Pt. II, p. 155, pl. V, fig. 3. Duj. & Hupé, Hist. Nat. Zooph. Echin., p. 297, 1862. Lyman, Ill. Cat. Mus. Comp. Zool., VIII, Pt. II, p. 62. Verrill, Trans. Conn. Acad., I, p. 341. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 278, pl. XLIV, figs. 1–5, 1882, anatomy; Bull. Mus. Comp. Zool., X, p. 280.

Ophiocreas, sp., Nutting, Narrative, p. 80.

Stations 4 and 13, of Havana, 110 to 200 fathoms, three examples; station 29, off Sand Key, 116 fathoms, one example; station 15, 200 fathoms, three examples. Taken by the Blake Exped., in many localities, in 69 to 288 fathoms.

Like the allied species, this clings to certain gorgonians that it closely imitates in form and colors.

One six-rayed specimen was taken off Havana.

ASTROSCHEMA ARENOSUM *Lyman.*

Astroschema arenosum Lyman, Bull. Mus. Comp. Zool., V, 9, p. 23, pl. III, figs. 62, 64, 1878; op. cit. X, p. 280; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, 278.

Ophicreas sp., Nutting, Narrative, p. 80.

Station 29, off Sand Key, 116 fathoms, one example; station 37, off Key West, 125 fathoms, one example. Taken by the Blake Exped., in 124 to 805 fathoms.

ASTROSCHEMA INTECTUM *Lyman.*

Astroschema intectum Lyman, Bull. Mus. Comp. Zool., V, 9, p. 235, pl. III, figs. 59–61, 1878; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 278.

Ophiocreas, sp., Nutting, Narrative, p. 80.

Station 13, off Havana, 200 fathoms, three examples. Taken by the Blake Exped., in 175 fathoms.

ASTROSCHEMA NUTTINGII, sp. nov.

PLATE VII; FIGURES 3, 3*a*.

Five long, slender, curled arms. Disk five-lobed, with ten prominent radial ridges (when dry), extending nearly to the center; its whole surface is covered with minute, rough, rounded granules, those on the ribs distinctly coarser and more crowded than the rest; those in the depressions between the ribs very minute and scattered, showing the naked skin between them; the skin is divided into small areas, which appear to cover small imbedded scales.

Upper surface of the arms without visible dorsal plates, covered with thin naked skin containing very minute granules, becoming more distinct distally. The outlines of the internal arm-plates can be seen. Near the tips of the arms small scattered granules occur.

Under side of disk and arms everywhere apparently naked, except for a few granules around the genital slits and mouth-angles, but the skin, when dry, is filled with minute rough grains, visible only when much magnified.

Mouth-papillæ five or six in a regular row, small, conical and granule-like; larger conical papillæ occur at the tip of the jaw. A pair of minute, conical, oral tentacle-scales at the outer corner of the mouth slits.

Spines or tentacle-scales on the first joint one, minute and sometimes lacking; on the second joint generally one or two, long and slender; on succeeding joints two rather long, about equal to breadth of arms, slender, tapered; the lower one is longest and largest, cylindrical, blunt, or even a little enlarged toward the end, and covered near the tip with rough spinules; on those close to the end of the arms the terminal spinules become almost claw-like. The upper spine is also roughened in the same way, but less distinctly so.

Color, in alcohol, light buff.

Diameter of disk, 7 mm; length of arms, about 50 mm.

Station 33, off Sand Key, 105 fathoms, one example; station 37, off Key West, 125 fathoms, one example.

Probably attached to gorgonians or hydroids.

OPHIOCREAS LUMBRICUS *Lyman.*

Ophiocreas lumbricus Lyman, Bull. Mus. Comp. Zool., I, 10, p. 347, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. I, figs. 19–21; Bull. Mus. Comp. Zool., V, 9, p. 236; op. cit., X, p. 281; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 284, 1882. Nutting, Narrative, Bahama Exp., p. 171, pl., fig. 1.

Station 4, off Havana, 110 fathoms, one example; stations 26, 28 and 48, off Key West, 60, 116 and 80 fathoms, four-

teen large examples; station 33, off Sand Key, 105 fathoms, four examples; station 62, off American shoal, 70 to 80 fathoms, four examples.

This and the allied species cling to gorgonian corals, which their long, slender arms imitate in form and color.

OPHIOCREAS SPINULOSUS *Lyman.*

Ophiocreas spinulosus Lyman, Bull. Mus. Comp. Zool., X, p. 281, pl. VIII, figs. 132–135, 1883; Three Cruises of the Blake, p. 109, fig. 389, 1888.

Station 28, off Sand Key, 116 fathoms, two large examples. Taken by the Blake Exped., in 116 to 288 fathoms.

Family, ASTROCHELIDÆ, nov.

Arms simple or with a few distal forks, granulated, and also annulated with raised ridges. Disk with five or ten radial ridges, its surface granulated or spinulose.

Teeth and tooth-papillæe numerous, spiniform; the latter form an apical cluster. Mouth-papillæ similar in form, sometimes lacking. The teeth may form double vertical rows. Under arm-plates rudimentary or lacking. Side arm-plates cover most of the under surface, but are hidden by cuticle and granules. They bear a short row of small rough spines or tentacle-scales; above them are double vertical rows of small plates,* forming raised ridges and bearing granules and also rows of minute glassy hooks, on the sides and top of the arms.

These sometimes extend on to the radial ridges of the disk. The genital openings are short, situated toward the margin of the disk or not close to the inner angle.

This family includes *Astrochele*, *Astrogomphus*, *Astroporpa*

*Mr. Lyman considered these the equivalent of the upper arm-plates, but to me they appear to be a continuation of the side-plates. In this case the upper plates would be represented, if present, by the rows of small plates between the ridges.

and *Astrotoma*, with simple arms, and *Astrocnida* with the arms forked near the ends.

ASTROGOMPHUS VALLATUS *Lyman.*

Astrogomphus vallatus Lyman, Bull. Mus. Comp. Zool., I, 10, p. 350, 1869; [Ill. Cat. Mus. Comp. Zool., VI, pl. I, figs. 16–18; Bull. Mus. Comp Zool., V, 9, p. 236; op. cit. X, p. 229, 279; Lyman, Report Voy, Challenger, Zool., Ophiuroidea, V, p. 271, pl. XLIV, figs. 10–12, 1882, anatomy. Nutting, Narrative, p. 171, pl., figs. 2, 2*a*.

The larger specimens usually have five arm-spines on the proximal part of the arm, but sometimes only four, or five and four irregularly alternating. A very large one has six spines on some of the basal joints, the extra one being external to the others and smaller. The spiniform single tentacle-scale of the first joint is often wanting on some of the arms. The second joint usually has four spines (or tentacle-scales), in form like those of the following joints. The disk has a definite marginal row of rough spinules; the interbrachial spaces and most of the oral region appear smooth in alcohol, but when partly dried have a fine tesselated appearance; when quite dry these parts are covered with a close mosaic of larger and smaller mostly flat granules, the larger ones being somewhat conical. The cluster of spinules in the interradial angles is pretty clearly circumscribed, but one spinule often stands a little apart and more towards the mouth-angle. The madreporic shield is small, roundish, and just outside one of the groups of interradial spinules.

Stations 28 and 29, off Sand Key, 116 fathoms, 40 examples; station 56, Pourtales Plateau, 200 fathoms, four examples; station 64, off American Shoal, 110 fathoms, four examples; station 62, 70 to 80 fathoms, two examples.

It was taken by the "Blake" in many localities throughout the West Indian region, in 88 to 337 fathoms.

It is found clinging to branches of *Gorgonella* and other gorgonian corals, which it imitates closely in colors.

One large specimen from Station 56 has repaired extensive

mutilations, having lost about one-third of the disk and two entire arms. The new arms are about one-half grown and are perfectly formed. The new section of the disk is not full grown and has a thinner skin, fewer and smaller spinules and granules, and smaller and somewhat more irregular radial ribs than the others.

A young specimen from Station 62, with the disk 7.5 mm. in diameter, agrees pretty closely with the larger ones in the armature of the disk and arms, but on the disk the larger granules are mostly short, conical, or obtuse; only a few of them are acutely conical; the smaller ones are rounded grains; on the arms the bands of granules are a little less numerous than on the adult. There are four or five sharp, conical mouth-papillæ, the outer one small. The granules of the lower and lateral surfaces are angular and flat, forming a smooth mosaic; a single row of small conical spinules runs from the base of one arm to another on the lower side, and at the upper margin of the interbrachial region there is a less regular row of conical grains, so that the sides of the body, between the arms, has a rigid, angular appearance. The smooth granulation of the lower side of the disk extends directly out on the lower side of the arms, concealing the plates. The spines or tentacle-scales are mostly in threes, short, nearly equal, oblong, thorny at the tips.

Still younger specimens, from 2 to 3 mm. in diameter of disk, from stations 13, 35 and 62, are quite different in appearance. In these the radial shields are *naked*, elevated, and oblong-ovate, parallel, separated by one to three rows of small, round granules; a radial row of three to five similar granules extends out from the center in each interradial area; the central area shows a central and five larger, obtuse-conical, primary, radial granules and five primary interradials, with many crowded smaller granules; two small round granules are situated on the outer end of each radial shield. The granules of the upper side of the arm are small, round, and prominent; about three rows alternate with the more ele-

vated rows corresponding to the lateral spines; part of the granules of the latter bear relatively large, claw-shaped hooks with a terminal, strongly incurved claw and two or three swollen secondary denticles on its inner edge. The lateral spines are mostly three, small, short, rough or thorny at the tip. Mouth-papillæ four or five, small, rough, mostly acute, the outer one larger and obtuse.

ASTROGOMPHUS RUDIS *Verrill*, sp. nov.

PLATE VII; FIFURES 1, 1*a*.

This species differs from *A. vallatus* in having the radial ribs wider and less raised, and the disk-spinules more numerous, shorter, and much more thorny, and not forming a definite marginal row; in having smaller, though similar, spinules on the whole under surface of the disk, up to the mouth-slits, not forming definite interradial groups, but having small granules between them; in having more numerous and smaller mouth-papillæ and tooth-papillæ; in having wider, closer, and more even, raised, granulated bands on the arms, with much narrower sunken intervals; and in having shorter, stouter, and much more thorny tentacle-scales or spines, usually five in a group. The minute hooks on the bands of the arms are very numerous.

Station 56, Pourtales' Plateau, 200 fathoms, one example; station 28, off Sand Key, in 116 fathoms, one example.

ASTROPORPA ANNULATA *Œrst. & Lütken.*

Astroporpa annulata Œrst. & Lutken, Vid. Meddel., p. 17, 1856; Add. ad. Hist. Oph., Pt. 11, p. 152, pl. V, fig. 4. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 270, 1882; Bull. Mus. Comp. Zool., X, p. 279, 1883. Verrill, Rep. U. S. Fish Comm., for 1883, p. 552, 579, 1885.

Astroporpa dasycladia Duj. & Hupe, Hist. Nat. Zooph. Echin., p. 298, 1862.

Sigsbeia, sp., Nutting, Narrative, p. 79.

Station 2. off Havana, 110 fathoms.

This curious species is found throughout the West Indies, in 50 to 163 fathoms. Off Cape Hatteras, 48 to 68 fathoms, on *Titanideum suberosum*, etc., U. S. Fish Comm. Off Barbados, on *Gorgonella*, Yale Museum.

This species clings to several species of gorgonians, which it closely imitates by its colors and by the form and ornamentation of the arms and disk.

ASTROCNIDA ISIDIS *Lym.*

Trichaster isidis Duchassaing, Animaux Radiaires des Antilles, 1850.

Astrocnida isidis Lyman, Ann. Sci. Nat., p. I, 1872; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 270, pl. XLVI, fig. 2, 1882, anatomy; Bull. Mus. Comp. Zool., X, p. 279, 1883; Three Cruises of the Blake, vol. II, p. 115, fig. 400, 1888.

Two young specimens are in the collection, labeled as from Station 69, off Cat Island, in 3 to 13 fathoms. But it is probable that this is an error, for it is known only from rather deep water (56 to 120 fathoms, Blake Exped).

This species clings to several species of *Gorgonella* and other gorgonian corals, which it closely imitates in color. Its arms also resemble the branches in form and roughnesses.

Off Barbados, on *Gorgonella*, Yale Museum.

Family, GORGONOCEPHALIDÆ Ljung. (restr).

Gorgonocephalinæ (pars) Ljung., 1867. Bell, 1892.

Arms divided dicbotomously into numerous branches. Disk swollen, with ten prominent radial ribs, covered with cuticle, which may bear granules or scattered spinules, or it may be more or less naked. Radial shields, each composed of several united plates. Teeth and tooth-papillæ numerous, spiniform. Mouth-papillæ when present, small, conical or papilliform. Adoral shields well-developed, but usually concealed by cuticle, sometimes broken into several plates. Oral shields rudimentary or wanting. Sometimes there are five small, madreporic plates, but usually only one. Under arm-plates mostly rudimentary, consisting of two or more small pieces,

sometimes absent. Side arm-plates are united below, and cover most of the under side of the arms. They bear a row of few, small, rough spines or spiniform tentacle-scales, which are usually hook-like distally. Two or more rows of small plates run up from each of the side plates and form transverse ridges around the arms, covered with granules; these usually bear rows of small glassy hooks. The dorsal arm-plates are rudimentary or wanting. The entire surface of the arms and disk above and below is covered with cuticle which is usually granulated, so that the plates are hidden.

ASTROPHYTON MURICATUM (*Lam.*) *Agassiz.*

Astrophyton costosum Seba, (*non* Linck), III, pl. IX, fig. 1, p. 16, 1758 (not binomial).

Euryale muricatum Lamarck, Hist. Anim. s. Vert., II, p. 538, 1816.

Astrophyton muricatum L. Agassiz, Mem. Sci. Nat. Neuchatel, I, p. 12, 1835. Mull. & Trosch., Syst. Ast., p. 122. Lütken, Add. ad Hist. Oph., Pt. II, p. 156. Verrill, Notes on Radiata, Trans. Conn. Acad., I. p. 341, 1868.

Astrophyton costosum Lyman, Proc. Boston Soc. Nat. Hist., XIX, pl. 4; Illus. Catal. Mus. Comp. Zool., I, p. 192, 1865; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 257, pl. XXXV, figs. 17–25, 1882. Nutting, Narrative Bahama Exp., p. 172.

The color is light chocolate brown, with irregular blotches of darker brown on the disk. The stout stumps on the radial ribs are variable. In some cases they are crowded, short, blunt, wart-like, and do not extend on the arms. In one example, from the Bahama Banks, each radial rib bears five or six, mostly in one row, and they are sharp and conical, while ten or twelve smaller conical spines extend along the proximal part of each arm.

A young specimen (disk 8 mm. in diameter) has but one or two stout spines on each rib; these are blunt, and in some cases two unequal spines are joined at base, as if the smaller were budding from the base of the larger; the spines are white and conspicuous against the chocolate ground-color. From four to eight smaller, blunt, white, dorsal spines occur irregularly on each arm. The outer ones, situated between

the second and third forks, become small and granule-like. Groups of small, roundish, white spots, surrounded by a circle of dark brown, occur on the radial areas of the disk. The arms are banded with brown and yellowish white, the latter becoming prominent.

It is useless to go back to polynomial writers, like Seba, for binomial names, as Lyman did for this species.

Station 68, off Little Cat I., 3 to 13 fathoms, one example; Tortugas, on anchor, 8 fathoms, one large example; Bahama Bank, one example.

This species has been taken from off Charleston, S. C., and the Florida Keys to St. Croix. It usually clings to gorgonians, having corresponding colors.

ASTROPHYTON CÆCILIA *Lütken.*

Astrophyton cæcilia Lütken, Vid. Meddel., p. 18, Jan., 1856; Add. ad Hist. Oph., Pt. II, p. 157, pl. V, fig. 6. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 258, 1882; Bull. Mus. Comp. Zool., X, p. 279, 1883; Three Cruises of the Blake, vol. II, p. 110, fig. 388, 1888.

Astrophyton krebsii Lütk., Vid. Meddel., p. 18, 1856; Add. ad Hist. Oph., Pt. II, p. 158, 1859.

Station 69, off Little Cat I., 3 to 13 fathoms, 1 young.

Not uncommon in the West Indies, in 50 to 124 fathoms, adhering to gorgonians. St. Croix, on a gorgonian (*Thesea*); off Barbados, on *Gorgonella*; and off Havana, Yale Museum.

GORGONOCEPHALUS MUCRONATUS *Lyman.*

Astrophyton mucronatum Lyman, Bull. Mus. Comp. Zool., I, 10, p. 348, 1869. Nutting, Narrative, p. 172.

Gorgoncephalus mucronatus Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 265, 1882; Bull. Mus. Comp. Zool., X, p. 279.

The color, in life, according to Prof. Nutting, is light buffy yellow, with transverse bars of brown on the arms.

The largest specimen, sent to me, from station 33, is 48 mm. in diameter of disk. The color of each, in alcohol, is pale

yellow, with small and not very distinct spots of light brown on the disk, and a double row of the same colored spots along the upper side of the arms. There is considerable variation in the number and form of the large disk-spines. The larger specimens have from twelve to sixteen stout, conical spines on each radial rib, in two irregular rows, but in some cases these are regularly conical, in others sharply acuminate. The spines of the central group are even more variable. In most cases part of them are regularly conical, and part are blunt or rounded at summit, while others may be acuminate. In one example a considerable number of similar spines are present in the interradial spaces of the disk, and some even between the adjacent ribs. In some specimens these parts are naked; in others, granulated with scattered round-topped grains. The large dorsal spines of the arms are also variable in number and form, but are similar to those of the disk, but smaller and usually less acute; between them there are coarse round-topped granules, variable in size. The larger specimens have three tentacle-scales at the base of the arms; the smaller, two.

Station 48, off Key West, 80 fathoms, 1 young; station 62, off American Shoal, 80 fathoms, 1 young. Prof. Nutting refers to it as "common" below 100 fathoms, but only two specimens were sent to me.

It was taken by the Blake Exp., off Florida, in 120 to 125 fathoms, and amongst the West Indies, in 218 to 288 fathoms.

This species clings to gorgonians, of several kinds, which it imitates in form of arms and color.

ERRATA.

Page 7, line 11, for FIGURE 4, read FIGURE 3.

Page 9, line 13, omit Figures 3, 4.

Page 11, line 26, for varietel, read varietal.

Page 13, line 16, for 3*e*, read 3*c*.

Explanation of Plate I.

The figures were drawn from nature by A. H. Verrill.

Fig. 1. *Ophioplus tuberculosus* (Lym.) Ver. Dorsal surface. × 8.

Fig. 1*a*. The same. Side view of several joints from the middle portion of an arm. × 8.

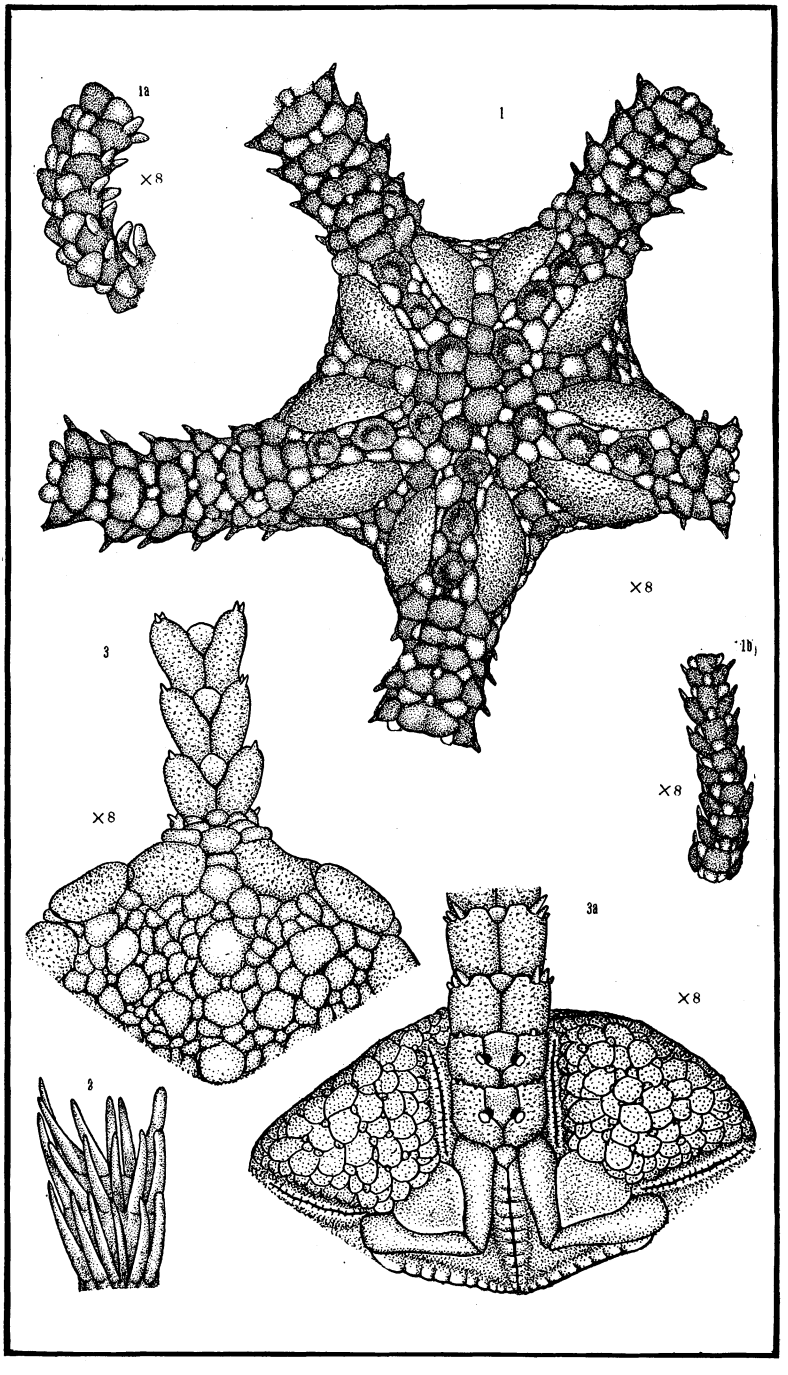
Fig. 1*b*. The same. Distal part of an arm, dorsal view. × 8.

Fig. 2. *Ophiacantha* (*Ophialcæa*) *nuttingii* Ver. Side view of a portion of an arm, near the base, showing three rows of spines.

Fig. 3. *Ophiomusium stellatum* Ver. Dorsal view of a part of the disk and base of an arm. × 8.

Fig. 3*a*. The same specimen. Ventral view. × 8.

Plate I.



Explanation of Plate II.

Fig. 1. *Sigsbeia murrhina* Lym. Dorsal side of a young specimen, from station 73. × 10.

Fig. 1*a*. The same. Ventral side of a part of the disk and bases of two arms. × 10.

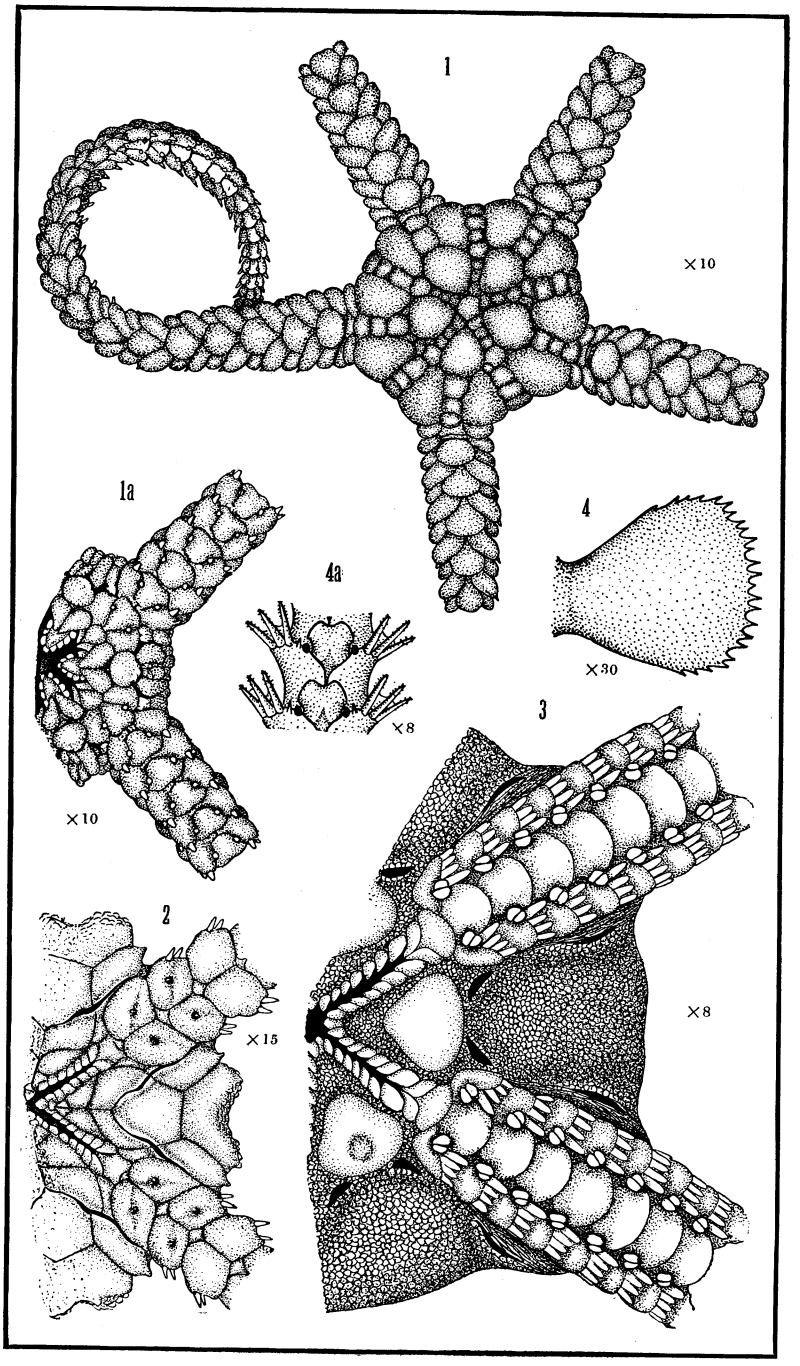
Fig. 2. *Ophiomusium sculptum* Ver. Oral side of part of the disk, and bases of two arms. × 15.

Fig. 3. *Ophiura pallida* Ver. Oral side of part of the disk and bases of two arms. × 8.

Fig. 4. *Ophiodera stimpsoni* Ver. One of the lower teeth. × 30.

Fig. 4*a*. The same specimen. Two arm-joints from near the base of the arm, ventral view. × 8.

PLATE II.



Explanation of Plate III.

Fig. 1. *Ophiomusium eburneum* Lym., var. *elegans* Ver. Dorsal side of part of disk and bases of two arms. × 6.

Fig. 1*a*. The same. Ventral side of a part of the disk and the bases of two arms. × 8.

Fig. 2. *Ophiozona nivea*, var. *compta* Ver. Ventral side of a part of the disk and of two arms. × 8.

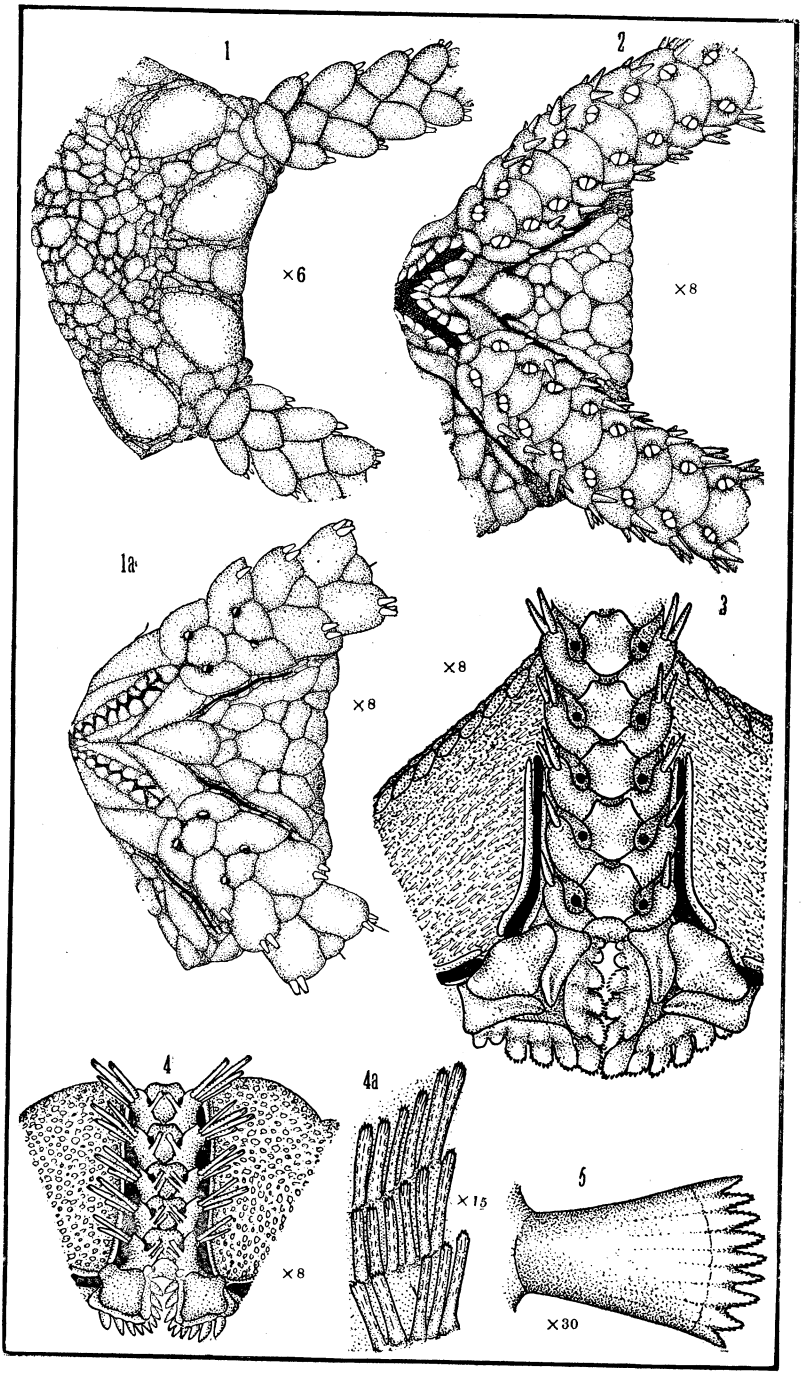
Fig. 3. *Ophiomyxa brevicauda* Ver. Ventral side of a part of the disk and bases of two arms. × 8.

Fig. 4. *Amphipsila maculata* Ver. Ventral side of disk and base of an arm. × 8.

Fig. 4*a*. The same specimen. Side view of three rows of arm-spines from the middle of an arm. × 15.

Fig. 5. *Ophiomyxa tumida* Lym. A lower tooth. × 30.

PLATE III.



Explanation of Plate IV.

Fig. 1. *Ophiopristis ensifera* Ver. Dorsal side of a part of the disk and the base of one arm. × 10.

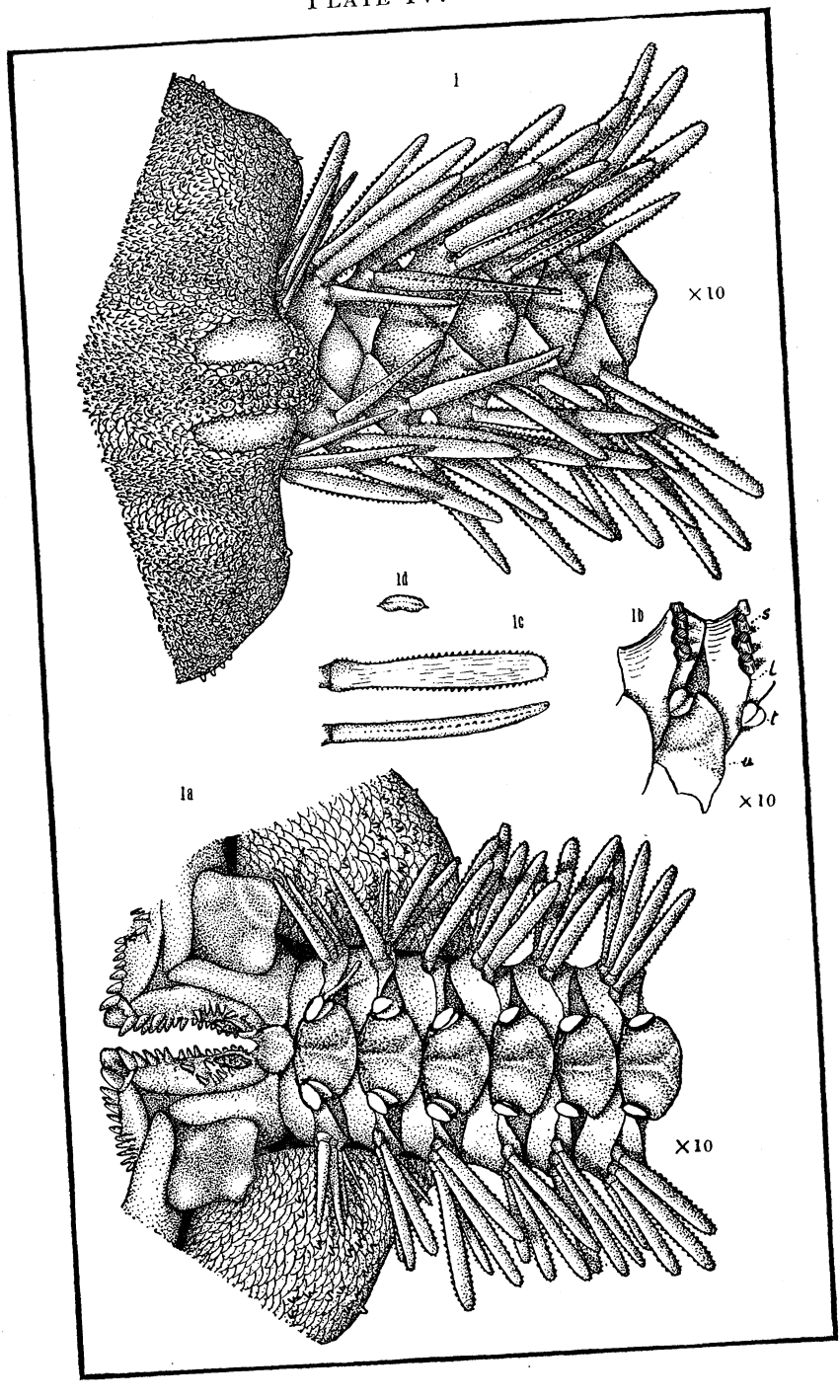
Fig. 1*a*. The same specimen. Oral side. × 10.

Fig. 1*b*. The same. Under side of portion of an arm, near the base, with the spines removed; *u*. under arm-plate; *l*. side arm-plate; *s*. bases of spines; *t*. tentacle-scales. Much enlarged.

Fig. 1*c*. The same. Side and profile view of one of the lower spines; enlarged about 15 diameters.

Fig. 1*d*. The same spine; end view.

PLATE IV.

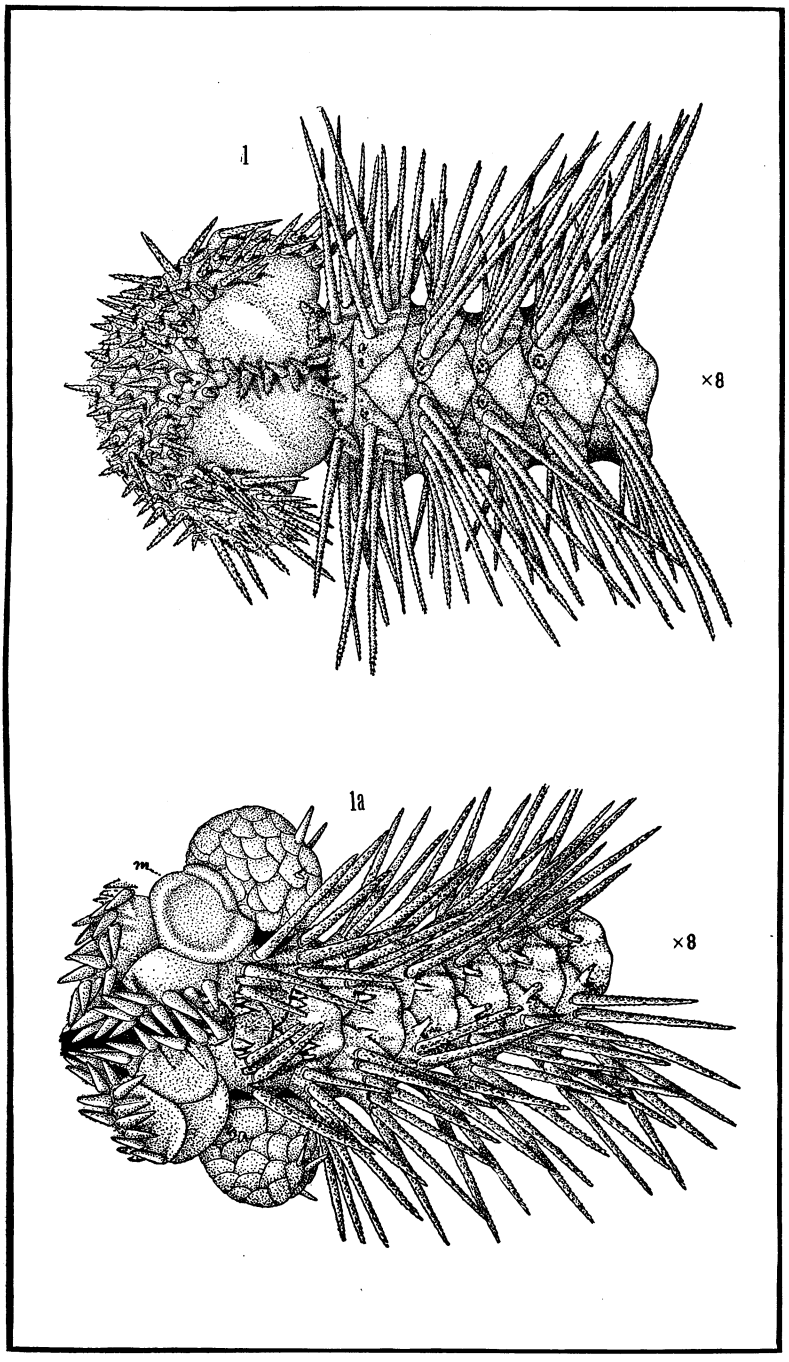


Explanation of Plate V.

Fig. 1. *Ophiomitra ornata* Ver. Dorsal view of part of the disk and the basal joints of an arm. × 8.

Fig. 1*a*. The same specimen. Ventral view; *m*. madreporic plate. × 8.

PLATE V.

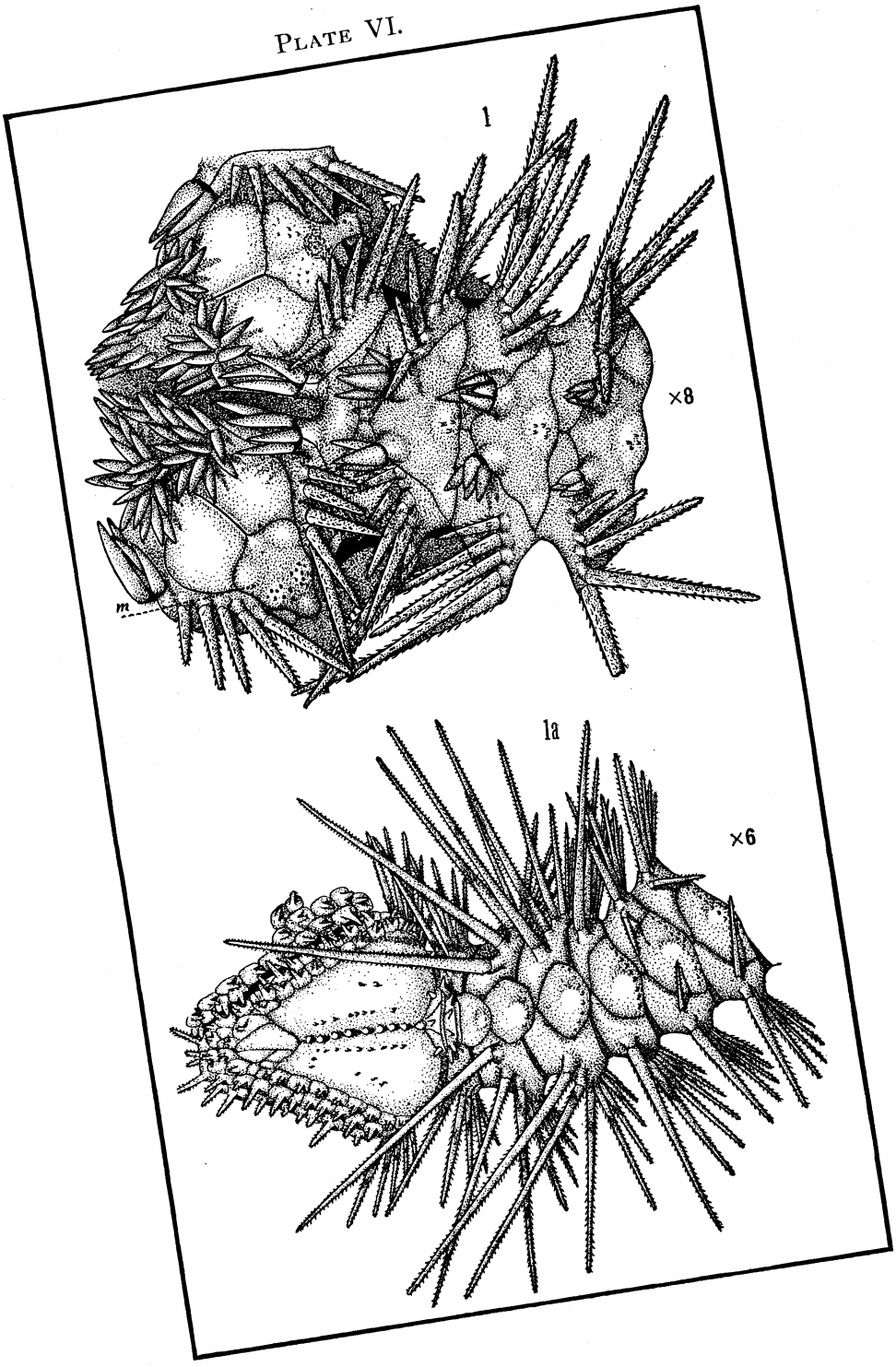


Explanation of Plate VI.

Fig. 1. *Ophiocamax austera* Ver. Ventral view of a part of the disk and base of an arm; *m*. madreporic plate. × 8.

Fig. 1*a*. The same specimen. Dorsal view of a small part of the disk, including two radial shields, and the basal part of an arm. × 6.

PLATE VI.



Explanation of Plate VII.

Fig. 1. *Astrogomphus rudis* Ver. Ventral side of the disk and the bases of two arms. × 8.

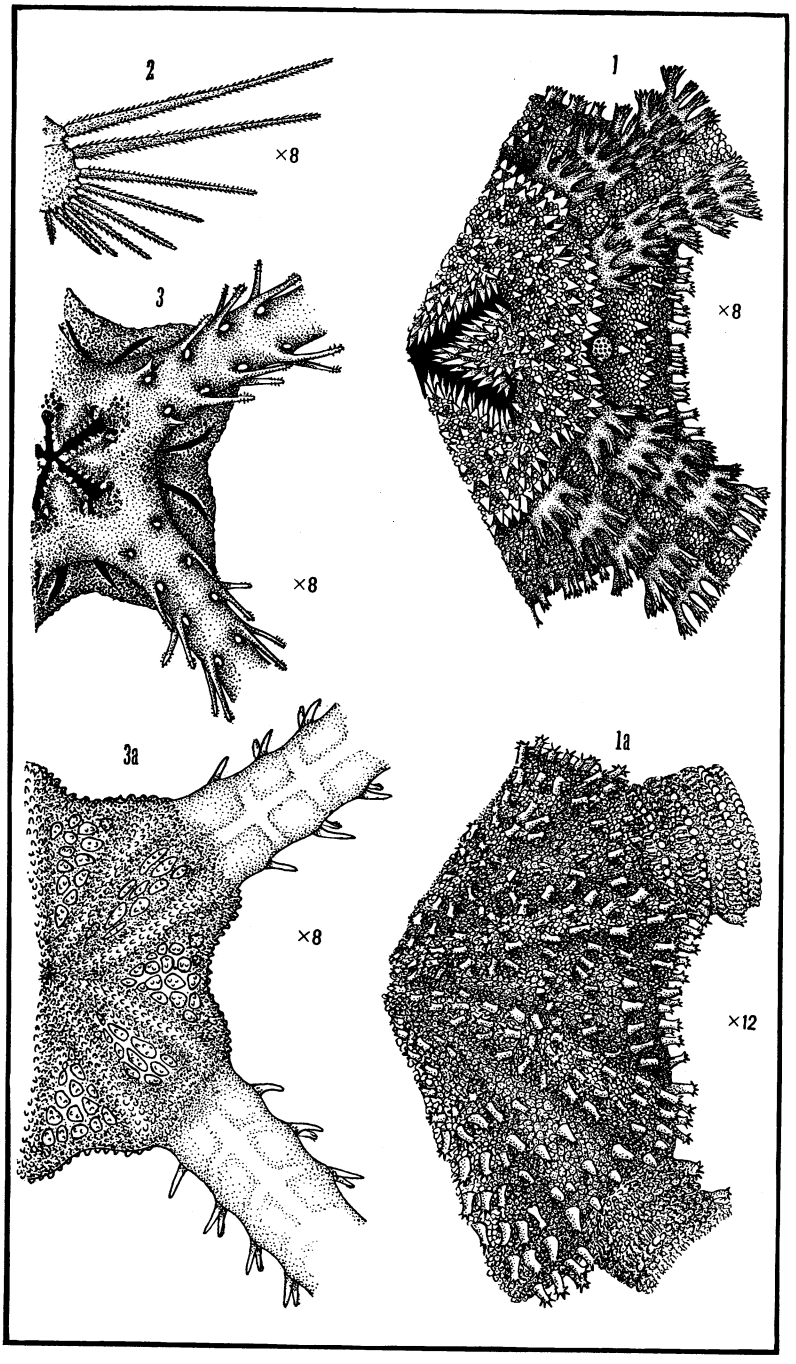
Fig. 1*a*. The same specimen. Dorsal side. × 12.

Fig. 2. *Ophiocamax austera* Ver. Profile view of a row of spines from near the base of an arm. × 8. The upper spines are more divergent than represented in the figure.

Fig. 3. *Astroschema nuttingii* Ver. Ventral side of the disk and the bases of two arms. × 8.

Fig. 3*a*. The same specimen. Dorsal side. × 12.

PLATE VII.



Explanation of Plate VIII.

Fig. 1. *Ophiacantha* (*Ophialcæa*) *nuttingii* Ver. Ventral side of a part of the disk and the base of an arm. × 8.

Fig. 1*a*. The same specimen. Dorsal side. × 8.

Fig. 2. *Ophiomusium sculptum* Ver. Dorsal side of a part of the disk and the bases of two arms. × 8.

Fig. 3. *Ophiactis dispar* Ver. Dorsal view of a portion of an arm, near the base. × 15.

Fig. 3*a*. The same specimen. Ventral side. × 15.

Fig. 3*b*, 3*c*. The same specimen. Profile views of two more distal rows of spines. × 15.

Fig. 4, 4*a*. *Astronyx lymani*, Ventral and side views of three joints from the proximal part of an arm. × 15.

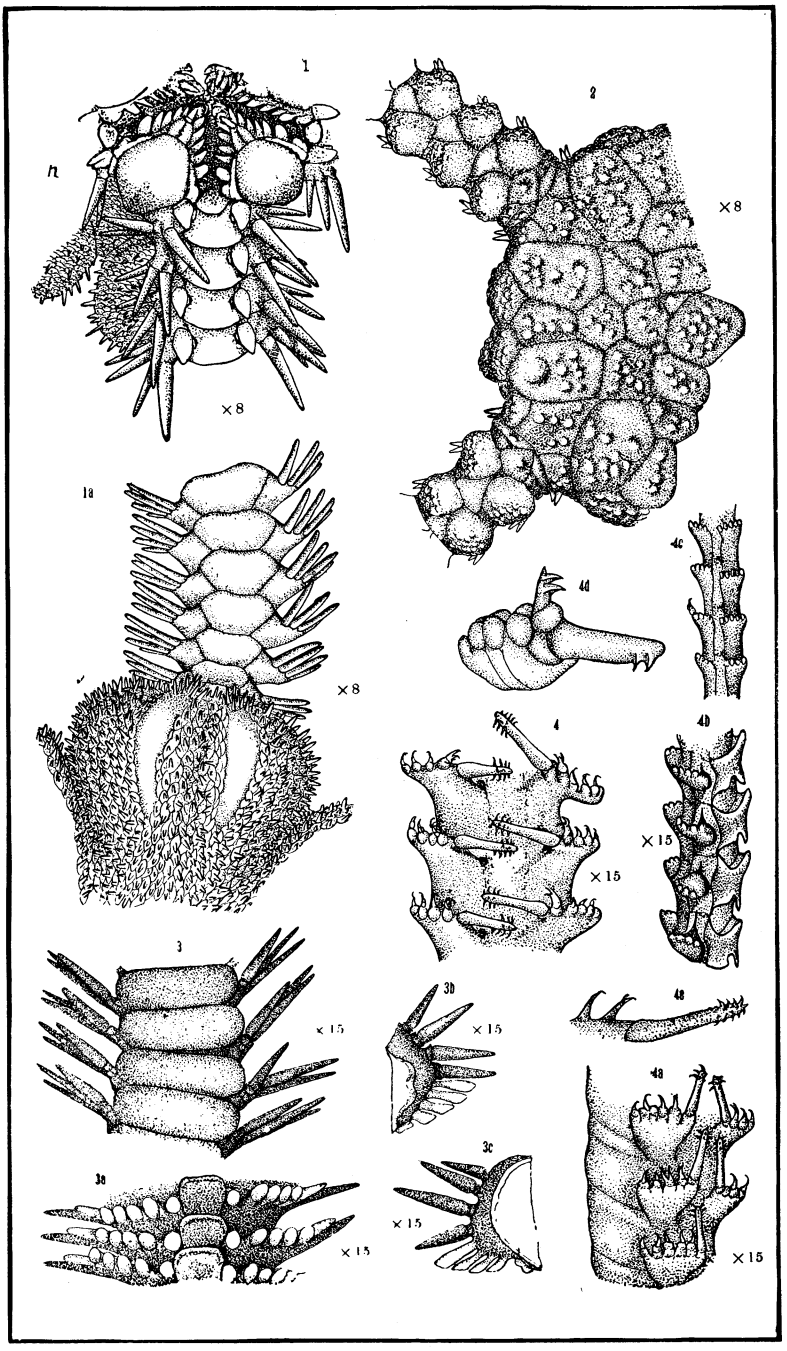
Fig. 4*b*. The same. Nearly side view of some of the more distal joints, after treatment with potash, to show the plates. The spines and hooks are removed. × 15.

Fig. 4*c*. The same. Side view of some of the joints near the end of the arm. Most of the hooks have fallen off. × 15.

Fig. 4*d*. The same. Two ventral hooks, from the middle of the arms. The smaller hooks have fallen off. Much enlarged.

Fig. 4*e*. The same. A spine and two small hooks from the proximal part of the arm. × 30.

Plate VIII.



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VOL. V. No. 2.

BULLETIN

FROM THE

LABORATORIES OF NATURAL HISTORY

OF THE

STATE UNIVERSITY OF IOWA.

THE RANUNCULACEÆ OF IOWA, . . . T. J. FITZPATRICK.
PYRAMIDULA SHIMEKII (*PILS.*) *SHIM.*, . . . B. SHIMEK.
IOWA PTERIDOPHYTA, ... B. SHIMEK.
DESCRIPTIONS OF AMERICAN UREDINEÆ, III, . . J. C. ARTHUR AND E. W. D. HOLWAY.
LOESS OF IOWA CITY AND VICINITY, . . B. SHIMEK.
IOWA PTERIDOPHYTA (*Continued*), . . . B. SHIMEK.
ADDENDA TO THE FLORA OF LYON COUNTY, IOWA, ... B. SHIMEK.

PUBLISHED

BY AUTHORITY OF THE REGENTS.

IOWA CITY, IOWA

MAY, 1901.

THE UNIVERSITY BULLETINS PUBLISHED BY THE UNIVERSITY ARE ISSUED EVERY SIX WEEKS DURING THE ACADEMIC YEAR, AT LEAST SIX NUMBERS EVERY CALENDAR YEAR. ENTERED AT THE POST OFFICE AT IOWA CITY, IOWA, AS SECOND CLASS MAIL MATTER.

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IOWA CITY, IOWA:
MAY, 1901.

Secretary WM. J. HADDOCK:

I take pleasure in submitting herewith Bulletin No. 2, of Volume V, from the Laboratories of Natural History, of the State University of Iowa.

T. H. MACBRIDE, *Editor.*

May, 1901.

EDITORIAL STAFF.

GEOLOGY, ...	S. CALVIN.
BOTANY, ...	T. H. MACBRIDE.
ZOOLOGY, ...	C. C. NUTTING.

THE RANUNCULACEAE OF IOWA.

BY T. J. AND M. F. L. FITZPATRICK.

RANUNCULACEAE Juss. Gen. 231. 1789.

THE CROWFOOT FAMILY.

This rather diverse family comprises about 35 genera and 1050 species. The family is universally distributed but reaches its greatest development in the temperate and cold regions of the northern hemisphere, more frequent in Europe than in Asia or America. Mr. Heller in his catalogue of North American plants, first edition, enumerates 32 genera and 314 species and varieties; in the second edition he enumerates 31 genera and 373 species and varieties. Dr. Watson gives 22 genera and 76 species as occurring within the limits covered by Gray's Manual. Britton and Brown in their illustrated Flora recognize 28 genera and 94 species and 7 varieties. We credit Iowa with 37 species and a probability of two or three more, distributed through 17 genera.

HISTORICAL.

Dr. C. C. Parry in his Catalogue of the Plants of Wisconsin and Minnesota, made in connection with the geological survey of the Northwest during the season of 1848 and published in 1852 as an appendix to Owen's Geological Survey of Wisconsin, Iowa, and Minnesota, incidentally enumerates the following species of *Ranunculaceae* as occurring in Iowa: "*Clematis viorna* L. Banks of the Mississippi river near Davenport." We however consider this a spurious Iowa species and that *C. pitcheri* T. & G. was intended; *C. simsii* Sweet. "*Anemone caroliniana*

Walt. Mississippi river bank, Davenport and Rock Island. *Anemone virginiana* L. Woods of Iowa. *Delphinium azureum* Mx. A characteristic larkspur, growing on sandy ridges or high prairies, Iowa and Illinois. *Actaea rubra* Willd. Woods and copses, Iowa. *Actaea alba* Bigelow. With the preceding." A total of six species of which five are readily confirmed. As the home of Dr. Parry was in Davenport we have referred for various reasons all his Iowa species to Scott county.

Prof. Bessey in his Contributions to the Flora of Iowa published in the Fourth Biennial report of the Iowa Agricultural College, 1872, pp. 90 and 91, gives a list of 31 crowfoots. Prof. Bessey used the nomenclature of the 5th edition of Gray's Manual. The list is quite long for the time when made, Iowa botany being then in its infancy. The list was made from personal work and expanded by contributed lists by Prof. Carpenter of Indianola, Prof. McLain of Fayette, Prof. Parker of Grinnell, and Rev. Isaiah Reid of Nevada who had collected plants around Burlington, Iowa. No doubt some mistakes were made by the use of this method as would naturally be the case. *Clematis viorna* L. is given but it is probable that *C. pitcheri* T. & G. is the species considered. *Anemone multifida* DC. is probably a blunder. *Hepatica triloba* Chaix is said to occur at Fayette and Burlington. It seems not to have been found at Fayette by subsequent botanists and its occurrence at Burlington was probably on the Illinois side of the river. *Thalictrum cornuti* L. (*T. polygamum* L.) while it has been reported by others is doubtless a mistake. *Delphinium exaltatum* Ait. is said to occur at Grinnell but no doubt an error was made and that some form of *D. azureum* Mx. was examined. All other species mentioned have been confirmed.

Prof. Arthur in his Contributions to the Flora of Iowa, a catalogue of Phenogamous plants published in 1876 by the Iowa Centennial Commission, lists 38 species of the family.

The list has three species of the genus Clematis, the two given by Bessey and *C. pitcheri* T. & G. Among the Anemones, *A. multifida* DC. is omitted and *A. cylindrica* Gray, a species overlooked by Bessey, is given. The two Hepaticas and four Thalictrums given by Bessey are included. Of the genus *Ranunculus* there appear the same species as in Bessey's list with the addition of *R. recurvatus* Poir., giving the locality Davenport, and *R. aquatilis* L. var. *stagnalis* DC., which variety is further mentioned in the appendix, p. 37. *Myosurus minimus* L. and *Hydrastis canadensis* L. are for the first time mentioned in Iowa literature, the locality for the former is given as Davenport and for the latter, Lee county. *Isopyrum biternatum* T. & G., *Caltha palustris* L., and *Aquilegia canadensis* L. are mentioned. The three Delphiniums, *D. azureum* Mx., *D. tricorne* Mx., and *D. exaltatum* Ait. are given, the locality mentioned for the last is Davenport, probably an error in determination. *Actaea spicata* L. var. *rubra* Mx. appears for the first time in Iowa literature.

Messrs. Nagel and Haupt published their annotated list of Phenogamous plants collected in the vicinity of Davenport, Iowa, during the years 1870 to 1875 inclusive in volume one of the Proceedings of the Davenport Academy of Natural Sciences. Advanced sheets were used by Prof. Arthur in the compilation of his Centennial catalogue. Messrs. Nagel and Haupt enumerate 23 species belonging to the crowfoot family and follow the nomenclature of the 5th edition of Gray's Manual.

Prof. Halsted in Bulletin of the Iowa Agricultural College, November, 1886, p. 6, mentions nine of the *Ranunculaceae* as occurring at Ames and studied by his class. On page 37 of the same bulletin is an article on pistillate flowers in Hepatica, and on pages 43 and 44 under the heading, "Observations upon weeds and useless plants," giving observations with a list of species studied, *Caltha palustris* L. is included. On pages 48 to 52 is a list of

species giving time of first blooming in which several of the crowfoot family are included. In the next bulletin from the Agricultural College Prof. Halsted gives a preliminary list of Iowa weeds, pages 36 to 47 in which nine species of the *Ranunculaceae* are included. They are *Anemone dichotoma* L. [*A. pennsylvanica* L., *A. canadensis* L.], *Thalictrum dioicum* L., *T. polygamum* Muhl. [a continued error], *T. purpurascens* L., *Ranunculus abortivus* L., *R. repens* L., *R. bulbosus* L., *R. acris* L., and *Delphinium azureum* Mx.

From a weed standpoint none of these are of much importance. *Ranunculus abortivus* L. is common but inoffensive. *R. repens* L., *R. bulbosus* L., and *R. acris* L. are of such infrequent occurrence as not to be noticed except by a botanist. *Delphinium azureum* Mx. would be better placed among our ornamental species.

The first five editions of Gray's Manual do not include our limits but the sixth edition published in 1890 does. However only three species of the crowfoot family are directly referred to Iowa. They are: *Ranunculus circinatus* Sibth., *Coptis trifolia* (L.) Salisb., and *R. affinis* R. Br. The former species has been observed a number of times by Iowa collectors but the latter two seem entirely to have escaped the vigilance of all. No Iowa list mentions them and our long search fails to find them.

Prof. Hitchcock published his catalogue of the *Anthophyta* and *Pteridophyta* of Ames, Iowa in the fifth volume of the Transactions of the St. Louis Academy of Science, the same having been read Oct. 20, 1890. The nomenclature used is a modification of Gray's Manual, 6th edition, the intention being to adhere to the law of priority. Twenty-four species are enumerated and commented upon. All these species still belong to the flora of Iowa and no errors seem to have been made in identification.

Prof. Pammel in Proceedings of Iowa Academy of

Sciences for 1895, volume 3, enumerates 14 species in his article, "Notes on the Flora of Western Iowa." In his notes on some introduced plants of Iowa in volume 6, Proceedings of the Iowa Academy of Sciences, p. 111, he mentions *Ranunculus acris* L. and *Delphinium consolida* L.

Prof. Shimek in Bulletin Laboratories of Natural History, S. U. I., volume 3, pp. 199-200, 1896, publishes new localities for *Clematis pitcheri* T. & G., *Anemone caroliniana* Walt., *Ranunculus multifidus* Pursh, *R. recurvatus* Poir., *R. septentrionalis* Poir., *R. repens* L., *Delphinium azureum* Mx., *D. tricorne* Mx., and *Isopyrum biternatum* T. & G. He also in his Flora of Lyon county published in 1900 in volume 10 of the Iowa Geological Survey enumerates several species as is noted farther on under their respective names.

Prof. Fink in his annotated *Spermaphyta* of the Flora of Fayette, Iowa, published in volume 4, Proceedings of the Iowa Academy of Sciences, lists 26 species. He notes *Clematis virginiana* L., five Anemones, *A. patens* L. var. *nuttalliana* Gray, *A. caroliniana* Walt., *A. cylindrica* Gray, *A. pennsylvanica* L., and *A. nemorosa* L., *Hepatica acutiloba* DC., given as common in woods and with the note that *H. triloba* Chaix is frequently reported but does not occur, *Anemonella thalictroides* Spach, *Thalictrum dioicum* L., *T. purpurascens* L., *Ranunculus circinatus* Sibth., *R. aquatilis* L. var. *trichophyllus* Gray, *R. multifidus* Pursh, *R. rhomboideus* Goldie, *R. abortivus* L., *R. fascicularis* Muhl., *R. septentrionalis* Poir., *R. hispidus* Hook. which is reported for the first time from Iowa with the note that it has probably been confused with *R. repens* L. or *R. pennsylvanicus* L. f., *Isopyrum biternatum* T. & G., *Caltha palustris* L., *Aquilegia canadensis* L., *Delphinium exaltatum* Ait. [probably an error], *D. ajacis* L., new to Iowa, *Actaea spicata* L. var. *rubra* Ait., *A. alba* Bigelow, and *Hydrastis canadensis* L.

T. J. and M. F. L. Fitzpatrick published in the Pro-

ceedings of the Iowa Academy of Sciences for 1897, volume 5, under the heading: "Notes on the Flora of Northeastern Iowa, a list of 22 species. There are listed one Clematis, five Anemones, one Hepatica, one Rue-Anemone, two Thalictrums, six of the genus Ranunculus, Isopyrum, the wild Columbine, two Actaeas, and *Hydrastis canadensis* L. In the same volume under title, "Flora of Southern Iowa," 25 species are listed. In volume six, 1898, under title, "Flora of Southern Iowa, II," there are listed ten species. The Manual of Flowering Plants of Iowa issued in 1899 and 1900 contains descriptions of and references for all forms known with certainty to occur within our limits at that time.

G. B. Rigg in his Notes on the Flora of Calhoun county, Iowa, privately published in 1896, lists the following: *Anemone patens* L. var. *nuttalliana* Gray, *A. cylindrica* Gray, *A. pennsylvanica* L., *Thalictrum purpurascens* L., *Ranunculus rhomboideus* Goldie, *R. abortivus* L., *R. sceleratus* L., *R. septentrionalis* Poir., *Isopyrum biternatum* T. & G., *Aquilegia canadensis* L., and *Delphinium exaltatum* Ait. which he says is a tall graceful plant of the fields. His specimen sent to the State University herbarium labeled *D. exaltatum* Ait. is *D. azureum* Mx. (*D. carolinianum* Walt.)

Messrs. Barnes, Reppert and Miller in their Flora of Scott and Muscatine counties published in the 8th volume of the Proceedings of the Davenport Academy of Natural Sciences, 1900, enumerate 27 species, all of which save two have been communicated to our herbarium by Mr. Reppert.

Britton and Brown in their Illustrated Flora refer only four species directly to Iowa. They are: *Caltha palustris* L., *Hepatica hepatica* (L.) Karst., *H. acuta* (Pursh) Britton, and *Ranunculus macounii* Britton. The second species is perhaps included as the result of an old continued error.

The above include the principal titles of works referring

to Iowa *Ranunculaceae*. Many works and journals contain notes on Iowa species the most important and accessible being quoted in the text.

AN ECOLOGICAL STUDY OF OUR SPECIES.

The following lists divide our species with reference to their environment rather loosely into four classes.

(*a*). Aquatic or hydrophytic plants.

Batrachium trichophyllum (Chaix) Bossch.
B. divaricatum (Schrank) Wimm.
Ranunculus delphinifolius Torr.

(*b*). Semi-hydrophytic plants.

Ranunculus sceleratus L.
Caltha palustris L.
Anemone canadensis L.

(*c*). Mesophytic species of woodlands and meadows.

Clematis virginiana L.
C. simsii Sweet.
Anemone cylindrica Gray.
A. virginiana L.
A. quinquefolia L.
Hepatica acuta (Pursh) Britton.
Delphinium tricorne Mx.
Actaea rubra (Ait.) Willd.
A. alba (L.) Mill.
Syndesmon thalictroides (L.) Hoffmg.
Thalictrum dioicum L.
T. purpurascens L.
Ranunculus repens L.
R. septentrionalis Poir.
R. recurvatus Poir.
R. pennsylvanicus L. f.
R. hispidus Hook.
R. abortivus L.
Myosurus minimus L.
Isopyrum biternatum (Raf.) T. & G.
Aquilegia canadensis L.
Hydrastis canadensis L.

(*d*). Xerophytic species of the dry prairies.

Pulsatilla hirsutissima (Pursh) Britton.
Ranunculus ovalis Raf.
R. fascicularis Muhl.
Oxygraphis cymbalaria (Pursh) Prantl.
Anemone caroliniana Walt.
Delphinium carolinianum Walt.

A PHAENOLOGICAL STUDY OF OUR SPECIES.

The following table was compiled from various sources. The time of first blooming for 1886 is from a record made by Prof. Hitchcock at Ames, Iowa, and published by Prof. Halsted in Bulletin Iowa Agricultural College, November, 1886. In using his observations we have corrected some of his determinations in accordance with his catalogue of the Ames Flora, a subsequent publication. For instance, *Clematis viorna* L. is changed to *C. pitcheri* T. & G., *Ranunculus repens* L. to *R. septentrionalis* Poir., etc. The observations for 1888, 1889, and 1890 were made by Mary F. L. Fitzpatrick at Iowa City. The observations for the other years were made by T. J. Fitzpatrick partly from field work and partly by examination of herbarium material checked by various notes made at the time. A general uniformity in time of appearance will be noted for many species which is the more remarkable when we consider the different localities, soils, north or south slopes, early or late seasons and the many other factors which tend to hasten or retard plant growth. A few further notes may be added. *Actaea alba* (L.) Mill. fruited Aug. 25, 1894 and Aug. 20, 1896. *Actaea rubra* (Ait.) Willd. fruited June 20, 1895. *Hydrastis canadensis* L. fruited July 10, 1894 and July, 1897 which dates appear in the table and are intended for fruiting dates. The species flowers in May. *Anemone quinquefolia* L. flowered April 17, 1880; *Ranunculus multifidus* Pursh flowered May 15, 1882; *Thalictrum purpurascens* L. flowered June 21, 1884; *Delphinium carolinianum* Walt. flowered June 29, 1884, all of which dates agree well with those given in the table.

	1885	1886	1888	1889	1890	1891	1894	1895	1896	1897	1898	1899
Actaea alba (L.) Mill	May		My 25	My 10	My 14	May		My 11			My 23	
A. rubra (Ait.) Willd		My 15					My 19					
Anemone caroliniana Walt							May					
A. cylindrica Gray		Jn 6					My 17	Jn 11		My 11	Jn 20	
A. quinquefolia L		Ap 20	Ap 15	Ap 10	Ap 19			Ap 24				
A. canadensis L		My 16	Jn 1	My 14	My 20	Jn 6	My 17	My 11		My 22	Jn 24	
A. virginiana L		Jn 15	Jn 15	Jn 15	Jn 20		June	Jn 13	July	Jul 14	Jul 25	
Aquilegia canadensis L		Ap 30	Ap 30	Ap 30	My 1		My 6	My 1				
Batrachium trichophyllum (Chaix) Bossch					May		My 20	Jn 20				Ag14
B. divaricatum (Schrank) Wimm	Jn 6					June	June	My 26				
Caltha palustris L		Ap 17	Ap 10	Ap 8	Ap 15		My 28	My 11				
Clematis simsii Sweet	May	Jn 4	Jn 16	Jn 12	Jn 13		Jn 10			Jn 10	Jn 27	Jn 27
C. virginiana L	July	Ag 3	Ag 2	Jul 30				Ag 1	Jul 12	Ag 10	Jul 25	
Delphinium carolinianum Walt		Jn 6					Jn 9		Jn 7		Jn 20	
D. tricorne Mx							My 11		My 9		My 30	
Hepatica acuta (Pursh) Britton		Ap 9	Ap 3	Mr 19	Ap 2	Ap 12		Ap 7			Mr 23	
Hydrastis canadensis L					May		Jul 10			July		
Isopyrum biternatum T. & G		Ap 15	Ap 15	Ap 10	Ap 15			Ap 26		May	Ap 23	
Myosurus minimus L							My 8	May				
Pulsatilla hirsutissima (Pursh) Britton							Ap 9					
Ranunculus abortivus L							Ap 29	Ap 21	Ap 25			
R. acris L		Jn 2										
R. fascicularis Muhl	My 16		Ap 3				Ap 20	Ap 17				
R. multifidus Pursh		My 16		June	May		My 17			May		
R. pennsylvanicus L. f		Jn 29						Jul 7	My 15			
R. recurvatus Poir	June		My 23	My 11	My 20			My 11		June		
R. repens L	My 21		Ap 26	Ap 19	Ap 20							
R. ovalis Raf							Ap 20					
R. septentrionalis Poir		Ap 14					Ap 29	Ap 21	My 2	My 1		
R. hispidus Hook							May					
Syndesmon thalictroides (L.) Spach	My 8	Ap 24	Ap 10	Ap 6				Ap 12		My 8	My 7	
Thalictrum dioicum L		Ap 30										
T. purpurascens L		Jn 1	Jn 22	Jn 13	Jn 10		Jn 17	Jn 4	Jn 3		Jn 21	Jn 18

The following key has been improvised for the genera represented in Iowa:

* *Carpels 1-2-ovuled or several-ovuled; fruit follicles or berries.*

† *Flowers regular; leaves palmately nerved; petals wanting.*

HYDRASTIS. Carpels ripening into a head of red berries.

CALTHA. Carpels ripening into a head of dry follicles.

†† *Flowers regular; leaves ternately or pinnately compound or decompound.*

‡ *Petals not spurred.*

ISOPYRUM. Flowers medium, white, solitary or panicled; fruit forming follicles.

COPTIS. Stemless herbs with trifoliolate leaves and umbellate follicles.

ACTAEA. Flowers small, white, fruit forming berries.

‡‡ *Petals produced backward into hollow spurs.*

AQUILEGIA. The only genus.

††† *Flowers irregular, posterior sepal spurred.*

DELPHINIUM. With us the only genus.

** *Carpels 1-ovuled; fruit an achene.*

† *Flowers involucrate.*

‡ *Styles none or short and glabrous or pubescent.*

ANEMONE. Involucre foliaceous, remote from the flower.

HEPATICA. Involucre of 3 simple sessile leaves, calyx-like, close to the flower.

SYNDESMON. Involucre of 3 compound sessile leaves, leaflets petiolulate.

‡‡ *Styles elongated, densely plumose.*

PULSATILLA. Involucre forming a cup.

†† *Flowers not involucrate.*

‡ *Leaves opposite.*

CLEMATIS. Sepals petaloid; petals wanting.

ATRAGENE. Sepals petaloid; petals small, spatulate.

‡‡ *Leaves alternate or basal.*

§ *Sepals spurred.*

MYOSURUS. Leaves basal, linear.

§§ *Sepals not spurred.*

A. *Petals present.*

RANUNCULUS. Flowers yellow; achenes compressed, smooth.

BATRACHIUM. Flowers white; achenes transversely wrinkled.

OXYGRAPHIS. Flowers yellow; achenes compressed, longitudinally striate.

B. *Petals none.*

THALICTRUM. Leaves ternately decompound.

HYDRASTIS CANADENSIS *L.* Syst. Ed. 10, p. 1088. 1759.

This is a hairy vernal plant, about one foot high, springing

from a thick yellow rootstock which contains a yellow dye. Leaves 3, reniform, palmately lobed, doubly serrate, the basal long-petioled, the 2 cauline terminal, alternate, petioled. Flower solitary, pedicelled, subtended by the upper leaf, greenish-white, sepals 3, caducous; petals wanting; stamens many; pistils 12 or more. Fruit 1–2-seeded crimson berries.

This species is commonly known as Orange-root or Golden Seal. It is rather rare within our limits. It occurs in rich woods, flowering during the months of April and May, and fruiting in July. Specimens before us are: One flowering specimen from Muscatine county, May, 1890, collected by Mr. F. Reppert who records, "rich woods, scarce," two fruiting specimens from Muscatine county transferred to our garden in July, 1895, and pressed July, 1897, and one fruiting specimen from Fayette county collected July 10, 1894 by Prof. B. Fink. We have seen a specimen in the collection of Herbert Goddard collected by him in Winneshiek county. Prof. J. C. Arthur reports the occurrence of the species in Lee county. It will be noticed that the range in Iowa is limited to a narrow strip along the eastern border. The species occurs in Minnesota (Upham, MacMillan), Wisconsin, Michigan, Western Ontario (Macoun), eastward to New York, New Jersey, and Delaware (Tatnall), in Ohio (Newberry), Kentucky, Tennessee, Georgia, Missouri, and Arkansas (Coville). Iowa forms a portion of the middle western boundary of the range of this species. The only other species of this genus occurs in Japan. Pursh claims that the flowers are pale rose-colored which does not agree with our observations. He further says: "The roots are yellow and afford a fine dye." The use of this dye was known to the aborigines.

The species has suffered little at the hands of systematists. Linnaeus named it *Hydrophyllum verum canadensium* in the first edition of his Species Plantarum, vol. 1, p. 146, in note, with the idea that the species was some form of a

waterleaf. In 1759 he called it *Hydrastis canadensis* in his Systema Naturae. This name is retained by Linnaeus in the second (1763) and third (1764) editions of his Species Plantarum. Willdenow, Michaux, Pursh, Elliott, Nuttall, and most subsequent writers have without comment followed the path of Linnaeus. Linnaeus however credits the genus to Ellis. Miller (Dict. n. 1.) called the species *Warneria canadensis*, the generic name, *Warneria*, is credited to Miller, ic. 2. p. 190., t. 285.

Linnaeus, Species Plantarum, ed. 2, 1763, vol. 1, p. 784, who says: "*Habitat in* Canadae *aquis*, 4. *Similis Hydrophyllo.* Folia *bina, petiolata, basi emarginata, palmata, serrata; lobis utrinque lobulo laterali:*" Willdenow, Species Plantarum, vol. 2, p. 1339, who quotes Linnaeus as above; Pursh, Flora Americae Sept., 1814, vol. 2, p. 389, who says, "In shady woods on fertile soil, and among rocks: Canada to Carolina, principally in Allegany mountains;" Michaux, Flora Bor. Amer. 1803, vol. 1, p. 317, who says it occurs in the mountains of the Alleghanies from Canada to Carolina, "HAB. in tractu montium *Alleghanis*, a Canada ad Carolinam;" Nuttall, Genera N. A. Plants, 1818, vol. 2, p. 21; Elliott, Sketch Bot. S. C. & Ga., vol. 2, p. 55; Torrey Compendium Fl. Northern and Middle States, 1826, p. 224; Torrey, Flora of New York, 1843, vol. 1, p. 26; DeCandolle, Prodromus, vol. 1, p. 53; Darlington, Flora Cest., p. 336; Botanical Magazine, t. 3019, and t. 3232 (the fruit) Torrey & Gray, Flora of N. A., vol. 1, p. 40; Newberry, Cat. Fl. Plants and Ferns of Ohio, p. 248 in Ohio Agr. Rep. 1859, ed. 1860; Tatnall, Cat. Phaen. and Filicoid Plants of Newcastle county, Del., 1860, p. 11; Gray's Manual, 5th ed., p. 46; 6th ed., p. 48; Britton and Brown's Ills. Flora, vol. 2, p. 50; Wood's Botanist and Florist, 1889, p. 23; MacMillan, Metaspermae of the Minnesota Valley, p. 230; Britton, Flora of New Jersey, p. 40; Chapman, Flora of the Southern States, p. 11; Upham, Flora of Minnesota, p. 20; Macoun, Flora of Canada, vol. 1, p. 27; Coville, Flora of Arkansas, p. 163; Beal and Wheeler, Michigan Flora, p. 69; Stanley Coulter Cat. Flowering Plants and of the Ferns and their Allies indigenous to Indiana, p. 745, in 24th Rep. State Geol. 1899; Kellerman and Werner, Cat. Ohio Plants, p. 174, in vol. 7, part 2 of Geology of Ohio; Arthur, Contr. Flora of Iowa, p. 6, 1876; Fink, Proc. Iowa Acad. of Sciences, vol. 4, 1896, p. 83, who says: "Rich woods rare;" Fitzpatrick, Manual of the Flowering Plants of Iowa, 1899, p. 6; Barnes, Reppert and Miller, Proc. Davenport Acad. Nat. Sciences, vol. 8, p. 202.

CALTHA PALUSTRIS *L.* Sp. Pl., p. 558. 1753. Marsh Marigold.

A glabrous perennial succulent herb; stem 1–2 feet

high, hollow, grooved, stout. Leaves entire or crenate, basal leaves long-petioled, cordate or reniform, with a narrow sinus, the upper with shorter petioles and more or less truncate bases. Flowers conspicuous; sepals 5–9, oval, obtuse, yellow, deciduous; petals wanting; stamens many; pistils 5–10; styles obscure; pods compressed, spreading, bearing the many seeds in two rows along the ventral suture.

This species occurs frequently in swamps, wet soil, along banks of streams, flowering in April and May, fruiting in May and June. Our specimens are from Winneshiek, Fayette, Muscatine, Johnson, and Emmet counties; the State University herbarium has specimens from Story and Dickinson counties. Messrs. Nagel and Haupt report the species from Scott county; Prof. Bessey from Floyd and Poweshiek counties; and Prof. Pammel from Woodbury county.

Bessey, Contr. to the Flora of Iowa, p. 91, in Fourth Report Iowa Agr. Col. ed. 1872; Arthur, Contr. to the Flora of Iowa, p. 6, 1876; Flora of Floyd county in History of Floyd county, p. 310; Nagel and Haupt, Proc. Davenport Acad. Nat. Sciences, vol. 1. p. 154. Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108 and p. 135; Manual of the Flowering plants of Iowa p, 5; Barnes, Reppert, and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201; Britton and Brown, Ills. Flora, vol. 2, p. 51; MacMillan, Met. Minn. Valley, p. 230.

ISOPYRUM BITERNATUM *(Raf.) T. & G.* False Rue Anemone.

A slender smooth perennial herb, 4–10 inches high; roots many, fibrous, occasionally thickened into small tubers. Leaves ternately decompound. Flowers long-peduncled, axillary or terminal; sepals 5, petaloid, deciduous; petals none; stamens many; pistils usually 4; pods ovate or oblong, sessile, 2–several-seeded. *Enemion biternatum* Raf. Journ. Phys. vol. 91, p. 70, 1820; *Isopyrum biternatum* T. & G. Fl. N. A., vol. 1, p. 660. 1840.

This species is very common in moist rich woods, bloom-

ing in May. Our specimens are from Winneshiek, Muscatine, Johnson, and Decatur counties. We have observed it in Scott county. In the State University herbarium are specimens from Henry, Calhoun, and Emmet counties. Prof. Bessey and Prof. Hitchcock report the species from Story county; and Prof. Fink reports it from Fayette county. No doubt the species is more general in its distribution than our present knowledge indicates. Britton and Brown gives its range as: "Ontario to Minnesota south to Florida and Texas."

Bessey, Contr. to the Flora of Iowa in Fourth Rep. Iowa Agr. Col., p. 90, ed. 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108 and p. 135; Manual of the Flowering Plants of Iowa, p. 5; Rigg, Notes on the Flora of Calhoun county, p. 10; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Halsted, Bul. Iowa Agr. Col., Nov. 1886, p. 48; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201; MacMillan, Met. Minn. Valley, p. 231.

COPTIS TRIFOLIA *(L.) Salisb.* Gold-thread.

A low perennial scapose herb, 3–6 inches high, with evergreen, trifoliolate, long-petioled leaves, and small, white, solitary flowers. Rootstocks slender; leaves reniform, 3-divided, petioles long, slender; divisions obovate, cuneate, mucronate-crenate; sepals 5–7, oblong, obtuse, petaloid, deciduous; petals 5–7, small, club-shaped; stamens 15–25; pistils 3–7, slender pedicelled; follicles 3–7, stipitate, membranous, 4–8-seeded. *Helleborus trifolius* L. Sp. Pl., p. 784, 1762; *Coptis trifolia* Salisb. Trans. Linn. Soc., vol. 8, p. 305, 1803; *Isopyrum trifolium* Britton, Bul. Torr. Club, vol. 18, p. 265, 1891.

We have not seen an Iowa specimen of this species. We include it on the authority of Gray's Manual which directly refers the species to Iowa.

Gray's Manual, 6th ed., p. 45; MacMillan, Met. Minn. Valley, p. 231.

ACTAEA RUBRA *(Ait.) Willd.* Red Baneberry.

Stem 1–2 feet high, bushy, leaves 2–3-ternately compound;

leaflets sharply cleft and toothed; flowers in an *ovate* raceme; sepals 5, white, deciduous; petals 4–10, spatulate, shorter than the numerous stamens; pistil 1; *berry red*, globular, many-seeded, pedicels *slender*. *Actaea spicata* var. *rubra* Ait. Hort. Kew., vol. 2, p. 221, 1788. *Actaea rubra* Willd. Enum., p. 561, 1809.

We have two fruiting specimens from Winneshiek county and have referred here flowering specimens from Fayette, Johnson, and Shelby counties. The State University herbarium has specimens referred here from Emmet, Story, Winnebago, and Pottawattamie counties. Prof. Pammel reports the species from Woodbury county and Dr. Parry reports it from Scott county.

Parry, in Owen's Rep. Geol. Sur. Wis., Iowa, and Minn., p. 609, 1852; Arthur, Contr. to the Flora of Iowa, p. 6, 1876, where it is written *Actaea spicata* L. var. *rubra* Mx., as it is given in the 5th edition of Gray's Manual; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108 and p. 135; Manual of the Flowering Plants of Iowa, p. 6; MacMillan, Met. Minn. Valley, p. 233.

ACTAEA ALBA *(L.) Mill.* White Baneberry.

This species which is of frequent occurrence in our woods is distinguished from the preceding by its oblong raceme, slender petals, thickened fruiting pedicels, and white berries. *Actaea spicata* var. *alba* L. Sp. Pl., p. 504, 1753. *Actaea alba* Mill. Gard. Dict., ed. 8, no. 2, 1768. *Actaea alba* Bigelow, as it is given in the 5th and 6th editions of Gray's Manual.

Our collection comprises good specimens from Winneshiek, Muscatine, Johnson, Jefferson, and Decatur counties. The State University herbarium has specimens from Winnebago and Emmet counties. Prof. Fink reports the species from Fayette county; Dr. Parry and Messrs. Nagel and Haupt report it from Scott county; Prof. Bessey from Story and Floyd counties; Mr. Mills by letter from Henry

county. In general we have found this species rather frequent. It blooms in May and the fruit ripens in June.

Parry, in Owen's Rep. Geol. Sur Wis., Iowa, and Minn., p. 609, 1852; Bessey, Contr. to the Flora of Iowa, p. 91, in Fourth Rep. Iowa Agr. Col.; Arthur, Contr. to the Flora of Iowa, p. 6, 1876; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Davenport Acad. of Sciences, vol. 5, p. 108 and 135; Manual of the Flowering Plants of Iowa, p. 6; Messrs. Barnes, Reppert, and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201.

AQUILEGIA CANADENSIS *L.* Sp. Pl. p. 533. 1753.

A perennial herb, 1–3 feet high, branched; leaves ternately compound, long-petioled, leaflets lobed; flowers solitary, showy, scarlet, nodding; sepals 5, petaloid; petals 5, prolonged backward into long hollow spurs; stamens numerous, exserted; pistils 5; follicles 5, erect, slightly spreading, tipped with a filiform beak, many-seeded.

A rather showy plant, common in our woodlands, preferring calcareous soil. It is not infrequently cultivated and should be preferred to the European species. The flowers appear during April, linger through May and June, and pass out the latter part of June or in the early part of July. The range of this species as given by Britton and Brown is: "Nova Scotia to the Northwest Territory, south to Florida and Texas." It has a vertical range of more than four thousand feet.

Specimens before us are from Winneshiek, Fayette, Muscatine, Johnson, Decatur, and Shelby counties. The State University herbarium has specimens from the additional counties of Henry, Mahaska, Winnebago, Lyon, Story, Jones, Calhoun, Polk, and Cerro Gordo counties. We have observed the species in Allamakee, Clayton, Dubuque, Scott, Des Moines, Van Buren, Ringgold, Page, and Pottawattamie counties. Prof. Pammel reports the species from Hamilton county and Prof. Bessey from Floyd and Poweshiek counties. In all probability there is not a county in

the state that does not include this species in its flora. The species has developed none of the tendencies of a weed. Because of close pasturing the number of individuals is becoming much less than formerly, yet all in all it persists with remarkable tenacity, however, reaching its greatest development along bluffs and in wooded ravines.

Bessey, Contr. to the Flora of Iowa, p. 91, in Fourth Rep. Iowa Agr. Col., 1872; Arthur, Contr. to the Flora of Iowa, p. 6, 1876; Flora of Floyd county in History of Floyd county, p. 310; Nagel and Haupt, Proc. Davenport Acad. Nat. Sciences, vol. 1, p. 154; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108 and p. 135; vol. 6, p. 177; Manual of the Flowering Plants of Iowa, p. 5; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201.

DELPHINIUM *L.* Sp. Pl. 530. 1753.

Annual or perennial erect branching herbs, with palmately cut or divided leaves, and racemose flowers. Sepals 5, the posterior one and occasionally the anterior one prolonged into a spur, petaloid. Petals irregular, 4 or 2, rarely more, the upper pair prolonged backward into the spur of the calyx. Pistils becoming many-seeded follicles in fruit.

**Perennials; leaves long-petioled; pistils 3.*

DELPHINIUM TRICORNE *Mx.* Fl. Bor. Am., vol. 1, p. 314. 1803. Dwarf Larkspur.

Stem simple or but very little branched, hollow, 1–3 feet high, glabrous or pubescent; roots a cluster of small tubers; leaves about 5-parted, divisions 2–3-cleft; raceme open; flowers blue or whitish; spur ascending, nearly straight; follicles 3, diverging, tipped with a short beak.

This species is to be found in prairies and rich woods, flowering in May. Its occurrence may be rated as frequent, though in many localities it is quite common, and again in some districts it is rare or not to be met with at all. Present information confines this species within our limits to

the southwestern quarter of the state. Our specimens are from Shelby and Decatur counties. We have observed the species in Union and Clark counties. The State University herbarium has specimens from Mahaska and Pottawattamie counties. Prof. Bessey reports the species from Warren county.

Bessey, Contr. to the Flora of Iowa in Fourth Rep. Iowa Agr. Col., p. 90, 1872; Arthur, Contr. to the Flora of Iowa, p. 5; Shimek, Bull. Lab. Nat. Hist., S. U. I., vol. 3, p. 200; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 135; vol. 6, p. 177; Manual of the Flowering Plants of Iowa, p. 6.

DELPHINIUM TRICORNE GRANDIFLORUM new var.

Petals mostly 8, the two upper as usual and six others, sometimes 6 or 7; anterior sepal spurred similarly to the posterior one but with a smaller spur. Type locality, Lamoni, Iowa.

For three consecutive seasons we studied individuals collected in one locality. The deviation of the specimens from the normal type was very pronounced and we think constant enough to warrant distinction as a variety.

Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 6, p. 177, where this form is spoken of in general terms only but not named.

DELPHINIUM CAROLINIANUM *Walt.* Fl. Car., p. 155. 1788.

Stem slender, 1–3 feet high, nearly solid, more or less pubescent; leaves 3–5-parted, the divisions cleft into linear segments; raceme strict; flowers blue to whitish, spur curved upward; follicles 3, erect or slightly spreading. *Delphinium azureum* Mx. Fl. Bor. Am., vol. 1, p. 314, 1803.

This species is common in the western portion of the state, occurring on the prairies, and blooming in June. In the eastern portion of the state it is infrequent or rare.

Our specimens are from Muscatine, Jefferson, Decatur, Union, Adams, Clark, Montgomery, Pottawattamie, Shelby,

Lyon, and Emmet counties. The State University herbarium has specimens from the additional counties of Page, Fremont, Calhoun, Cerro Gordo, Polk, Hancock, and Webster counties. Dr. Parry and Messrs. Nagel and Haupt report the species from Scott county; Prof. Bessey from Floyd and Story counties; Prof. Pammel from Woodbury county; and Mr. Mills by letter from Henry county.

Parry, in Owen's Rep. Geol. Sur. Wis., Iowa, and Minn., p. 609, 1852; Bessey, Contr. to the Flora of Iowa in Fourth Report Iowa Agr. Col., p. 91, 1872; Arthur, Contr. to the Flora of Iowa, p. 6, 1876; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Halsted, Bull. Bot. Dept. Iowa Agr. Col., Nov., 1886, p. 50 and 1888, p. 37; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 135; vol. 6, p. 177; Manual of the Flowering Plants of Iowa, p. 6; Shimek, Bull. Lab. Nat. Hist., S. U. I., vol. 3. p. 200, and Flora of Lyon county, p. 170, in tenth volume, Iowa Geological Survey; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201.

DELPHINIUM URCEOLATUM *Jacq.* Coll., vol. 1, p. 153. 1786.

Stem slender, 2–6 feet high; many-flowered, spur straight, follicles erect; otherwise similar to the preceding. *Delphinium exaltatum* Ait. Hort. Kew., vol. 2. p. 244, 1789.

The species ranges from Pennsylvania west to Minnesota and Nebraska south to Alabama and North Carolina. We have rather doubted its occurrence in Iowa although it has been reported a number of times. Prof. Bessey reports it from Poweshiek county on the authority of Prof. Parker; Prof. Arthur from Scott county on the authority of Messrs. Nagel and Haupt which report is not confirmed by Messrs. Barnes, Reppert and Miller in their Flora of Scott and Muscatine counties; and Prof. Fink from Fayette county. Mr. J. B. Rigg in his notes on the Flora of Calhoun county lists this species but his specimens sent to the State University herbarium so labeled are *Delphinium carolinianum* Walt. (*D. azureum* Mx.)

Bessey, Contr. to the Flora of Iowa, p. 91; Arthur, Contr. to the Flora of Iowa, p. 6; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Rigg, Notes on the Flora of Calhoun county, p. 10; Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 6.

** *Annuals; petals 2, pistils 1.*

DELPHINIUM AJACIS *L.* Sp. Pl., p. 531. 1753.

Leaves nearly sessile; the divisions narrow, numerous; flowers numerous; spur long and narrow; follicle erect, pubescent.

This species has not infrequently escaped from gardens in Johnson county where our specimens were obtained. Prof. Fink reports it as occurring under similar conditions in Fayette county.

Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 135; Manual of the Flowering Plants of Iowa, p. 6; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83.

DELPHINIUM CONSOLIDA *L.* Sp. Pl. p. 530. 1753.
Field Larkspur.

This species differs from the preceding only by its glabrous follicles, longer and slightly bent spurs, and shorter and more open racemes. Prof. Pammel reports it as occurring at Corning, Adams county in Proc. Iowa Acad. of Sciences, vol. 4, p. 111.

ANEMONE *L.* Sp. Pl. p. 538. 1753.

Perennial herbs, with the leaves mostly radical, long-petioled, the few cauline whorled so as to form a foliaceous involucre remote from the flower, all compound or dissected. Peduncle 1-flowered. Sepals 5–20, petaloid. Petals none. Fruit compressed, 1-seeded achenes.

* *Achenes densely woolly.*

† *Leaves of the involucre sessile, 3-cleft.*

ANEMONE CAROLINIANA *Walt.* Fl. Car., p. 157. 1788.

Stem 3–8 inches high, pubescent, from a small tuber; root-

leaves slender-petioled or 3-cleft; involucre far below the flower; sepals 6–20, linear, purplish varying to whitish, head of fruit oblong.

This species blooms in April and May and within our limits it is of infrequent occurrence though often abundant over small areas. Our specimens are from Muscatine county contributed by Mr. Reppert who sends the following note: "Sandy soil, Muscatine Island, and along Cedar river. Flowers vary from white to bluish-purple." The State University herbarium has specimens from Hancock and Hardin counties. Dr. C. C. Parry reported the species from Scott county which report is confirmed by Messrs. Barnes, Reppert and Miller; and Prof. Bessey from Story county which report is confirmed by Prof. Hitchcock. This seems to confine the species within our limits to the northern half of the state. The species ranges from Illinois to Wisconsin and Nebraska, south to Georgia and Texas. Dr. Parry in his catalogue has the following interesting note: "*Anemone caroliniana* Walt., May 3d. Mississippi river bank, Davenport and Rock Island. The geographical range of this interesting species is deserving of notice. First known as a native of the Carolinas, it is again met with in Louisiana, Texas, and Arkansas, thence finding its way to the Missouri and Platte rivers; the locality just specified, probably determining its northeastern limits. It here grows always associated with *Draba caroliniana* and *Androsace occidentalis*, a significant relationship, connecting as it were the two extremes, Carolina and Nebraska."

Parry, in Owen's Geol. Rep. Wis., Iowa, and Minn., p. 608, 1852; Bessey, Contr. to the Flora of Iowa in Fourth Report Iowa Agr. Col., p. 90, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 153; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 482; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Shimek, Bull. Lab. Nat. Hist., S. U. I., vol. 3, p. 199; Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 2; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200.

ANEMONE MULTIFIDA *Poir.* in Lam. Encycl. Suppl., vol. 1, p. 364. 1810.

This species is readily distinguished from the preceding by its sessile or short-petioled involucral leaves, red sepals and globose or oval head of fruit. It is included by Prof. Bessey in his contributions to the Flora of Iowa, p. 90, giving the locality and note, "Burlington—rare." It is to be presumed that he includes it on the authority of one Rev. Isaiah Reid, of Nevada who at one time resided at Burlington and collected plants in that vicinity and afterwards sent Prof. Bessey a partial list of the plants of Burlington, Des Moines county. As the range of this species as given by Britton and Brown is north and west of our limits and as no other collector has found or recorded it we very much doubt its occurrence. *Anemone multifida* DC. of Gray's Manual, *A. multifida* of authors, not Poiret, so state late writers who claim the proper name to be *A. globosa* Nutt. ex Pritz in Linnaea 15:673, 1841.

†† *Leaves of the involucre slender-petioled; sepals 5–8, usually silky beneath.*

ANEMONE CYLINDRICA *Gray*, Ann. Lyc. N. Y., vol. 3, p. 221. 1836. Long-fruited Anemone.

Stem slender, branching at the involucre, 1–2 feet high, silky-pubescent; basal leaves tufted, long-petioled, 3–5-parted, divisions *cuneate-obovate* or *cuneate-oblanceolate, narrow;* involucral leaves 4–18, 3-divided, the divisions cuneate-lanceolate, cleft, toothed toward the apex; flowers 2–6, on exserted naked peduncles, sometimes one-involucellate; head of fruit cylindrical, one inch long; achenes compressed, pubescent, tipped with the minute styles.

This species is rather common on prairies and in hilly woods, blooming in June and July, and is widely distributed. Specimens in our collection are from Winneshiek, Johnson, Decatur, Union, Adams, Montgomery, Ringgold,

Fremont, Pottawattamie, Shelby, Lyon, and Emmet counties. We have observed the species in Allamakee, Clayton, and Dubuque counties. The State University herbarium has specimens from Story, Calhoun, Cerro Gordo, Dallas, and Jones counties. Messrs. Nagel and Haupt report the species from Scott county; Messrs. Barnes, Reppert and Miller from Scott and Muscatine counties; Prof. Bessey from Floyd county; Prof. Pammel from Sioux county; and Prof. Fink from Fayette county.

Bessey, Contr. to the Flora of Iowa in Fourth Report of Iowa Agr. Col., p. 90; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Bull. Iowa Agr. Col., Nov. 1884, p. 155 and 167; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 482; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 153; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 107 and p. 134; vol. 6, p. 177; Manual of the Flowering Plants of Iowa, p. 2; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200; Shimek, Flora of Lyon county, in vol. 10, Iowa Geol. Survey, p. 175; Halsted, Bull. Iowa Agr. Col., Nov. 1886, p. 50; Rigg, Notes on the Flora of Calhoun county, p. 9; MacMillan, Met. Minn. Valley, p. 238.

ANEMONE VIRGINIANA *L.* Sp. Pl., p. 540. 1753.

Stem slender, rather stout, branching at the involucre, 2–3 feet high, pubescent; involucral leaves 3, 3-parted, the divisions *ovate-lanceolate*, cleft and serrate; the first peduncle naked, the later with a 2-leaved involucel near the middle; sepals 5; head of fruit oval to oblong, achenes compressed, woolly, tipped by the subulate styles.

This species occurs in woods, blooming from June until August. It is of frequent occurrence and widely distributed within our limits. At the close of the season the heads of fruit loosen and the woolly pubescence spreads to the wind which is also characteristic of *Anemone cylindrica* Gray. This pubescence is commonly known as birds' cotton.

Our specimens are from Winneshiek, Allamakee, Muscatine, Jefferson, Johnson, Appanoose, Decatur, Ringgold,

Page, and Fremont counties. We have observed it in Des Moines and Pottawattamie counties. The State University herbarium has specimens from Louisa, Lee, Henry, Floyd, Story, Winnebago, Taylor, Cerro Gordo, and Webster counties. Dr. C. C. Parry and Messrs. Nagel and Haupt report the species from Scott county; Prof. Pammel from Woodbury county; and Mr. Cratty by letter from Emmet county.

Parry, in Owen's Rep. Geol. Sur. Wis., Iowa, and Minn., p. 608, 1852; Bessey, Contr. to the Flora of Iowa in Fourth Report Iowa Agr. Col., p. 90, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Halsted, Bull. Iowa Agr. Col., November, 1884, p. 155 and 167 and November, 1886, p. 50; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 482; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 107 and p. 134; vol. 6, p. 177; Manual of the Flowering Plants of Iowa, p. 2; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200; MacMillan, Met. Minn. Valley, p. 237.

** *Achenes pubescent, or nearly glabrous.*

† *Leaves of the involucre 3, sessile.*

ANEMONE CANADENSIS *L.* Syst. Ed. 12, vol. 3, p. 231 App. 1768.

Stem usually 1–2 feet high, hairy; radical leaves 5–7-parted or 5–7-cleft, divisions cut or toothed toward the apex; primary peduncle naked, two lateral ones with a 2-leaved involucre; sepals 5, obovate, white; achenes in a globose head, flat, nearly orbicular, pubescent, tipped with the persistent style. *Anemone pennsylvanica* L. Mant., vol. 2, p. 247, 1771. Sometimes erroneously referred to *Anemone dichotoma* L. which is a Siberian species with glabrous ovate achenes.

This species is common in low grounds, blooming in June and July, and is widely distributed over the state. Our specimens are from Winneshiek, Allamakee, Fayette, Muscatine, Johnson, Ringgold, Pottawattamie, Shelby, and Emmet counties. We have observed it in Scott and Des

Moines counties. The State University herbarium has specimens from Chickasaw, Jones, Linn, Lee, Polk, Story, Page, Mahaska, Calhoun, Winnebago, Cerro Gordo, Dallas, Dickinson, and Lyon counties. Prof. Bessey reports the species from Poweshiek county, Prof. Pammel from Woodbury county, and Mr. Mills by letter from Henry county.

Bessey, Contr. to the Flora of Iowa in Fourth Report of Iowa Agr Col., p. 90; Arthur, Contr. to the Flora of Iowa, p. 5; Bull. Iowa Agr. Col., Nov. 1884, p. 167; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 153; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 482; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol 5, p. 108 and p. 134; vol. 6, p. 177; Manual of the Flowering Plants of Iowa, p. 2; Shimek, Flora of Lyon county, p. 178 in vol. 10, Iowa Geol. Survey; Rigg, Notes on the Flora of Calhoun county, p. 9; Halsted, Bull. Iowa Agr. Col., Nov. 1886, p. 49; and Bull. Iowa Agr. Col., 1888, p. 36; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200.

†† *Leaves of the involucre 3, petioled.*

ANEMONE QUINQUEFOLIA *L.* Sp. Pl. p. 541. 1753. Wind-flower.

Stem 4–8 inches high, simple, frail, smooth or slightly pubescent, from horizontal rootstocks; involucral leaves 3, leaflets wedge-shaped, conspicuously toothed, somewhat lobed; sepals 4–7, ovate, white varying to blue or purple. *Anemone nemorosa* Mx. Fl. Bor. Am., vol. 1, p. 319, 1803, not L. as he refers. *Anemone nemorosa* var. *quinquefolia* Gray, Manual, Ed. 5, p. 38, 1867.

This species occurs in rich upland woods, flowering in April and May, and common only locally. Our present information limits this species in our state to the northeast quarter. Many botanists have considered this species as identical with the European *Anemone nemorosa* L. Our species is said to differ much in aspect from the European one, having smaller flowers, slender petioles, and the divisions of the involucral leaves less lobed.

Specimens in our collection are from Fayette, Muscatine, and Johnson counties. We have observed the species in Winneshiek county. Prof. Bessey reports it from Story, Floyd, and Des Moines counties, and Messrs. Nagel and Haupt from Scott county.

Bessey, Contr. to the Flora of Iowa in Fourth Report Iowa Agr. Col., p. 90; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Flora of Floyd county in History of Floyd county, p. 310; Bull. Iowa Agr. Col., Nov. 1884, p. 157, p. 167, and p. 174; Hitchcock, Trans. St. Louis, Acad. of Science, vol. 5, p. 482; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 153; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108 and p. 134; Manual of the Flowering Plants of Iowa, p. 2; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200.

HEPATICA ACUTA *(Pursh) Britton*. Liverleaf. Hepatica.

Low perennial scapose herbs; scapes 4–8 inches high, villous. Leaves evergreen, thick, heart-shaped, 3-lobed or sometimes 5-lobed; lobes and those of the involucre acute or acutish. Flowers blue, purple or white; involucre 3-leaved, close to the flower, calyx-like; stamens many, filaments short, anthers 2-celled. *Hepatica triloba* var. *acuta* Pursh, Fl. Am. Sept., p. 391, 1814. *Hepatica acutiloba* DC. Prodr. vol. 1, p. 22, 1824. *Hepatica acuta* Britton, Ann. N. Y. Acad. Sci., vol. 6, p. 234, 1891.

This species is common in rich upland woods, blooming in March and April, and preferring calcareous soil. It is common in the eastern half of the state but apparently rare or absent in the western portion. Some specimens before us have the leaf lobes somewhat lanceolate and with the margins fluted. Five-lobed leaves occur in our collection. Prof. Halsted, one time botanist at Ames, discovered specimens in Story county which exhibited dioecious tendencies, a matter which he reported.

Our specimens are from Muscatine, Johnson, and Decatur counties. We have observed it in Winneshiek, Allamakee, Clayton, Scott, Des Moines, and Linn counties. The State University herbarium has specimens from Henry, Cerro Gordo and Chickasaw counties. Profs. Bessey and

Hitchcock report the species from Story county; Profs. Bessey and Fink from Fayette county; Prof. Bessey from Floyd county; and Mr. Cratty by letter reports the species as rare in the woods at Estherville, Emmet county.

Bessey, Contr. to the Flora of Iowa in Fourth Report Iowa Agr. Col., p. 90, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Flora of Floyd county in History of Floyd county, p. 310; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Halsted, Bull. Iowa Agr. Col., Nov., 1886, pp. 6, 37 and 48; Bull. Tor. Bot. Club, vol. 14, p. 119; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 482; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108 and p. 134; Manual of the Flowering Plants of Iowa, p. 2; Britton and Brown, Illustrated Flora, vol. 2, p. 66; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200; Gray and Robinson, Synop. Fl. N. A., 1:14.

HEPATICA HEPATICA *(L.) Karst.*

This species also commonly known as Liverleaf closely resembles the preceding. It is distinguished by its rounded or obtuse lobes of the leaves and involucre. *Anemone hepatica* L. Sp. Pl., p. 538, 1753. *Hepatica triloba* Chaix in Vill. Hist. Pl. Dauph., vol. 1, p. 336, 1786. *Hepatica hepatica* Karst. Deutsch. Fl., p. 559, 1880–83.

Prof. Bessey reports this species from Des Moines and Fayette counties. Prof. Fink does not confirm Prof. Bessey in his Spermaphyta of the Flora of Fayette, Iowa, published in volume 4, Proc. Iowa Acad. of Sciences. He says: "*H. triloba* Chaix is frequently reported here, but does not occur." Messrs. Nagel and Haupt report the species from Scott county. This, however, is not confirmed by Messrs. Barnes, Reppert and Miller in a subsequent flora. Some leaves of this species are in the Burlington High School collection but it is not apparent on which side of the Mississippi river they were collected. Britton and Brown refer this species to Iowa, but present evidence indicates that it does not belong here.

Bessey, Contr. to the Flora of Iowa in Fourth Rep. Iowa Agr. Col. p. 90, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 153; Britton and Brown, Illustrated Flora, vol. 2, p. 65; Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 2.

SYNDESMON THALICTROIDES *(L.) Hoffmg.* Rue Anemone.

A low glabrous perennial herb, 3–5 inches high, with stem and radical leaves rising from a cluster of tuberous roots. Leaves 2–3-ternately compound; involucral leaves similar, sessile; leaflets more or less 3-lobed, rounded to heart-shaped at the base and long petiolate. Flowers white or pinkish, umbellate; sepals 5–10, large, broad-ovate, thin; petals none. Achenes terete, ribbed, sessile. *Anemone thalictroides* L. Sp. Pl., p. 542, 1753. *Thalictrum anemonoides* Mx. Fl. Bor. Am., vol. 1, p. 322, 1803. *Syndesmon thalictroides* Hoffmg. Flora, 15: Part 2, Intell. Bl. 4, 34, 1832. *Anemonella thalictroides* Spach, Hist. Veg., vol. 7, p. 240, 1839.

This pretty vernal species is common in rich upland woods where it may be gathered during the months of April and May, varying earlier or later according to the vicissitudes of the seasons. The flowering stem first appears, later the basal leaves which much resemble those of a Thalictrum, a fact which led Michaux to place the species in that genus. Double flowered forms are not infrequent. Occasionally the floral envelope and organs simulate leaves.

This species is the only one of the genus and its range is confined to the New World. The limits as set by Brit ton and Brown are eastern United States west to Kansas and Minnesota, sparingly in Ontario. In Iowa it is more common in the eastern counties. Our specimens are from Muscatine, Johnson, and Decatur counties. We have observed the species in Winneshiek, Allamakee, and Van Buren counties. The State University herbarium has specimens from Henry and Mahaska counties. Messrs. Nagel and Haupt report the species from Scott county which report is confirmed by Messrs. Barnes, Reppert and Miller. Prof. Bessey reports the species from Fayette county, which

report is confirmed by Prof. Fink, and from Story county, confirmed by Prof. Hitchcock.

Bessey, Contr. to the Flora of Iowa in Fourth Rep. Iowa Agr. Col., p. 90; Arthur, Contr. to the Flora of Iowa, p. 5; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 482; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108 and 134; Manual of the Flowering Plants of Iowa, p. 3; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200.

PULSATILLA HIRSUTISSIMA *(Pursh) Britton.*

Stem 6–14 inches high, villous; flowering before leafing; leaves ternately-parted, the divisions dissected into narrow linear lobes; involucral lobes linear; peduncle solitary, lengthening after flowering; involucre forming a cup; flower large, sepals 5–7, ovate, whitish or purplish; petals none; stamens many, the outer ones often sterile; carpels in a globular head, with long persistent plumose styles. *Clematis hirsutissima* Pursh, Fl. Am. Sept., p. 385, Ed. 1814; *Anemone nuttalliana* DC. Syst. vol. 1, p. 193, Ed. 1818; *Anemone patens* var. *nuttalliana* A. Gray, Man. Edition 5, p. 36, 1867; *Pulsatilla hirsutissima* Britton, Ann. N. Y. Acad. Sci., vol. 6, p. 217, 1891.

A very pretty species, once common on the highest prairies of the northern portion of the state. Being the first of the vernal flora to unfold its flowers above the dead grass, as is its usual habit, it presents a striking and welcome object in early spring, turning the brown and sear hills to beautiful roseate tints. The plow has played havoc with the prairies and this species lingers by the waysides or in open upland thickets and out of way places which have been untouched by the tillers of the soil. It has long been called the American or Nuttall's Pasque flower. In portions of the state it is called Easter lily. The flowers open in March or early April immediately after the melting of the snow and are mostly fallen before May,

though in upland thickets, where the frost stays late in the ground, a few individuals may be found even so late as the last of June. The lengthening of the peduncle after flowering and the globular head of achenes with their long plumose styles give a striking aspect to the plant as it moves to and fro before the wind, a veritable little plumed knight of the prairie. The plumose character of the styles gave Pursh who first described the species the idea that it was a clematis. He founded the species upon specimens collected by Mr. Lewis on the plains drained by the Columbia river. DeCandolle first assigned it to the genus *Anemone* and gave it the specific name *nuttalliana*. Many considered it only a form of the European *Anemone patens* L. This was the position held by Dr. Gray who called it *Anemone patens* var. *nuttalliana*. The range of the species is from Illinois to the Northwest Territory, British Columbia, Nebraska, and Texas. Iowa is near the eastern border of its range.

Dr. C. C. Parry in his catalogue of plants of Wisconsin and Minnesota published in Owen's report gives the following interesting note concerning this species: "Pulsatilla patens, (Mill.) May 15. In fruit. Galena, Ill. This characteristic and handsome plant occurs abundantly to the north and west [Probably referring to Iowa] of the locality specified, preferring high prairies and gravelly ridges, which, in early spring, it adorns with its elegant blue flowers, or later, with its no less beautiful plumed fruit. It posesses the acrid properties, and probably equal medicinal qualities, with a closely allied European species. It is said by the Indians frequently to occasion sores on the lips of children, attracted by their showy blossoms. It may farther be mentioned as an interesting fact in connection with its geographical range, that the same plant is found in New Mexico, specimens from that locality having been shown me by Dr. Englemann, of St. Louis."

The specimens before us were collected in Winneshiek,

Allamakee, Emmet, and Shelby counties. The State University herbarium has specimens from Delaware, Hardin, Calhoun, and Lyon counties. We have seen a specimen from Crawford county. Prof. Bessey reports the species from Fayette and Floyd counties; Prof. Hitchcock from Story county; and Prof. Pammel from Woodbury county. This restricts the species in our state to the northern half, reaching its southern limit on the western border.

Bessey, Contr. to the Flora of Iowa in Fourth Report Iowa Agr. Col., p. 90, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Flora of Floyd county in History of Floyd county, p. 310; Bull. Iowa Agr. Col., Nov. 1884, p. 157; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 482; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, p. 4, 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 107 and p. 134; Manual of the Flowering Plants of Iowa, p. 2; Shimek, Flora of Lyon county in Iowa Geol. Survey, vol. 10, p. 170.

CLEMATIS VIRGINIANA *L.* Amoen. Acad., vol. 4, p. 275. 1759. Virgin's Bower.

A rather long, trailing vine, with opposite trifoliolate leaves, and small, white, polygamo-dioecious, cymose-paniculate flowers. Sepals 4. Petals wanting. Stamens many. Achenes many, in a globular head, with long, persistent, plumose styles.

The Virgin's Bower is rather common in low grounds in thickets or along fenceways, flowering from July until September. Our specimens are from Winneshiek, Allamakee, Fayette, Muscatine, Johnson, Appanoose, Decatur, Ringgold, Page, Fremont, and Dickinson counties. We have observed the species in Scott, Des Moines, and Union counties. The State University herbarium has specimens from Delaware, Jones, Lee, Story, Cerro Gordo, and Lyon counties. Prof. Bessey reports the species from Floyd county; Prof. Pammel from Woodbury county; and Mr. Mills by letter from Henry county. This shows that the distribution of this species is general throughout the state.

Bessey, Contr. to the Flora of Iowa in Fourth Rep. Iowa Agr. Col., p. 90, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 153; Hitchcock, Trans. St. Louis Acad. of Sciences, vol. 5, p. 482; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 107 and p. 134; vol. 6, p. 176; Manual of the Flowering Plants of Iowa, p. 1; Halsted, Bull. Iowa Agr. Col., Nov. 1886, p. 52; Barnes, Reppert, and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200; Shimek, Flora of Lyon county in vol. 10, Iowa Geological Survey, p. 175; Reppert, Iowa Geol Sur., vol. 9, p. 381.

CLEMATIS SIMSII *Sweet*, Hort. Brit., vol. 1, p. 1.

A rather high climbing vine, with opposite, pinnate leaves, terminating in tendrils, and large purplish, solitary flowers. Leaflets 3–7, ovate, entire, lobed or trifoliolate, thick, reticulated, more or less mucronate. Calyx campanulate, pubescent, less than an inch in length; sepals thin, tips recurved. Achenes with filiform, persistent, silky but not plumose styles. *Clematis pitcheri* T. & G., Fl. N. A., vol. 1, p. 10, 1838. *Clematis cordata* Sims, Bot. Mag. pl. 1816, 1816. Not Pursh, 1814.

This species is frequent in thickets, flowering from June until August. Our specimens are from Muscatine, Johnson, Appanoose, Decatur, Pottawattamie, and Shelby counties. We have observed the species in Union and Fremont counties. The State University herbarium has specimens from Louisa, Henry, Lee, and Story counties. Messrs. Nagel and Haupt report the species from Scott county. Our present information indicates that within our limits this species is restricted to the southern portion of the state. Britton and Brown give the range as southern Indiana to Missouri and Texas which indicates a range south of Iowa, a mistake however. A form with cream colored flowers occurs at Moscow, Muscatine county.

Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 153; Shimek, Bul. Lab. Nat. Hist., S. U. I., vol. 3, p. 199; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 134; vol. 6; p. 177; Manual of the Flowering Plants of Iowa, p. 1; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200.

CLEMATIS VIORNA *L.* Sp. Pl. p. 543. 1753. Leather-flower.

This species was reported as belonging to the flora of Iowa by Dr. C. C. Parry in Owen's Rep. Geol. Sur. Wis., Iowa, and Minn., p. 608, 1852, and by Prof. Bessey in his contributions to the Flora of Iowa in Fourth Report of Agricultural College, p. 90, 1872. He gives Polk and Story counties as localities. Prof. Hitchcock does not list this species in his catalogue of Anthophyta and Pteridophyta of Ames, published 18 years later. Prof. Bessey does not list *Clematis simsii* Sweet. (*C. pitcheri* T. & G.). Prof. Arthur in his contributions to the Flora of Iowa, p. 5, 1876, reports *C. viorna* L., *C. simsii* Sweet (*C. pitcheri* T. & G.), and *C. virginiana* L. *Clematis viorna* L. very much resembles *C. simsii* Sweet except that the persistent styles are plumose throughout in the latter species.

We have seen no reliable specimens from Iowa. The so-called specimens which have fallen into our hands are *Clematis simsii* Sweet. The range of the species as given by Britton and Brown is southern Pennsylvania to Ohio and West Virginia, south to Georgia and Tennessee, a range much east of our limits. In all probability the species does not belong to our flora; specimens which have been referred here belong to the species *Clematis simsii* Sweet.

ATRAGENE AMERICANA *Sims*, Bot. Mag. Pl. 887. 1806.

A perennial, trailing or twining vine, with opposite, petioled, trifoliolate leaves, and large, solitary, axillary flowers; leaflets ovate, acute, entire or toothed, somewhat cordate; sepals, large, purplish blue; petals small, spatulate; stamens many; styles persistent, plumose. *Clematis verticillaris* DC. Syst. Nat., vol. 1, p. 166, 1818.

The only Iowa specimen we have of this species was sent by Herbert Goddard of Decorah, Winneshiek county, Iowa. It bears the label "E. W. D. Holway, col., 5–27–'93."

Mr. Goddard writes, July 7, 1899, "This specimen was found by Mr. Holway and Mr. H. E. Case growing on the top of a bluff in open woods or thin brush, far from any house, and one mile northwest of Decorah, the other side of the river and three-quarters to one mile from the river. Mr. Holway says that it had every appearance of being native. No more than one specimen has ever been found."

We have no doubt of the identity of the specimen as it agrees with the description and compares well with specimens received from the northeastern portion of the United States. The species is commonly known as Purple Virgin's Bower.

Prof. Macbride informs us that many years ago he collected this species in Delaware county and that at that time it was of not infrequent occurrence. No specimens were preserved and the species has since disappeared.

Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 139.

MYOSURUS MINIMUS *L.* Sp. Pl., p. 284. 1753. Mouse-tail.

A small annual herb, 1–6 inches high, glabrous. Leaves linear, basal, tufted, entire. Scapes 1-flowered. Sepals 5, spurred. Petals small, narrow. Stamens usually many. Pistils numerous. Achenes numerous, on an elongated receptacle, glabrous, apiculate. *Myosurus shortii* Raf. Am. Journ. Sci., vol. 1, p. 379, 1819. *Myosurus minimus* var. *shortii* Huth, Engler's Bot. Jahrb., vol. 16, p. 284, 1893.

We have only two sheets of this species from Iowa. They were sent by Mr. Reppert of Muscatine county. The first sheet bears the following note: "Moist grounds in places along Cedar river, Moscow, Salisbury bridge, May 8th, 1894." The second sheet bears the legend "Wet or damp places along Cedar river and Muscatine slough, not common; Muscatine county, Cedar river region, May, 1895." In the State University herbarium is a specimen contributed by Mr. Reppert with the following note:

"Sandy bottom lands of Cedar river, Salisbury bridge region, Lake township, and at Moscow lake, Moscow where it grows with *Anemone caroliniana* Walt. The Anemone occupying slight ridges while the Myosurus grows in the shallow depressions where the soil is more damp or wet at times, May 8th, 1894. No. 762. Muscatine county. These specimens from Moscow."

The species is credited to Scott county by Prof. Arthur in his Contributions to the Flora of Iowa, p. 5, 1876; also by Barnes, Reppert and Miller in their Flora of Scott and Muscatine counties.

The range of this species is from southern Ontario to Illinois, Kentucky and Florida. It is said to occur on the Pacific coast and in central Europe.

Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 5; Barnes, Reppert and Miller, Proc. Davenport Acad. Nat. Sciences, vol. 8, p. 200.

RANUNCULUS *L.* Sp. Pl., p. 548. 1753.

Annual or perennial herbs, with alternate, simple, entire, lobed, divided or dissected leaves, and white or yellow, solitary or sometimes corymbed flowers. Sepals 5, deciduous. Petals 5, rarely more or less, sometimes minute, with a nectariferous pit or scale at the base inside. Achenes many, usually flattened, pointed, capitate or spicate.

* *Aquatic.*

RANUNCULUS DELPHINIFOLIUS *Torr.* Eaton, Man. Ed. 2, p. 395. 1818. Yellow Water Crowfoot.

Stem floating or immersed, sometimes emersed; leaves repeatedly 3-forked, the ultimate divisions long, capillary; out of water the leaves are often reniform, lobed or toothed or else the divisions are shorter and linear; petals 5–8, bright yellow; achenes callous-margined, with a straight beak which is one-half their length or more. *Ranunculus multifidus* Pursh, Fl. Am. Sept., p. 736, 1814, a name preoccupied by Forskal in 1775 for an Arabian species.

Ranunculus lacustris Beck and Tracy, N. Y. Med. and Phys. Journ. 2, 112, 1823.

This species is to be found in ponds and slow streams from May until June. It is sometimes common locally, but generally throughout the state it is very infrequent. Specimens before us are from Muscatine, Emmet, Dickinson, and Decatur counties. The State University herbarium has in addition specimens from Johnson, Hardin, and Story counties. Messrs. Nagel and Haupt report the species from Scott county; Prof. Fink from Fayette county; Prof. Bessey from Warren county; and Prof. Pammel from Hamilton and Lyon counties.

Forms of this species growing out of the water closely resemble *Ranunculus purshii* Richards, which is distinguished by the marginless achenes and different habitat. Prof. Arthur sends a specimen from Dickinson county labeled *Ranunculus purshii* Richards, but as the achenes are more or less margined we have referred the specimen to *Ranunculus delphinifolius* Torr. Mud-flat forms of the species constitute variety *terrestris* Gray, the flowers and fruit being twice or thrice smaller, the leaves being reniform and coarsely dissected.

Bessey, Contr. to the Flora of Iowa in Fourth Report of the Iowa Agr. Col., p. 91, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Halsted, Bull. Iowa Agr. Col., Nov. 1886, p. 50; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Plant World, vol. 2, p. 44; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 6, p. 177; Manual of the Flowering Plants of Iowa, p. 3; Shimek, Bull. Lab. Nat. History, S. U. I., vol. 3, p. 199; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201; MacMillan, Met. Minn. Valley, p. 247.

** *Plants of swamps or muddy shores; leaves narrow and usually entire.*

RANUNCULUS REPTANS *L.* Sp. Pl. 549. 1753. Creeping Spearwort.

A shore-plant, trailing or reclining, glabrous or pubes-

cent, the branches and peduncles ascending; the leaves linear, lanceolate, or spatulate, usually entire; flowers yellow, solitary, petals much exceeding the sepals; achenes flattish, with a minute sharp beak. *Ranunculus filiformis* Mx. Fl. Bor. Am. 1, 320, 1803; *Ranunculus flammula* var. *reptans* E. Meyer, Pl. Lab. 96, 1830.

This species is included on the authority of Prof. Pammel as we have not seen an Iowa specimen. He says the species occurs at Webster City in moist, sandy soil near artesian wells, close to the Des Moines river. By letter, Prof. Pammel also informs us that the species occurs at Ames, Story City, and in Kossuth county.

Pammel, Proc. Iowa Acad. of Sciences, 1890–1891, vol. 1, part 2, p. 89; MacMillan, Met. Minn. Valley, p. 246.

**** Plants terrestrial, frequently growing in wet or muddy places.*

† *Basal leaves or some of them crenate.*

RANUNCULUS PEDATIFIDUS *J. E. Smith* in Rees Cyclop. No. 72. 1813–16.

A small hairy or glabrous plant, from 4–10 inches high; flowers small, pale yellow; root-leaves pedately cleft, stem leaves with narrow oblanceolate divisions; heads of fruit oblong; achenes oval, frequently hairy, tipped with a short beak. *Ranunculus affinis* R. Br. in Parry's Voy. App. 265. 1823.

We have seen no specimen of this species collected in Iowa. We include it only on the authority of Gray's Manual. Britton and Brown give the range of this species—"Labrador and Quebec to Alaska, south in the Rocky Mountains to Arizona," which indicates a range north of our limits. Gray's Manual gives; "Minn., Iowa, north and west ward."

Gray's Manual, 6th ed., p. 42; Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 5.

RANUNCULUS OVALIS *Raf.* Proc. Dec. 36. 1814. Prairie Crowfoot.

Stem 4–16 inches high, hairy, somewhat branched; root-leaves roundish to rhombic-ovate, toothed or crenate, others 3–5-lobed or 3–5-parted, the upper sessile or nearly so; petals large, deep yellow; head of fruit spherical; achenes oval or orbicular, minutely beaked. *Ranunculus rhomboideus* Goldie, Edinb. Phil. Journ., vol. 6, p. 329. 1822.

A vernal species of the fields and prairies, ranging from Labrador and Ontario to the Northwest Territory, Illinois and Wisconsin, and coming within our limits only in the northern portion. Our specimens were collected in Winneshiek, Fayette, and Emmet counties. The State University herbarium has specimens from Calhoun and Lyon counties, and Prof. Bessey has reported the species from Floyd county.

Bessey, Contr. to the Flora of Iowa in Fourth Report of Iowa Agr. Col., p. 91, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Flora of Floyd county in History of Floyd county, p. 310; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108; Manual of the Flowering Plants of Iowa, p. 5; Rigg, Notes on the Flora of Calhoun county, Iowa, p. 9; Shimek, Flora of Lyon county in Iowa Geol. Sur., vol. 10, p. 170.

RANUNCULUS ABORTIVUS *L.* Sp. Pl., p. 551. 1753. Small-flowered Crowfoot.

Biennial, glabrous or nearly so, 6–20 inches high, branched, conspicuous by having the primary root-leaves round, heart-shaped, or kidney-shaped, obscurely crenate and long-petioled, other leaves 3–5-lobed or 3–5-parted and variously toothed, petioled or nearly sessile; flowers small, inconspicuous, pale yellow; petals shorter than the reflexed sepals.

This species is common throughout the state in moist soil in fields and woods. The flowers appear during the months of April, May, and June. Our collection contains specimens from Winneshiek, Fayette, Muscatine, Johnson, Decatur, Shelby, and Emmet counties. We have ob-

served the species in Allamakee and Page counties. The State University herbarium contains in addition specimens from Scott, Lee, Henry, Story, Mahaska, Pottawattamie, and Lyon counties. Prof. Pammel reports the species from Woodbury and Hamilton counties; Prof. Bessey from Poweshiek and Warren counties; and J. B. Rigg from Calhoun county.

Bessey, Contr. to the Flora of Iowa, in Fourth Report Iowa Agr. Col. p. 91, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Nagel and Haupt, Proc. Davenport Acad. Nat. Sciences, vol. 1. p. 154; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108 and p. 135; Manual of the Flowering plants of Iowa p, 4; Rigg, Notes of the Flora of Calhoun county, Iowa, p. 9; Halsted, Bull. Iowa Agr. Col., Nov. 1886, p. 6, and Bull. 1888, p. 36; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201; Shimek, Flora of Lyon county in vol. 10, Iowa Geol. Sur., p. 176.

†† *Leaves all lobed or divided.*

‡ *Plant glabrous; flowers small.*

RANUNCULUS SCELERATUS *L.* Sp. Pl., p. 551. 1753.

Annual; stem 6–20 inches high, glabrous, thick, hollow, with acrid juice; root-leaves of 3–5 rounded lobes, others 3-parted, cut and toothed, the upper nearly sessile, deeply lobed or divided; lobes oblong or linear, obtuse, entire or toothed, petals about as long as the sepals, pale yellow; head of fruit oblong or cylindric, achenes mucronulate.

This species occurs in wet ditches, flowering from June until August, and is infrequent or rare within our limits. There is a specimen in the State University herbarium collected by G. B. Rigg in Calhoun county. Mr. Cratty by letter reports the species common in Emmet county. Messrs. Nagel and Haupt report the species from Scott county; and Prof. Bessey from Story county.

Bessey, Contr. to the Flora of Iowa, in Fourth Rep. Iowa Agr. Col., p. 91; Arthur, Contr. to the Flora of Iowa, p. 5; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Rigg, Notes on the Flora of Calhoun county, Ia., p. 10.

‡‡ *Plants more or less pubescent.*

§ *Beak of the achene strongly hooked.*

RANUNCULUS RECURVATUS *Poir.* in Lam. Encycl. 6: 125. 1804. Hooked Crowfoot.

Stem 8–20 inches high, hirsute; leaves all similar, long-petioled, broadly reniform, deeply 3-cleft, the divisions cuneate, toothed and lobed beyond the middle; flowers small, on long peduncles; calyx reflexed; petals shorter; achenes compressed, tipped by a recurved beak which is half their length.

This species ranges from Nova Scotia to Manitoba, south to Florida and Missouri. In Iowa it is known to occur only in three counties situated on or near the eastern border. It occurs rather infrequently in woods, flowering in May and June. Specimens before us are from Winneshiek, Muscatine, and Johnson counties. Prof. Arthur and Messrs. Nagel and Haupt report the species from Scott county which report is confirmed by Messrs. Barnes, Reppert and Miller.

Arthur, Contr. to the Flora of Iowa, p. 5, 1872; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 135; Manual of the Flowering Plants of Iowa, p. 4; Shimek, Bull. Lab. Nat. Hist., vol. 3, p. 200; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201.

§§ *Beak of the achene short.*

(*a*) *Introduced erect plants, in fields.*

RANUNCULUS ACRIS L. Sp. Pl., p. 554. 1753. Tall Crowfoot or Meadow Buttercup.

Stem 2–3 feet high, hairy; leaves of 3 sessile divisions, the basal 3–7-divided, the divisions 3-cleft or 3-parted, the segments cut into narrow or linear lobes; petals obovate, 2–3 times longer than the calyx; head of fruit globose; achenes compressed; short-beaked.

This species occurs infrequently in fields and waste places,

flowering from May until September. We have seen one specimen collected in Page county and another in the State University herbarium from Jones county. Prof. Hitchcock reports the species from Story county and Mr. Mills by letter from Henry county. The species is scarcely if at all persistent.

Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Pammel, Proc. Iowa Acad. of Sciences, vol. 4, p. 111; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 135; Manual of the Flowering Plants of Iowa, p. 4; Halsted, Bull. Iowa Agr. Col. 1888, p. 36.

RANUNCULUS BULBOSUS *L.* Sp. Pl., p. 554. 1753. Bulbous Buttercup or Bulbous Crowfoot.

Stem about one foot high, from a bulbous base; radical leaves 3-divided, lateral divisions sessile, the terminal stalked and 3-parted, all more or less cleft and 3-toothed; calyx reflexed; petals much longer; head of fruit globose; achenes compressed, short-beaked.

We have seen no Iowa specimen of this species. Prof. Bessey reports it from Indianola, Warren county; Prof. Arthur lists it in his Flora; and Prof. Halsted includes it in his list of Iowa weeds. If it belongs to the Iowa Flora it is an introduced weed and apparently very rare.

Bessey, Contr. to the Flora of Iowa in Fourth Rep. Iowa Agr. Col., p. 91; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Halsted, Bull. Iowa Agr. Col., 1888, p. 36; Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 4.

(*b*) *Erect or ascending plants of moist soil.*

RANUNCULUS PENNSYLVANICUS *L. f.* Suppl., p. 272. 1781. Bristly Buttercup.

Annual; Stem 1–2 feet high, branching, bristly hairy; leaves ternately compound, divisions frequently 3-cleft, the lobes lanceolate, cuneate, cut or toothed; flowers small; calyx reflexed; petals not longer than the sepals; head of fruit oblong, achenes tipped by a sharp beak one-third their length.

This species is infrequently found in wet soil, blooming

during the months of June, July, and August. Our specimens are from Winneshiek, Allamakee, Muscatine, and Linn counties. Additional specimens in the State University herbarium are from Henry, Winnebago, Cerro Gordo, Hancock, Dickinson, Emmet and Woodbury counties. Prof. Bessey reports the species from Des Moines county and Prof. Hitchcock from Story county. Prof. Fink says the species probably occurs in Fayette county.

Bessey, Contr. to the Flora of Iowa in Fourth Rep. Iowa Agr. Col., p. 91, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108; Manual of the Flowering Plants of Iowa, p. 4; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201.

RANUNCULUS MACOUNII *Britton*, Trans. N. Y. Acad. Sci. 12:3. 1892.

This species much resembles *Ranunculus pennsylvanicus* L. f. and in some respects *R. septentrionalis* Poir. Annual or biennial; ascending or declined, hairy or somewhat hispid; stems 1–2 feet long, rarely rooting; leaves 3-divided, leaflets petiolulate, ovate or broadly oblong, cuneate, mostly 3-parted or 3-cleft, or variously lobed or cleft, somewhat toothed; head of fruit oblong, achenes smooth, the sharp straight beak about one-fourth their length. *Ranunculus hispidus* Hook. Fl. Bor. Am., vol. 1, p. 19, 1829; not *R. hispidus* Mx. Fl. Bor. Am., vol. 1, p. 321, 1803.

The Iowa forms of this species are not well understood. All the material which has fallen into our hands is in the flowering stage. Prof. Fink who first reported the species from Iowa sends us a specimen from Fayette county. While we have referred it here we are by no means sure that our reference is correct. Specimens from Henry, Emmet and Pottawattamie counties which we have examined may belong here. Britton and Brown directly refer this species to Iowa and remark that their description probably includes two or more species. While this uncertainty ex-

ists in regard to the true conception of the species but little can be done with our material.

Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 4; Britton and Brown, Illust. Flora, vol. 2, p. 80; Davis, Minn. Bot. Studies. 2nd Series, p. 469.

(*c*) *Ascending or creeping by stolons.*

RANUNCULUS REPENS *L.* Sp. Pl. p. 554. 1753.

Habit and foliage closely resembling *Ranunculus septentrionalis* Poir., more or less hairy, spreading by runners and forming patches; leaves often blotched; achenes margined, the beak stout, short, and slightly bent.

The only genuine specimens of this species we have seen are from Muscatine and Johnson counties. Messrs. Nagel and Haupt reported the species from Scott county which report is confirmed by Messrs. Barnes, Reppert and Miller. Prof. Bessey reports the species from Poweshiek, Warren and Story counties. Prof. Hitchcock does not include this species in his Catalogue of the plants of Ames, Story county. It seems entirely probable that the species considered by Prof. Bessey was *Ranunculus septentrionalis* Poir. which species is *R. repens* of Gray's Manual, 5th edition, the current edition at the time of the publication of Prof. Bessey's article. The same in part may be said in regard to Messrs. Nagel and Haupt's report of the species from Scott county. The species blooms in low grounds from May until July, and is apparently infrequent.

Bessey, Contr. to the Flora of Iowa in Fourth Report of Iowa Agr. Col., p. 91: Arthur, Contr. to the Flora of Iowa, p. 5; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Shimek, Bull. Lab. Nat. Hist., S. U. I., vol., 3, p. 200; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 135; Manual of the Flowering Plants of Iowa, p. 4; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83, says it probably occurs in Fayette county; MacMillan, Met. Minn. Valley, p. 242.

§§§ *Beak of the achene long and slender.*

(*a*) *Roots fibrous.*

RANUNCULUS SEPTENTRIONALIS *Poir.* Lam. Encycl., vol. 6, p. 125. 1804.

Low, 6–20 inches high, pubescent, erect or in wet places mostly procumbent and forming runners; roots many, fibrous; leaves petioled, 3-divided; the divisions usually all stalked, 3-cleft or 3-divided, the segments toothed or cut; achenes margined, tipped by a sword-shaped style of about their length.

A common species, found in moist soil in all parts of the state, blooming in April and May. This species is considered one of our common weeds, though with us it is a harmless one, having no obnoxious spines or fruit and occupies ground for the most part in neglect or unfit for cultivation, spreads slowly and easily succumbs to proper cultivation.

Our specimens are from Muscatine, Johnson, Decatur, Shelby, and Emmet counties. We have observed the species in Winneshiek county. Additional specimens in the State University herbarium are from Henry, Lee, Mahaska, Calhoun, and Pottawattamie counties. Prof. Hitchcock reports it from Story county; Prof. Pammel from Cherokee county; Prof. Fink from Fayette county; and Messrs. Barnes, Reppert and Miller from Scott county. The early articles on the Iowa Flora do not include this species. It was formerly included with *Ranunculus repens* L.

Hitchcock, Trans. St. Louis Acad. of Sciences, vol. 5, p. 483. Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, pp. 108 and 135; Manual of the Flowering Plants of Iowa, p. 4; Shimek, Bull. Lab. Nat. Hist., S. U. I., vol. 4, p. 200; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, 201; Rigg, Notes on the Flora of Calhoun county, p. 10.

(*b*) *Roots thickened.*

RANUNCULUS FASCICULARIS *Muhl.* Cat. 54. 1813.

Plant pubescent, low, 3–10 inches high, fibrous roots

thickened; leaves 3–5-divided, divisions lobed and cleft, the ultimate segments oblong or linear; petals 5–7, spatulate-oblong; achenes flat, beaked by a subulate style.

This species occurs on the prairies and on the wooded hillsides, flowering in early April and continuing until late in May. In the eastern portion of the state it is generally common. Our specimens are from Fayette, Muscatine, and Johnson counties. We have observed the species in Winneshiek and Scott counties. Additional specimens in the State University herbarium are from Henry, Mahaska, Polk, and Pottawattamie counties. Prof. Bessey reports the species from Warren and Des Moines counties.

Bessey, Contr. to the Flora of Iowa in Fourth Report of Iowa Agr. Col., p. 91, 1872; Arthur, Contr. to the Flora of Iowa, p. 5; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, pp. 108 and 135; Manual of the Flowering Plants of Iowa, p. 3; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201.

BATRACHIUM *S. F. Gray*, Nat. Arr. Brit. Pl. 2: 720. 1821.

Our species are perennial, aquatic herbs, with alternate, dissected leaves, and solitary, white flowers, which are borne on peduncles opposite the leaves. Sepals and petals 5. Stamens several or many. Achenes oblique, compressed, not margined, nearly or quite beakless, transversely wrinkled. An assemblage of plants distinguished from *Ranunculus* by their white flowers and transversely wrinkled achenes.

BATRACHIUM TRICHOPHYLLUM *(Chaix) Bossch.* Water Crowfoot.

Stem about one foot high; leaves 1–2 inches long, *petioled*, flaccid, divided into capillary divisions, *collapsing* when withdrawn from the water; petals ovate, twice as long as the calyx, white; head of fruit small, globose; achenes apiculate. *Ranunculus trichophyllus* Chaix in Vill. Hist. Pl. Dauph., vol. 1, p. 335, 1786; *Batrachium*

trichophyllum Bossch, Prodr. Fl. Bat. 5, 1850; *Ranunculus aquatilis* var. *trichophyllus* A. Gray, Man. Ed. 5; p. 40, 1867; *Ranunculus aquatilis* var. *caespitosus* DC. Prodr., vol. 1, p. 26, 1824.

Our species grows in the soft mud in shallow water and is wholly immersed except the flower which is borne on a stout peduncle and spreads its floral envelops just above the surface of the water. The time of blooming is during the months of June, July, and August. Owing to the dry years and the constant drainage of the ponds this species is rapidly diminishing but may yet be found rather frequently in favorable locations. A pond of still water with this species in full bloom presents a pleasing picture.

Specimens before us are from Winneshiek, Fayette, and Muscatine counties. The State University herbarium has in addition specimens from Delaware county and other localities. Profs. Bessey and Pammel report the species from Hamilton county; and Messrs. Barnes, Reppert and Miller from Scott county.

Bessey, Contr. to the Flora of Iowa in Fourth Report of Iowa Agr. Col., p. 91, 1872; Arthur Contr. to the Flora of Iowa, p. 5, 1876; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5. p. 108; Manual of the Flowering Plants of Iowa, p. 3; Pammel, The Plant World, vol. 2, p. 44; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201.

BATRACHIUM DIVARICATUM (*Schrank*) *Wimm.* Stiff White Water Crowfoot.

Similar to the preceding, but leaves one inch long or less, *sessile* or nearly so, rigid, *not collapsing*; stipules conspicuous. *Ranunculus divaricatus* Schrank, Baier. Fl., vol. 2, p. 104, 1789; *Ranunculus circinatus* Sibth., J. E. Smith, Fl. Brit., vol. 2, p. 596, 1800; *Ranunculus aquatilis* var. *divaricatus* A. Gray, Man. Ed. 2, p. 7, 1856.

This species is found in similar situations and during the same months as the preceding. It ranges quite extensively over the United States, being found in New England, New Jersey, Pennsylvania, Ontario, westward to the Pacific

coast, and in the Rocky Mountains extending southward to Arizona. It is also found in Europe. The flowers and fruits of these two species apparently present no constant differences; they are to be distinguished only by their leaves.

Our specimens are from Emmet, Johnson, and Muscatine counties. Prof. Fink reports the species from Fayette county.

Prof. Arthur in his Flora of Iowa, p. 37, Appendix, has the following note concerning this species: "RANUNCULUS AQUATILIS L. var. STAGNATILIS DC. (*R. divaricatus* of Gray's Manual.)

" 'Frequent forms occur connecting this variety with the last. It can hardly be *R. divaricatus* Schrank, as European and Asiatic specimens of that species show a well-defined lamina to the segments of the leaves, while in American specimens they are always filiform.' *Watson's Rep. in King's Exp.*"

Arthur, Contr. to the Flora of Iowa, pp. 5 and 37; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 135; Manual of the Flowering Plants of Iowa, p. 3; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 201; MacMillan, Met. Minn. Valley, p. 248.

OXYGRAPHIS *Bunge*, Verz. Suppl. Fl. Alt. 46. 1836.

OXYGRAPHIS CYMBALARIA *(Pursh) Prantl.* Seaside Crowfoot.

Perennial, low, smooth, spreading by long, rooting runners; leaves clustered at the roots and on the joints of the runners, long-petioled, cordate or kidney-shaped, crenate; scapes 1–several-flowered, sometimes leaf-bearing toward the base; petals 5 or sometimes as many as 8 or even 12; each with a small nectar pit near the base; stamens and pistils many; head of fruit oval or oblong; achenes compressed, longitudinally striate. *Ranunculus cymbalaria* Pursh, Fl. Am. Sept., p. 392, 1814; *Oxygraphis cymba-*

laria Prantl, in Engl. & Prantl, Nat. Pfl. Fam. 3; Abt. 2, 63, 1891.

A species closely resembling those of the genus *Ranunculus* but distinguished by the longitudinally striated achenes. The habitat is wet prairies and sandy shores, the flowers appearing in June, July, and August. The range of this species is from Labrador to New Jersey west along the St. Lawrence river and Great Lakes to Minnesota and Northwest Territory. Within our limits this species appears to be confined to the northwest. Our specimens are from Dickinson, Emmet, and Lyon counties. Prof. Bessey reports the species from Story county and Prof. Pammel from Lyon county. The University herbarium contains in addition, specimens from several other northern counties.

Bessey, Contr. to the Flora of Iowa in Fourth Report of Iowa Agr. Col., p. 91, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Hitchcock, Trans. St. Louis Acad. of Sciences, vol. 5, p. 483; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fitzpatrick, Manual of the Flowering Plants of Iowa, p, 5.

THALICTRUM *L.* Sp. Pl. 545. 1753.

THALICTRUM DIOICUM *L.* Sp. Pl., p. 545. 1753.

Early Meadow-Rue.

Perennial, stem 1–2 feet high, glabrous; leaves alternate, 3–4-ternate, petioled; leaflets drooping, 3–9-lobed, rounded, *thin*, pale beneath, stalked; flowers dioecious, purplish or greenish, in an elongated panicle which is laterally corymbose or umbellate; sepals 4 or 5; petals none; stamens many, exserted, filaments shorter than the anthers; stigma elongated; achenes ovoid, sessile or minutely stipitate, deeply grooved, much longer than the style.

This species is frequent in upland woods and meadows, flowering in April and May. Within our limits it seems to be found mostly in the northern half of the state though it is found in Missouri and Alabama to the southward, and extends eastward to Labrador and northwestward to the Saskatchewan.

The only specimens in our herbarium were collected in

Winneshiek county. We have observed it in Allamakee, Clayton, and Scott counties. The State University herbarium has additional specimens from Des Moines, Webster, Dallas, Dickinson, and Cerro Gordo counties. Prof. Bessey reports the species from Story and Fayette counties. The former locality is confirmed by Prof. Hitchcock and the latter by Prof. Fink. The species is reported from Scott county by Messrs. Barnes, Reppert and Miller.

Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Bessey, Contr. to the Flora of Iowa in Fourth Report Iowa Agr. Coll., p. 90, 1872; Hitchcock, Proc. St. Louis Acad. of Science, vol. 5, p, 482; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, p. 108; Manual of the Flowering Plants of Iowa, p. 3; Halsted, Bull. Iowa Agr. Coll., Nov. 1886, p. 48; 1888, p. 36; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200.

THALICTRUM PURPURASCENS *L.* Sp. Pl., p. 546. 1753.

Perennial, stem 2–6 feet high, branching above, frequently purplish, pubescent or glabrous; leaves 3–4-ternate, the cauline nearly sessile; leaflets thick, oblong-ovate to nearly lanceolate, veiny, often waxy beneath, usually with three apical lobes; flowers greenish or purplish, dioecious or polygamous, in a compound panicle; filaments *narrow*; anthers linear or linear-oblong, cuspidate; stigma linear, persistent; achenes ovoid, pubescent or glabrous, short-stipitate, with 6–8 longitudinal wings.

This species is common in low prairies and woods throughout Iowa, flowering in May and June. It ranges westward to Arizona and northward to the Saskatchewan, eastward to Nova Scotia and Anticosti, southward to Florida. The form with the leaflets waxy beneath is called variety *ceriferum*, Austin in Gray's Manual, p. 39, 5th edition, 1867.

Our specimens are from Winneshiek, Allamakee, Muscatine, Johnson, Appanoose, Decatur, Ringgold, Union, Fremont, Pottawattamie, Shelby, and Sioux counties. The State University herbarium has specimens from the additional counties of Henry, Des Moines, Lee, Linn, Calhoun,

Winnebago, Dickinson, Cerro Gordo, Lyon, Webster, Dallas, Story, and Emmet counties. Messrs. Nagel and Haupt, report the species from Scott county; Prof. Hitchcock from Story county; Prof. Pammel from Sioux and Hamilton counties; Prof. Fink from Fayette county; and J. P. Anderson by note from Lucas county.

Bessey, Contr. to the Flora of Iowa in Fourth Report of the Iowa Agr. Coll., p. 90, 1872; Arthur, Contr. to the Flora of Iowa, p. 5, 1876; Halsted, Bull. Iowa Agr. Coll., 1888, p. 36; Hitchcock, Trans. St. Louis Acad. of Science, vol. 5, p. 483; Nagel and Haupt, Proc. Davenport Acad. of Nat. Sciences, vol. 1, p. 154; Pammel, Proc. Iowa Acad. of Sciences, vol. 3, p. 111; Fink, Proc. Iowa Acad. of Sciences, vol. 4, p. 83; Fitzpatrick, Proc. Iowa Acad. of Sciences, vol. 5, pp. 108 and 134; vol. 6, p. 177; Manual of the Flowering Plants of Iowa, p. 3; Barnes, Reppert and Miller, Proc. Davenport Acad. of Nat. Sciences, vol. 8, p. 200.

THALICTRUM POLYGAMUM *Muhl.* Cat. p. 54. 1813.

Very similar to the preceding but differing in having no glandular or waxy pubescence, while the filaments are broadened. Torrey and Gray in Flora of North America, vol. 1, p. 38, 1838, referred this species to *Thalictrum cornuti* L., a species entirely distinct, hence this name becomes a synonym. In most cases where this species is reported from Iowa it is under the Torrey and Gray name.

Britton and Brown give the range as Labrador and Quebec to Florida, west to Ohio, a range far east of our limits. It has been nevertheless frequently reported from various localities in Iowa. From the material which has fallen into our hands we have concluded that *Thalictrum purpurascens* L. was the species examined and incorrectly labeled *T. polygamum* Muhl. (*T. cornuti* L. of Gray's Manual.) in most if not all cases. Prof. Bessey reports the species from Story, Poweshiek, Fayette, and Floyd counties in his Contributions to the Flora of Iowa in Fourth Report Iowa Agr. Col., p. 90. Prof. Arthur lists the species in his catalogue, p. 5, 1876, along with the other species mentioned in this article. Prof. Hitchcock does not confirm Prof. Bessey in his catalogue of the Ames flora. Messrs. Nagel

and Haupt report the species from Scott county in Proc. Davenport Academy of Natural Sciences, vol. 1, p. 154 which report is not confirmed by Messrs. Barnes, Reppert and Miller in their flora of Scott and Muscatine counties. Prof. Halsted lists the species as an Iowa weed in Bull. Iowa Agr. Col., 1888, p. 36.

Fitzpatrick, Manual of the Flowering Plants of Iowa, p. 3.

Explanation of Plate I.

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2. Pods of *Isopyrum biternatum* ..... p. 99.
3. Pods of *Caltha palustris* ..... p. 98.
4. Fruiting raceme of *Actaea alba* ..... p. 101.
5. Fruiting raceme of *Actaea rubra* ..... p. 100.
6. Flower of *Aquilegia canadensis* ..... p. 102.
7. Follicles of *Aquilegia canadensis* ..... p. 102.
8. Follicles of *Delphinium ajacis* ..... p. 106.
9. Follicles of *Delphinium carolinianum* ..... p. 104.
10. Follicles of *Delphinium tricorne* ..... p. 103.
11. Flower of *Delphinium tricorne grandiflorum* ..... p. 104.
12. Head of fruit of *Anemone cylindrica* ..... p. 108.
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14. Head of fruit of *Anemone canadensis* ..... p. 110.
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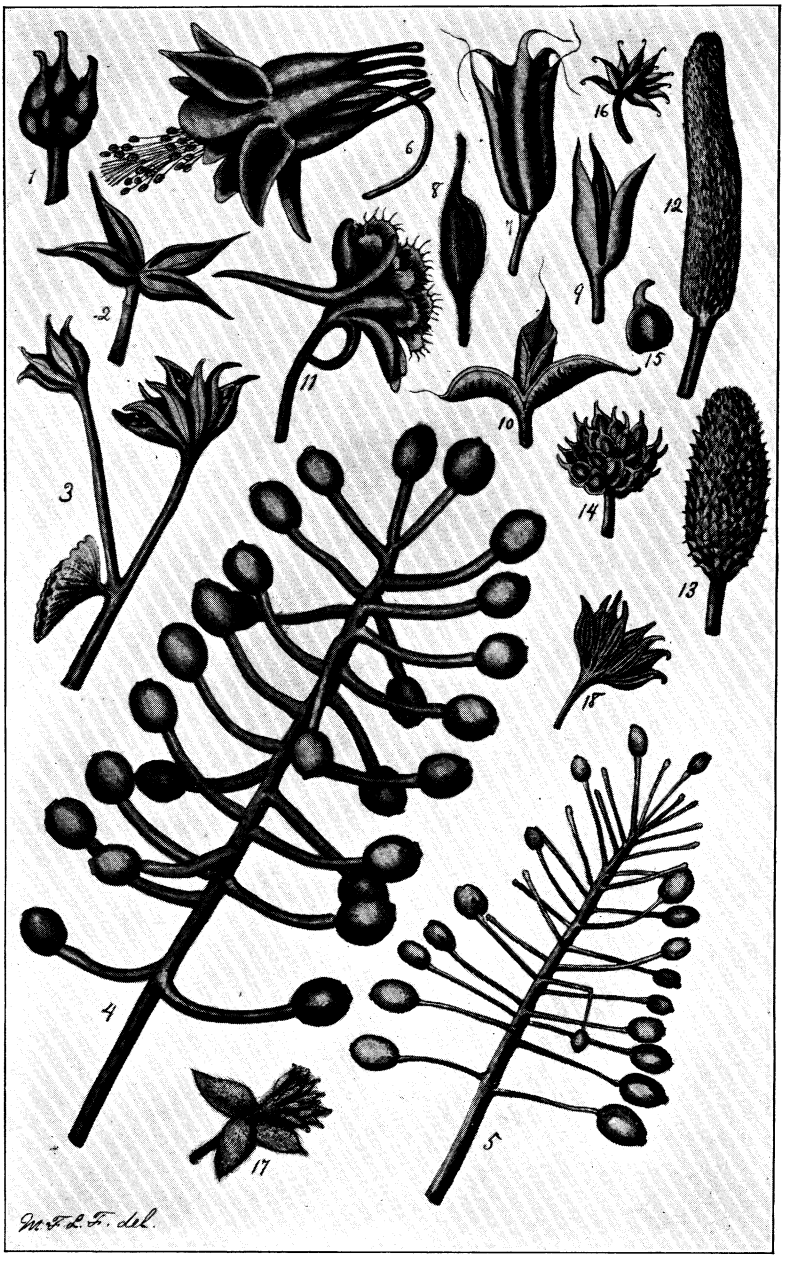
16. Head of fruit of *Anemone quinquefolia* ..... p. 101.
17. Achenes and involucre of *Hepatica acuta* ..... p. 112.
18. Achenes of *Syndesmon thalictroides* ..... p. 114.

PLATE I.



Explanation of Plate II.

1. *Ranunculus fascicularis* .... p. 130.
2. Achenes of *Ranunculus repens* .... p. 129.
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4. Achenes of *Ranunculus recurvatus*.... .... p. 126.
5. *Ranunculus delphinifolius* .... p. 121.
6. Achenes of *Ranunculus delphinifolius* .... p. 121.

6*a*. A single achene of *Ranunculus delphinifolius*. .... p. 121.

7 and 7*a*. Achenes and a single achene of *Ranunculus purshii* . p. 122.

8 and 8*a*. Achenes and a single achene of *Ranunculus abortivus* . p. 124.

9. Achenes of *Ranunculus pennsylvanicus* .... p. 127.
10. Flowers and leaves of *Batrachium tricophyllum*.... p. 131.
11. Achenes of *Batrachium trichophyllum* .... p. 131.
12. Achenes of *Batrachium divaricatum*. .... p. 132.
13. *Oxygraphis cymbalaria* .... p. 133.
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PLATE II.

Explanation of Plate III.

1. *Pulsatilla hirsutissima* ... p. 115.
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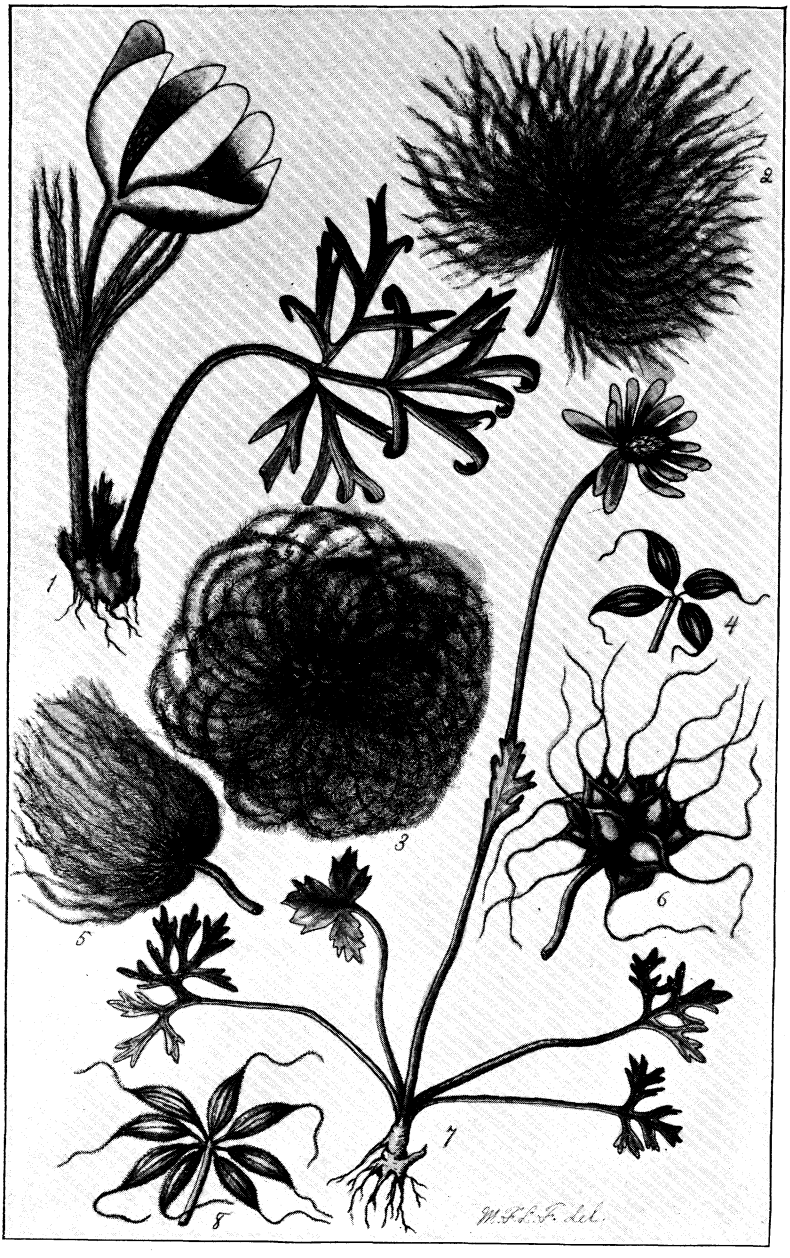
7. *Anemone caroliniana* ... p. 106.
8. Achenes of *Thalictrum purpurascens* ... p. 135.

PLATE III.



PYRAMIDULA SHIMEKII (*Pilsbry*) *Shimek*.

BY B. SHIMEK.

In nearly all of the fossiliferous loess deposits of Iowa and Nebraska there occurs a fossil mollusc which has had a curious history. More that twenty years ago it was the subject of earnest boyish dispute between Mr. H. A. Pilsbry and the present writer, who together collected it at Iowa City. For some years both Mr. Pilsbry and the writer distributed it as *Zonites limatulus* Ward, under which name it was also published*, and no correspondent questioned the identification, although the fossil is very distinct from that species. Having reached the conclusion that the species is distinct, the author prepared a description and figure of the fossil in 1890, and was about to publish it under the name *Zonites pilsbryi*, when he re-received Pilsbry's paper† in which the same species is described under the name *Zonites shimekii!* In that paper Pilsbry calls attention to the fact that "except in sculpture, the *Z. shimekii* is far more like *Z. nitidus* than to *Z. limatulus*." So great is this resemblance to *Z. nitidus* that the author once referred the fossil to that species‡.

However, the coarser sculpturing on the upper surface

* B. Shimek: Am. Geologist, vol. i, p. 149, Mar., 1888; Bull. Lab. Nat. Hist. State Univ. of Iowa, vol. i, p. 61, Nov., 1888; vol. i, p. 202, 1890.
C. L. Webster: Am. Naturalist, vol. 22, p. 419, May, 1888, (list of shells by Shimek).
W J McGee: 11th Ann. Rep. U. S. Geol. Sur., p. 461, 1891.
C. R. Keyes: Ia. Geol. Sur., vol. vii, p. 344; 1897.

† Proc. Acad. Nat. Sci. Phil. for 1890, p. 297.

‡ Proc. Iowa Acad. Sci., vol. v, p. 33.

usually readily marks the fossil. The fossil form is widely distributed in the loess, being one of the characteristic species of that deposit, and has usually heretofore been regarded as extinct. In the paper cited, Pilsbry says that "this form is interesting as being the only well-defined species of loess fossil which seems to have become extinct," and that has been the universally accepted opinion.

However, in 1898* Pilsbry described a living species of *Pyramidula* from New Mexico and Colorado under the name *P. cockerellii*. While at Washington two years ago the author had an opportunity, through the kindness of Mr. C. T. Simpson of the Smithsonian Institute, to examine shells of that species, and was at once struck by their resemblance to *Zonites shimekii*. Indeed, Mr. Simpson himself had named a set of the fossil shells *P. cockerellii!* Through the kindness of Rev. E. H. Ashmun, the author subsequently received three sets of *P. cockerellii* numbering thirty specimens. They are from LaBelle (one of the type-localities), Estes Park and Red River, in New Mexico.

A careful comparison of these shells with our fossil leaves no doubt of their identity. The recent shells are somewhat more depressed than many of the fossils, but among the latter are specimens which are even more depressed than the most extreme recent forms. Moreover the dimensions of the types, recorded by Pilsbry, indicate some variation in this character in the recent shells. In every detail of form, size, apex, sculpture on upper and lower surfaces, thickness of shell, tendency toward formation of peripheral angle except on the last third of the fully-formed body-whorl, size of umbilicus, etc., the fossils are like the recent shells, and Pilsbry's description of *P. cockerelli* exactly fits them in every detail which is still discernible in fossil shells.

A comparison of the original descriptions of *Z. shimekii* and *P. cockerellii* is facilitated by bringing them together

* Nautilus, vol. xii, p. 85, December, 1898.

in parallel columns. The wording of the original descriptions is preserved, but they are so re-arranged as to bring like characters opposite each to each.

Zonites shimekii Pils.	*Pyramidula cockerellii* Pils.
A shell of about the size and shape of *Z. nitidus.*	Shell having the general shape of *P. striatella**.
Surface sculptured with strong, curved riblets above, rather finely striated beneath. The outer three (whorls) ribbed-striate.	Very irregularly wrinkle-striate, some specimens unequally ribbed in places above and at the margin of the umbilicus.
Spire low-conical.	Spire convex.
First (or nuclear) whorl planorboid but noticeably projecting, a trifle mammillated, snowy-white, smooth and polished.	The first whorl a little protruding, whitish-corneous and glabrous when unworn.
Whorls 4½.	Whorls 4⅛.
Aperture oblique, nearly circular, the ends of the peristome approaching.	Aperture oblique, rounded, the penultimate whorl cutting out a segment of about one-fourth the whole circle of the thin and simple peristome.
Alt. 4, greater diam. 5¾, lesser 5¼ mm.	Alt. 2.8, diam. 5.5 mm. (from New Mexico) Alt. 3.2, diam. 6.5 mm. (from Colorado).
Width of umbilicus 1¼ mm.	Width of umbilicus "contained about 3.7 times in that of the shell."—hence about 1½ mm.

The surface-markings are variable in both forms. Sometimes the upper surface is quite regularly ribbed, and again merely "irregularly wrinkle-striate," while the lower surface may or may not show plications or coarser striæ around the margin of the umbilicus. The large series of fossils in the author's collection especially shows much variation in these characters.

The dimensions in the original descriptions would indi-

* All of the shells in the author's collection resemble *Z. nitidus* much more closely.

cate that the fossil is much more elevated. The fossils however exhibit so much variation in this respect that the flattest recent shell in the author's sets easily falls within its range. The dimensions of two fossil specimens from the collections made at Iowa City illustrate this:

Flat form:
Great. diam. 7.4 mm.; alt. 3.5 mm., umbilicus 3 mm.

Elevated form:
Great. diam. 6.5 mm.; alt. 4.2 mm.; umbilicus 1.7 mm.

This may be compared with the dimensions given in the original description, and with those of the two largest shells in two of the author's recent sets.

La Belle, N. Mex.:
Gr. diam. 6.2 mm.; alt. 3 mm.; umbilicus 1.9 mm.

Red River, N. Mex.:
Gr. diam. 7.0 mm., alt. 3.7 mm.; umbilicus 1.9 mm.

The original description of *P. cockerellii* also contain the following additional description which applies equally well to the fossils:

"The rest (of whorls other than apical) convex, regularly widening, separated by a deep suture; last whorl obtusely angular at the periphery in front, becoming rounded on its later portion; base well rounded, the umbilicus showing all the whorls. . . The greatest diameter of aperture contained about 2.4 times in that of shell."

The comparison of both the descriptions and the shells of *Z. shimekii* and *P. cockerellii* therefore establishes their identity. As *Zonites shimekii* was described in 1890, and *Pyramidula cockerellii* in 1898, the former specific name will stand, but the species must be transferred to the genus *Pyramidula* (=*Patula*), and the name becomes *Pyramidula shimekii* (Pils.) Shimek, of which *P. cockerellii* Pils. is a synonym.

The following references show the previous history of the name:

Zonites shimekii Pilsbry, Proc. Acad. Nat. Sci. Phila. for 1890, p. 297.
Zonitoides shimekii Pilsbry, Nautilus, vol. xi, p. 131, March., 1898.
Pyramidula cockerellii Pilsbry, Nautilus, vol. xii, p. 85, Dec., 1898.

The fossils in the author's collection are from the following localities:

Near Rome, Henry county, Iowa. (coll. Prof. T. E. Savage). Very common.

Columbus Junction, Louisa county, Iowa (coll. Prof. J. A. Udden). Not rare.

Iowa City, Iowa, several exposures. Quite common.

Marshall county, Iowa, (coll. Prof. S. W. Beyer). Rare.

Story county, Kelley and Ames, Iowa (coll. of S. W. Beyer). Rare.

Carroll county, Iowa. Quite common.

Woodbury county, Iowa. Rare.

Monona county, Iowa. Rare.

Pottawattamie county, Iowa, several localites. (coll. Prof. J. A. Udden and the author). Widely distributed in the county, but not common.

Fremont county, Iowa. Quite common.

Otoe county, Nebraska. Rare.

Lancaster county, Nebraska. Not common.

Saunders county, Nebraska. Quite common.

Cuming county, Nebraska. Not rare.

The last four localities bring the western range of the fossils comparatively close to Colorado, the present eastern limit of distribution of *P. cockerellii*.

That this species should now be represented by living colonies in regions quite remote from the deposits in which the fossils occur is not remarkable, for other species

quite as characteristic of the loess show similiar peculiarities of distribution. Thus *Pupa muscorum* (L.), widely distributed in the loess of Iowa and Nebraska, is now found living in this country only in the north, from Maine to Montana, and thence through the dry western regions to Utah and Nevada, and its near relative, *Pupa blandi* (Morse) Binn., also frequent in the loess, is likewise found only in the dry west, from the Dakotas to New Mexico; *Sphyradium edentulum alticola* (Inger.) Pils., a common loess fossil, while scarcely distinct from the type, is the form commonly living in the Rocky Mountain region, and occurs only sparingly with the type eastward; *Pyramidula strigosa iowensis* Pils., the fossil form, while now considered extinct, belongs to a species which now spreads over all the western dry regions from Montana and Washington to Mexico, and its extremely great variation in form, size and sculpturing warrants the belief that the now fossil form was a mere geographical race in no wise outranking the dozen or more living varieties of *Pyramidula strigosa* now recognized; while less marked examples are found in such species as *Vallonia gracilicosta* Reinh., *Succinea grosvenorii* Lea and *Helicina occulta* Say, which, though now living, are yet entirely extinct in many localities in which the fossils are found. There is, therefore, nothing unique in the relative distribution of the recent and fossil shells herein discussed.

That the first-described, and for many years only known, specimens of this species were fossils is an interesting fact which has its counterpart in the history of another common loess fossil, *Helicina occulta* Say, which was described by Say from fossil specimens, and which for many years was regarded as extinct. Yet it has been discovered living in widely-separated isolated colonies from Virginia and Pennsylvania to Wisconsin and Iowa.

It is interesting to note in this connection that the few species of loess fossils which form marked exceptions to

the rule that the loess-fauna of any region is essentially the same as its recent terrestrial molluscan fauna, are species of land-shells now living in the western, comparatively dry highlands. They are *Pupa muscorum* (L.), *Pupa blandi* (Morse) Binn., *Sphyradium edentulum alticola* (Inger.) Pils, *Pyramidula strigosa iowensis* Pils. (represented only by other varieties of the species), and now *Pyramidula shimekii* (Pils.) Sh.

IOWA PTERIDOPHYTA

in the Herbarium of the State University of Iowa.

BY B. SHIMEK.

It is the purpose of this paper to record the *Pteridophyta* from Iowa now found in the herbarium of the State University of Iowa. Such lists are of two-fold interest: they assist the student of geographical distribution of plants, and they locate material for study and reference.

In a modest paper such as this it seems presumptuous to discuss the question of nomenclature. Yet this question is met in the very effort to make such a record as that here presented.

Few groups of equal size with the Pteridophyta present as much variation in characters. Representing the most ancient vascular vegetation which formerly formed the forests of the earth, and still constituting an important feature of the tropics, this subkingdom has been sufficiently plastic to adjust itself to the varied conditions of several geological ages, and this probably accounts for that intergradation of characters which is the delight of the evolutionist, but which has furnished many pitfalls to the systematist. This is equally true of both the more important structural and developmental characters which mark larger groups, and

the minor morphological characters which determine species or even genera, and accounts for the wide difference between the extravagant genus-making of Feè, Presl and John Smith, and the extreme conservatism of many more recent English and American students of the group. It is not purposed here to enter upon a general discussion of the subject of nomenclature, nor indeed to take up the discussion in detail with reference to this group. The purpose of this paper is fully accomplished in the recording of certain forms under names which will leave no doubt of their identity, but as there are a few deviations from the names now ordinarily recognized, some explanation is desirable.

So far as the larger subdivisions are concerned the writer sees no reason for the abandonment of the names applied by earlier writers to well-defined groups. For that reason Willdenow's *Gonopterides* and *Hydropterides*, elevated to the rank of classes, are here used.

Willdenow* defined these groups in 1810, though he had already made use of the names in the preceding year†.

The group *Gonopterides* was made to include the genus *Equisetum*, and was well defined.

The group *Hydropterides* included the class as used here and the genus *Isoetes*. As the position of the latter is still problematic, and as no specimens from Iowa are found in the University herbarium,‡ no attempt is here made to assign to it a definite place. It may be necessary to still further subdivide the *Hydropterides*. The name *Stachyop-*

*Sp. Plantarum, vol. v, pp. xxxxi and xxxxii.

†In *Enumeratio Plantarum*, pp. 1064–1076 (1809).

‡*Isoetes melanopoda* J. Gay was collected in Iowa by G. Vasey in 1862 (Botanical Works of Englemann, p. 452, foot-note), and was reported from Clinton county by Prof. Arthur (Proc. Dav. Acad. Sci., vol. iv, p. 67, 1886). All subsequent reports are based on these records.

terides was not adopted for any group because it is made to include such divers forms as *Lycopodium* and *Botrychium*, and hence does not represent a natural group.

For the remaining classes Swartz's names *Filices* (used by Linné in a broader sense) and *Lycopodineæ* are adopted. The group *Filices* as recognized by him* was assigned the same limits as are here recognized. Later Willdenow (l. c.) used the name in a more restricted sense, omitting the eusporangiate groups now called *Ophioglossaceæ* and *Marattiaceæ*†, and also the *Schizeaceæ* and *Osmundaceæ*.

The name *Lycopodineæ*‡ was the first name applied to the correctly defined group, and it is retained in its original form for the same reason, and because in that form it has become a familiar name.

The use of these names can scarcely cause confusion, and it is warranted by the law of priority.

Generic names, because entering directly into all binomial combinations, present a much more serious problem. Genera, at least among ferns, are not distinct entities, for well-defined characters which would absolutely mark them do not exist in most cases. That this is true has been amply demonstrated by the wide divergence in the definitions of genera offered by the many eminent pteridologists who have sought to introduce order into the classification of this fascinating group. Thus the genus *Polypodium* as defined by Hooker was subdivided by John Smith into nearly thirty genera, and the more restricted *Polypodium* of American authors is now subdivided into five genera. Swartz's *Aspidium* (with occasional combinations with

*Fl. Ind. Occ., vol. iii, pp. 1578-1758 (1806) and in Synopsis Filicum. (1806).

†If a separate class is created out of this family as has recently been done by Bitter (Eng. and Prantl Nat. Pflanzenf., 195 Lief., p. 422, —1900) it should bear the name *Poropterides* (Willdenow, *l. c.*)

‡Syn. Fil., p. 87 (1806).

parts of other genera) has been divided and re-divided into overlapping genera until the application of the strict laws of priority to the nomenclature of the group has been made extremely difficult, if not in many cases impossible. The confusion in nomenclature has been due only in part to improper citations,—it results more frequently in its most serious phases from the fact that the grouping of the varied and more or less blending characters of these plants has been left largely to the judgment of individuals, and of course each new grouping has resulted in the displacement of old names, or in their application in a sense different from that in which they were first used. In consequence comparatively few generic names are now used strictly in the original sense, and most of our ferns have been shifted from one genus to another until a cumbersome and confusing synonymy has resulted.

It is absolutely impossible to establish a stable nomenclature until pteridologists reach some substantial agreement concerning the limits of genera. Until this is done in the more confusing (and hence confused) groups all the binomials which are employed for members of such groups must be considered provisional. The more recent classifications, which are by no means in harmony, indicate that a thorough systematic discussion of the best grouping of class, ordinal and generic characters is desired above any mere juggling with names. This discussion should be sufficiently comprehensive to include the morphology, histology, habit and fruit of the sporophyte, and the development and correlation of both oöphyte and sporophyte, and all these should be collectively employed in settling so far as this is possible the vexed questions of rank and relationship. So long as only a portion of these characters is employed confusion is inevitable.

Another source of confusion is to be found in the attempt to apply rigidly various "codes of nomenclature" which in every case are recognized by only a part of the

working systematists of the world. Anything approaching stability of nomenclature is out of question until these codes are reduced to one.

The difficulties which result from the condition of affairs above set forth are well illustrated in a number of cases. Thus *Phegopteris dryopteris* (L.) Fèe was described as *Polypodium dryopteris* by Linné. In 1803 Michaux* referred it to the genus *Nephrodium*, and recently Diels restored the name†. In 1850-1852 Fée established the genus *Phegopteris* to which our species was referred. Up to this point, then, the synonymy would stand as follows:

Polypodium dryopteris L.

Nephrodium dryopteris Michaux.

Phegopteris dryopteris (L.) Fée.

Nephrodium dryopteris (L.) Mx. (restored).

But O. Kuntze refers *Nephrodium* to *Dryopteris*, and if Diels' view of genera and Kuntze's nomenclature be adopted the name would stand as *Dryopteris dryopteris* (L.). But there are those who insist that homonyms are not permissible, hence they would drop the specific name *dryopteris*. The next specific name which could be used is *calcarea*,—*Polypodium calcareum* Pursh‡ (non Smith), and accordingly the name would stand *Dryopteris calcarea* (Pursh). But *calcarea* had previously been used by Smith§ for the form now known as *Phegopteris dryopteris robertiana* (Hoffm.) Dav. If those, who hold that "once a synonym always a synonym," reached this point therefore they would wholly discard the specific name *calcarea*, and if they further believed *P. robertiana* to be distinct from *P. dryopteris* the latter would be left without a name! Or if

*Flora Boreali-Americana, vol. ii, p. 270.

†Nat. Pflanzenfamilien, 188-189 Lief., p. 175 (1899).

‡Fl. Am. Sept., vol. ii, p. 659, (1814).

§Fl. Brit. p. 117 (1804).

robertiana and *dryopteris* were to be regarded as varieties of the same species, the former would be the type and the latter the variety!

Another striking case is that of our common ostrich-fern the synomymy of which has been recently discussed by Underwood.*

This case, as he shows, presents possibilites of complications without number. Admitting the identity of the European and American forms, of which there is little question, we may still have the following names for a species concerning the identity and distinctness of which there is no question:

1. If the species is retained in the genus *Onoclea* the name would be *Onoclea struthiopteris* (L.) Hoffm.

If placed in a separate genus several possibilities arise:

2. In 1810 Willdenow established for the species the genus *Struthiopteris*. The name had been previously used by Scopoli for the genus now called *Lomaria* and by Bernhardi for the present *Osmunda*. But *Lomaria* has been united, with some reason, with the genus *Blechnum* by several authors.† If this is done, and *Osmunda* is used in the sense in which it has been so long understood, then the generic name *Struthiopteris* might be used for our species and the name would be *Struthiopteris struthiopteris* (L.).

3. Or if objection is made to the homonym, then the next name would be *Struthiopteris nodulosa* (Mx.).

4. Or if the generic name *Struthiopteris* is given up (so far as this species is concerned) for the reasons given in (2), the name would be *Matteucia struthiopteris* (L.) Todaro.

*Our Native Ferns, 6th ed., pp. 49-50 (1900).

†Most recently by Diels in Engler and Prantl's Nat. Pflanzenf., 190-191 Lief., p. 245 (1899).

And this suggests other complications. If *Lomaria* is not recognized as a distinct genus the name *Struthiopteris* might be applied to the present genus *Osmunda*, and the latter name might again be retained for the genus *Botrychium* on the ground that the first species of the genus is the type, and the first species of the Linnean *Osmunda* are now referred to *Botrychium!* The foregoing transfers are based on the practices of various botanists, or on views concerning generic relationship and nomenclature actually expressed, and clearly illustrate the causes of the great confusion in nomenclature which actually exists.

Considering this state of affairs it seems hardly worth while to offer more than a bare list of names, such as will be readily traced or recognized, in a paper of this character, for it is impossible to make a final disposition of many specific and generic names until the limits of genera are more definitely fixed.

For that reason some of the names here inserted are used without hesitation because they clearly designate well-defined and well-known species, rather than because the disposition of their nomenclature is considered a finality. Thus on account of the doubt, to which reference has already been made, the generic name *Struthiopteris* is retained because its use will not add to the confusion already existing, and because the species is thus sufficiently marked. That the genus is distinct from *Onoclea*, however, seems clear. Not only does it differ from that genus in habit of growth and venation, but the indusium approaches that of *Cystopteris*, while *Onoclea* resembles *Woodsia* more nearly in that character.

Cystopteris is retained because of its long usage, and because it is a question whether *Filix* Adanson should not be relegated with *Lichen* and other similar generic names.

No group of ferns offers greater difficulties to the

systematist than the Family *Aspidieæ*, and the writer does not presume to be able to remove them.

Unless the indusium is practically disregarded as a generic character, as has been suggested by Gilbert* and the group is subdivided on new lines, generic limitations will remain more or less indefinite and unsatisfactory. But so long as this character is employed there can be no warrant for the union of *Aspidium* (restricted) and *Nephrodium* under one generic name (*Dryopteris* Adanson, according to Kuntze†,) while *Phegopteris* is recognized as a valid genus, for whatever may be the difficulty in distinguishing between *Aspidium* (restricted) and *Nephrodium*, it is even greater between *Nephrodium* and *Phegopteris*. Yet much of this difficulty is due to imperfect material, and a change in classification ought scarcely to be demanded merely for the purpose of facilitating the disposition of imperfect material. On the same ground objection may be made to Diels' union of a part of *Phegopteris* with *Nephrodium*‡ while *Polystichum*, *Aspidium*, *Nephrodium*, etc. are recognized as genera.

Whatever may be the difference of opinion as to the name, the conviction that the group known as *Polystichum* should constitute a distinct genus seems to be growing. The habit of growth, texture, venation and distinctly peltate indusium separate all of the species distinctly from other members of the family, and Roth's name *Polystichum* is probably the correct one for the genus.

The generic name *Dryopteris* has been used in such a variety of senses in recent years§ that it is impossible to determine its correct application from recent references,

*Report of Boston Meeting, Linnaean Fern Chapter, pp. 19-25 (1899).

†Britton and Brown, Ill. Flora, vol. i, (1896). Prof. Underwood has since restricted *Dryopteris* to the species formerly included under *Nephrodium*,–*vide* "Our Native Ferns," 6th ed., 1900.

‡Nat. Pflanzenfamilien, 188-189 Lief., pp. 166, *et seq.*

§See Britton and Brown, l. c., Engler, l. c., Underwood, l. c., etc.

and until generic limits are better defined; and the writer prefers to retain the well-known *Nephrodium* for the present because its use cannot in the least increase the existing confusion, and may be a final necessity. *Phegopteris* is retained in its original sense for the clearly non-indusiate forms.

It is easy to subscribe to Diels' and Underwood's restoration of the genus *Pteridium* for our *Pteris aquilina* L., the double involucre separating it at once from *Pteris*. Equally satisfactory is the transfer of *Pellæa gracilis* Hk. to the genus *Cryptogramma* under the earliest specific name *stelleri*, provided the genus *Cryptogramma* is to be maintained, which seems desirable.

The genus *Adiantum* is removed from the *Pteridieæ* and placed in a separate family,—John Smith's *Adianteæ*. The position of the sori on the reflexed involucre, and the habit and texture of these ferns certainly entitle them to take rank as a family with such groups as *Davallieæ* and *Lindsayeæ*.

Still other changes may be necessary. Thus, as already stated, the eusporangiate ferns,—the *Ophioglossaceæ* and *Marattiaceæ*, the latter of course not represented in Iowa, may have to be removed from the class *Filices* (and from each other), and the *Selaginellaceæ* and *Lycopodiaceæ* may also take rank as related classes. However, further comprehensive comparative study is necessary before these points can be satisfactorily decided.

The following is a complete list of the Iowa Pteridophytes in the State University Herbarium in April, 1901. Unless the collector's name is given the specimens were collected by the writer.

Subkingdom PTERIDOPHYTA Cohn.

Class I GONOPTERIDES Willd., Sp. Pl., vol. V, p. xxxxi.

Order EQUISETACEÆ DC., Fl. Fr., vol. II, p. 580, (1805).

Genus EQUISETUM *L.*, Sp. Pl., vol. II, p. 1061 (1753).

EQUISETUM ARVENSE *L.*

Very common in sandy or clayey soil. The fertile stems appear late in April or early in May, and are soon followed by the sterile shoots. The herbarium contains a large series of specimens, — mostly sterile. The following counties are represented: Lee (July, 1895 and June, 1897); Henry (*J. H. Mills*, no date); Muscatine (Oct., 1900); Johnson (*T. H. Macbride*, May, 1880, fertile; *Shimek*, 1882, fertile; fertile in April and sterile in May, 1891); Linn (June, 1894); Winneshiek (*T. E. Savage*, May, 1899); Cerro Gordo (July, 1896, June, 1899); Hancock (July, 1896); Winnebago (Sep., 1895); Emmet (*R. I. Cratty*, no date, fertile; *Shimek*, Aug., 1899); Lyon (Aug., 1896); Webster (July, 1897); Dallas (July, 1897); Adair (*J. E. Gow*, Aug., 1900); Pottawattamie (*J. E. Cameron*, May, 1898).

EQUISETUM FLUVIATILE *L.*

Not common, in swamps in the north-central part of the state. This is *E. limosum* L. Four counties are repre-

sented: Emmet (*R. I. Cratty*, June, 1884, fruiting); Winnebago (July, 1899, old fruit, branching); Hancock (July, 1896, sterile, somewhat branched); Hamilton (May, 1882, fertile).

EQUISETUM ROBUSTUM *A. Braun*, Engelm., Am. Jour. Sci., vol. XVI, p. 88 (1844).

This species is not rare in the state, but is often confused with *E. hyemale* and sometimes with *E. lævigatum*. It is readily distinguished from these species, even when sterile, by the short sheaths whose ridges are *tri*-carinate, at least toward their tips. The ridges are four-carinate in the former and two-carinate in the latter. The species grows commonly on wet banks. The following counties are represented: Henry (*J. H. Mills*, no date); Johnson (Mch., and Apr., 1901); Linn (May, 1892, fertile; Jackson (*T. H. Macbride*, Aug., 1883); Winnebago (Sep., 1895); Shelby (*T. J. Fitzpatrick*, May, 1884). The last specimen is well-fruited. It was labelled *E. lævigatum*, but, though the sheaths are rather elongated, it seems clearly to be the present species.

EQUISETUM HYEMALE *L.*

This species does not seem to be common in the state. Two counties only are represented: Lee (July, 1895); and Des Moines (*P. Bartsch*, Aug., 1895). It is readily recognized by the slender stems (usually tufted) and by the four-carinate ridges on the elongated sheaths.

EQUISETUM LÆVIGATUM *A. Braun*; Engelm. Am. Jour. Sci. vol. 46, p. 87. (1844).

This is the most common species of the genus in the State. It is found most commonly on sandy banks or ridges, often in rather dry places, and does not often produce sterile branches. Some specimens are quite strongly tuberculate, as for example the Lee county specimens (1895) and those from Winnebago and Webster counties. The latter have rather strong transverse tubercles as in *E.*

robustum, and there is also an occasional faint trace of a central carina on the ridges of the sheaths, which brings these specimens still nearer to that species. It fruits in May and June. The following counties are represented: Lee (July, 1895; June, 1897); Linn (June, 1894, and May, 1896; fruiting); Black Hawk (July, 1898); Cerro Gordo (Mason City, July, 1896; Clear Lake, June, 1899, the latter well-fruited); Winnebago (July, 1899); Emmet (*R. I. Cratty*, July, 1886, fruiting; *Shimek*, Sept., 1895); Dickinson (July, 1897, fruiting); Webster (July, 1897); Dallas (July, 1896); Adair (*J. E. Gow*, Aug., 1900); Pottawattamie (*J. E. Cameron*, May, 1896); Woodbury (Aug., 1900); and Lyon (Rock Rapids, Aug., 1897; northwest corner, June, 1897, fruiting; Granite, June, 1897, fruiting).

Class II. FILICES (L.) Swartz, (l. c.).

Sub-class I. EUSPORANGIATÆ Goebel.

Order I. OPHIOGLOSSACEÆ Lindl.*

Genus BOTRYCHIUM *Swartz*, Schrad. Jour. Bot. vol. II, p. 8 (1800).

1. BOTRYCHIUM VIRGINIANUM (*L.*) *Swz.*

This species, while nowhere gregarious, is widely distributed through the wooded portions of the State. It prefers deeper shade, but may sometimes be found in more open woods. Specimens from the following counties are in the herbarium: Johnson (June, 1891; May, 1894; May, 1896); Black Hawk (*Miss Minnie Howe*); Henry (*J. H. Mills*); Shelby (*T. J. Fitzpatrick*, June, 1894); Jones (*T. H. Macbride*, Aug., 1895; *J. E. Cameron*,

*On authority of Underwood (l. c.)

June, 1895); Winnebago (July, 1896); Cerro Gordo (July, 1896); Pottawattamie (*J. E. Cameron*, June, 1897); Webster (July, 1897); Bremer (July, 1898); Emmet (Aug., 1899); Delaware (*J. E. Cameron*, Sept., 1899).*

Sub-class II. LEPTOSPORANGIATÆ Goebel.

Order FILICACEÆ.

Sub-order **OSMUNDACEÆ**, *R. Br.*, Prod. Fl. N. Holl., vol. I, p. 161 (1810).

Genus OSMUNDA *L. Sp. Pl.*, vol. II, p. 1063 (1753).

OSMUNDA REGALIS *L.*

Rare in the state. Two specimens, one well-fruited, collected in 1891, the other sterile, collected in 1893, both secured by Mr. Fred. Reppert in "swampy depressions on sandy hills near Cedar river, Lake twp., Muscatine county" are in the herbarium. Mr. Reppert notes that they are being tramped out by cattle.

OSMUNDA CINNAMOMEA *L.*

The collection contains one fine fruiting specimen from Lake twp., Muscatine county. Mr. Reppert collected it in June, 1891, "in one of the frequent hillside swamps of the sandy hills along the Cedar river." About twenty years ago the writer collected fruiting specimens of this species near Old Man's creek in Johnson county. Some of the specimens were in the University herbarium for a time, but they have disappeared.

*"*B. ternatum* Swz." (*B. obliquum* Muhl.) has been reported from Fayette county (Fink), and from Floyd county (Arthur), but the University herbarium contains no specimen from Iowa.

OSMUNDA CLAYTONIANA *L.*

Very common in shady places, especially at the heads of heavily wooded ravines. The following counties are represented in the herbarium: Johnson (June, 1880 and 1892); Jones (*J. E. Cameron*, July, 1895); Delaware (*J. E. Cameron*, Oct., 1897); Allamakee (*T. E. Savage*, June, 1899); Adair (*J. E. Gow*. August, 1900.)

The specimens vary from the unfolding fertile fronds of spring through the fully expanded state still retaining the withered fertile pinnæ, to the sterile forms of late summer and autumn. The species is much more common in the State than it would seem to be from the comparatively small number of locality sets in the collection. However, with the clearing and pasturing of timber it is very rapidly diminishing in numbers.

Sub-order **POLYPODIACEÆ** *R. Br.*, Prod. Fl. Holl., vol. I, p. 145 (1810).

Family **POLYPODIEÆ** *J. Sm.*, *Hk. Jour. Bot.*, (1841).

Genus P O L Y P O D I U M *L.*, Sp. Pl. vol. II, p. 1082, (1753).

POLYPODIUM VULGARE *L.*

This species has thus far been received only from the extreme eastern part of the State, where it is locally common on moss-covered banks, etc. The specimens are all in full fruit, those from Clayton county alone being somewhat immature. Three counties only are represented: Muscatine (*T. H. Macbride*, Sept., 1882; *F. Reppert*, Aug., 1894, "on sandstone ledges"; *Shimek*, Nov., 1897,

and Oct., 1900); Allamakee (*T. H. Macbride*, Aug., 1893); and Clayton (*T. J. Fitzpatrick*, July 7, 1895).

Family **WOODSIEÆ** *Eaton*, Ferns N. Am., vol. ii, p. xi. (1880).

Genus W O O D S I A *R. Br.*, Tr. Linn. Soc., vol. II, p. 170, (1812).

WOODSIA SCOPULINA *D. C. Eaton.*

A species which was first found by the writer in the extreme north-western corner of the State, in Lyon county, in August, 1896. In June, 1897, much finer sets were secured on two exposures, about two miles apart. These have an abundance of younger fruit with well-developed involucres, and their excellent condition makes the indentification certain. Three representative sets are in the herbarium.

WOODSIA OBTUSA (*Spreng.*) *Torr.*

This species seems to be rather rare in the State. It is found sparingly in a number of localities in Johnson county, usually on the moss-covered tops of limestone ledges. The fruiting begins in June. Some of the fronds from Johnson county in the herbarium measure nearly seventeen inches in total length. The following counties only are represented: Johnson (Sep., 1893; June, 1894); Boone (*L. H. Pammel*, Aug., 1896).

Genus O N O C L E A *L.*, Sp. Pl. vol II, p. 1062 (1753).

ONOCLEA SENSIBILIS *L.*

This species is locally common in rather wet meadows, in the bottoms of wooded ravines, etc. The fruiting fronds begin to appear in June and mature in August. The herbarium specimens are from Johnson county (Sep., 1880; Aug., 1893); Muscatine county (*F. Reppert*, June,

1891, "from wooded island opposite Fairport"); Ringgold county (July, 1890, sterile); Delaware county (*J. E. Cameron*, Sep., 1897, sterile); and Linn county, (July, 1898).

Genus STRUTHIOPTERIS *Willd.*, Mag. Ges. Nat. Fr. Berl., p. 160 (1809).

STRUTHIOPTERIS STRUTHIOPTERIS (*L.*).

Quite widely distributed in the State. It prefers moist banks and alluvial (more or less sandy) flats. Specimens have been received from the following counties: Johnson (June, 1891; Sept., 1894; *F. S. Aby*, no date); Jackson (*T. H. Macbride*, Aug., 1883); Muscatine (*F. Reppert*, no date; *Shimek*, Oct., 1900); Shelby (*T. J. Fitzpatrick*, May, 1894); Webster (July, 1897, sterile).

Genus CYSTOPTERIS *Bernhardi*, Schrad. Neu. Jour. Bot. vol. I, pt. 2, p. 26 (1806).

CYSTOPTERIS FRAGILIS (*L.*) *Bernh.*

One of the most common ferns in the State. It appears early in clumps of hazel-bushes, etc., most commonly in rather low, rich woods, and begins to fruit in June or even in May. Occasional fruiting specimens may be found in favorable localities all summer long, but most of the fronds wither and die by the end of July. If a wet autumn follows a long dry summer a second growth of fertile fronds may be developed. The following counties are represented. Emmet (*R. I. Cratty*, June, 1882); Pottawattamie (*J. E. Cameron*, June, 1897); Webster (July, 1897); Dallas (July, 1897); Ringgold (July, 1890); Delaware (*J. E. Cameron*, Sept. 24, 1897, the largest fronds in the collection, in fine fruit); Johnson (July, 1880; June, 1900); Louisa (*P. C. Myers*, August, 1897, sterile); Lee (June, 1897).

CYSTOPTERIS BULBIFERA (*L.*) *Bernh.*

A common species, and one of the prettiest, in eastern Iowa, growing on shaded limestone banks. It begins to fruit in June, and endures longer than the preceding species. Nearly all of the specimens in the herbarium have the characteristic bulblets. The following counties are represented: Allamakee (*T. H. Macbride*, Aug., 1893; *T. E. Savage*, June, 1899, young frond); Winneshiek (*T. J. Fitzpatrick*, July, 1896; *T. E. Savage*, May, 1899, sterile); Cerro Gordo (July, 1896, sterile); Clinton (*L. H. Pammel*, Sep., 1896); Jones (*J. E. Cameron*, July, 1895; *T. H. Macbride*, Aug., 1895); Delaware (*J. E. Cameron*, Sep., 1897); Johnson (June, 1881 and 1896); Webster (July, 1897).

Family **ASPIDIEÆ** *J. Smith*, Hk. Jour. Bot. (1841.)

Genus PHEGOPTERIS *Fee*, Gen. Fil., p. 242. (1850-2).

PHEGOPTERIS PHEGOPTERIS (*L.*) *Underwood.*

Rare, in low woods, etc. The herbarium contains but one specimen from Iowa, collected by Prof. T. H. Macbride in Delaware county in July, 1878. It is in full fruit, and is a typical specimen.

PHEGOPTERIS HEXAGONOPTERA (*Mx.*) *Fee.*

Locally common in the eastern part of the State on wooded slopes in leaf mould, etc. The following counties are represented in the herbarium: Johnson (July, 1881, in fine fruit); Delaware (*J. E. Cameron*, Oct., 1897, with mature fruit); Muscatine (Pine creek and Sweetland creek, Oct., 1900; the former scantily fruited, the latter in full,

mature fruit). Fruiting specimens may be found from June until October.

PHEGOPTERIS DRYOPTERIS (*L.*) *Fee.*

Rare in Iowa. Two specimens from Johnson county, probably collected by Prof. Macbride, are in the collection. They are well-fruited. The species was formerly occasionally found in deep woods north of Iowa City.

PHEGOPTERIS ROBERTIANA (*Hoffm.*) *Fee.*

Probably a mere variety of the preceding. Not common in Iowa. One county only is represented: Allamakee (*T. H. Macbride*, Aug., 1893, in full fruit.)

Genus NEPHRODIUM *Richard* (*?*)* in Michaux, Flor. Bor. Am., vol. II, p. 266. (1803).

NEPHRODIUM THELYPTERIS (*L.*) *Desv.*

Quite common in wet meadows and ravines. Usually fruiting in July and August. The following counties are represented: Johnson (July, 1881, and August, 1893, both fruiting); Delaware (*T. H. Macbride*, Aug., 1883, in full fruit); Cerro Gordo (July, 1896, sterile); Hancock (July, 1896, sterile).

NEPHRODIUM CRISTATUM (*L.*) *Mx.*

Two specimens, one in fine fruit, were furnished by Mr. Fred. Reppert, who collected them in July, 1894, in Bloomington township, Muscatine county, in "damp ravines, etc." No other Iowa specimens are in the herbarium.

NEPHRODIUM GOLDIEANUM (*Hk.*) *H. & G.*

This handsome species has been received only from the eastern part of the State, where it grows in a number of localities on well-shaded banks, etc. It begins to fruit in August, and fertile fronds may be found until late in October. The herbarium contains specimens from the

* Richard's name does not appear in Michaux.

following counties: Muscatine (*T. H. Macbride*, Sep., 1882; *Shimek*, Oct., 1900; both in full fruit); Jackson (*T. H. Macbride*, Aug., 1883, with mature fruit).

NEPHRODIUM SPINULOSUM (*Retz.*) *Desv.*

Quite rare in the State, two counties only being represented: Johnson (Aug., 1881, sterile); and Muscatine (*Fred. Reppert*, no date, in fine fruit; *Shimek*, Oct., 1900, in full fruit; *T. H. Macbride*, Sept., 1882, fruiting; *De-Jong*, Oct., 1894, fruit immature). The last two specimens are clearly the variety *intermedium*, having the glandular indusium, etc. The other specimens probably also belong to the variety.

Genus POLYSTICHUM *Roth*, Tent. Fl. Germ., vol. III, (1800).

POLYSTICHUM ACROSTICHOIDES (*Mx.*) *Schott.*

Found only in the eastern part of the State, growing on well-shaded banks and slopes. It begins to fruit in August. The following counties are represented in the collection: Jackson (*T. H. Macbride*, Aug., 1883. with mature fruit); Muscatine (*T. H. Macbride*, Sep., 1882, in full fruit; *Shimek*, Oct., 1900, in fruit); Johnson (fall, 1894, sterile; Aug., 1895, cultivated from a native rootstock).

Family **ASPLENIEÆ** *J. Smith*, Hk. Jour. Bot. (1841).

Genus ATHYRIUM *Roth*, Tent. Fl. Germ., vol. I (1788).

ATHYRIUM FILIX-FŒMINA (*L.*) *Roth.*

This is probably the most common and most widely distributed fern in Iowa. It is found in more or less shaded places, and varies in size and cutting with the

habitat. Fruit begins to appear in June and continues until September, or even later. The athyrioid character (like so many similar characters of ferns) becomes obscured as the fern grows older, and the sori then sometimes almost cover the back of the frond, especially in fronds with narrow divisions. The specimens from Jackson county collected by Prof. Macbride in 1883 show this very well. The following counties are represented: Louisa (*P. C. Myers*, Aug., 1897, sterile); Muscatine (July, 1895, sterile); Johnson (July, 1880, well-fruited); Jones (*J. E. Cameron*, July, 1895, fruit nearly mature); Jackson (*T. H. Macbride*, Aug., 1883; well-fruited and with unusually narrow segments); Delaware (*T. H. Macbride*, Aug., 1883, fruit advanced); *J. E. Cameron*, Oct., 1897, with old fruit); Allamakee (*T. E. Savage*, June, 1899, with young fruit); Cerro Gordo (July, 1899, shows some mature fruit); Winnebago (July, 1896, fruit scant); Emmet (Sept., 1895, fruit well advanced); Webster (July, 1897, sterile); Polk (*pupils of E. Des Moines High School*, no date; well-fruited); Ringgold (July, 1890, sterile); Calhoun (*G. B. Rigg*, no date, sterile); Pottawattamie (*J. E. Cameron*, June, 1897, sterile); Lyon (July, 1899, sterile).

ATHYRIUM THELYPTEROIDES (*Mx.*) *Desv.*

Locally rather common in the eastern part of the State. It grows in shady places, in the lower parts of wooded ravines, etc., preferring rather moist places, and begins to fruit in August. Mature fruits show apparent diplazioid characters, and the species has been referred to *Diplazium*.* An examination of young fruits however shows very clearly that the seemingly two sori are one reverted in athyrioid fashion. It will probably be necessary to similarly remove other species of *Diplazium* to

*Underwood, *l. c.*, refers it to the sub-genus *Athyrium*.

Athyrium.† Specimens from the following counties are in the herbarium: Muscatine (*T. H. Macbride*, Sep., 1882, in fine fruit); Johnson (1882, well-fruited); Jones (*T. H. Macbride*, Aug., 1898, in fine fruit); Jackson (*T. H. Macbride*, Aug., 1883, well-fruited); Delaware (*T. H. Macbride*, Aug., 1883, well-fruited; *J. E. Cameron*, Sep., 1897, in fine fruit); Cerro Gordo (Sept., 1900; sterile, rather more hairy than is usual, and the veins are more frequently forked.)

Genus ASPLENIUM *L.*, Sp. Pl., vol. II, p. 1078 (1753).

ASPLENIUM ANGUSTIFOLIUM *Mx.*

Not common in the State. Growing in deep woods, on rocky slopes, etc. northeastward. All the specimens in the herbarium show well-fruited fronds. Mature fruits appear in the latter part of August. Two counties only are represented: Jackson (*T. H. Macbride*, Aug., 1883; *Shimek*, Aug., 1894); Delaware (*T. H. Macbride*, Aug., 1883; *J. E. Cameron*, Sep., 1897).

ASPLENIUM PLATYNEURON (*L.*) *Oakes.*

The only specimens in the herbarium were received (as *A. ebeneum*) from Mr. Fred. Reppert. The first set was collected "in open woods along Leutzinger's creek, 4 mi. below Muscatine, Iowa, by Kenneth McKenzie." The second was cultivated in Muscatine by Mr. Reppert from native rootstocks in 1894, and is reported by him "from sandy hill-side woods, rare."

Genus CAMPTOSORUS *Link*, Hort. Berol., vol. II, p. 69, (1833).

CAMPTOSORUS RHIZOPHYLLUS (*L.*) *Link.*

Locally common in the eastern part of the State, grow-

†Milde (in Soc. Siles. Cult. Nat., Nov., 1869) includes *Diplazium* in *Athyrium*.

ing in shaded places on moss-covered rock, etc., usually on or near limestone ledges. Fruiting specimens may be found at all seasons of the year. All of the specimens in the herbarium are well fruited, and most of them show the proliferous habit. The following counties are represented: Muscatine (*T. H. Macbride*, Sept., 1882; *Shimek*, Oct., 1900); Johnson (Aug., 1881; Aug., 1893; Sept., 1897; March, 1898. These are from different stations); Jones (*T. H. Macbride*, Aug., 1895); Delaware (*J. E. Cameron*, Sept., 1897); Winneshiek (*T. E. Savage*, June, 1899); Dubuque (*J. A. Anderson*, July, 1900).

Family **PTERIDIEÆ** *J. Smith*, Hk. Jour. Bot. (1841).

Genus PTERIDIUM *Scopoli*.*

PTERIDIUM AQUILINUM (*L.*) *Kuhn*.

This species, so common in the eastern part of the State, is represented by a comparatively small series. It grows in deep woods where its long creeping rootstocks frequently send up fronds at intervals of two to four feet. It begins to fruit in July, or even in June. The following counties are represented: Muscatine (Oct., 1900, sterile); Johnson (Sept., 1880; another without date); Delaware (*J. E. Cameron*, Sep., 1897, sterile); Allamakee (*T. E. Savage*, June, 1899, sterile); Winneshiek (*T. J. Fitzpatrick*, June 24, 1896, well-fruited); Winnebago (July, 1899, well-fruited).

Genus PELLÆA *Link*, Fil. Hort. Berol., p. 59, (1841).

PELLÆA ATROPURPUREA (*L.*) *Link*.

Locally rather common in crevices of rock on exposed limestone ledges. New fruits are formed in June or July and may continue all winter. The following counties are represented: Johnson (July, 1880, well-fruited); Jones

* On authority of Diels (l. c.).

(*T. H. Macbride*. Aug., 1895, mature fruit); Delaware (*J. E. Cameron*, Nov., 1897, with mature fruit); Winneshiek (*T. E. Savage*, May, 1899, with old fruit).

Genus CRYPTOGRAMMA *R. Br.*, Ex. App. Frankl. Narr., p. 767 (1823).

CRYPTOGRAMMA STELLERI (*Gmel.*) *Prantl.*

On sandstone or limestone rocks, in less exposed situations than the preceding species. It begins to fruit in May and June. All the specimens show more or less fruit, those collected in May and some of those in June, being immature. The following counties are represented: Johnson (*Dr. C. M. Hobby*, June, 1880); Cedar (*T. H. Macbride*, July, 1893); Delaware (*T. H. Macbride*, Aug., 1883); Jackson (Aug., 1894); Dubuque (*F. M. Irish*, May, 1891; *J. A. Anderson*, July, 1900); Winneshiek (*T. E. Savage*, May, 1899); Cerro Gordo (July, 1896).

Genus CHEILANTHES *Swartz*, Syn. Fil., p. 129, (1806).

CHEILANTHES FEEI *Moore.*

Cheilanthes lanuginosa Nutt.

Quite rare, on rocky ledges. The specimens in the herbarium are all well-fruited. They are from the following counties: Jones (*T. H. Macbride*, Aug., 1895); Dubuque (*Paul Bartsch*, July, 1895); Allamakee (*T. E. Savage*, May, 1899).

Family **ADIANTEÆ** *J. Smith*, Hist. Fil., p. 273, (1875).

Genus ADIANTUM *L.*, Sp. Pl., vol. II, p. 1094 (1753).

ADIANTUM PEDATUM *L.*

This species rivals *Athyrium filix-fœmina* in abundance

and extent of distribution, and is found in similar habitats. It begins to fruit in June. Specimens from the following counties are in the herbarium: Lee (June, 1897, sterile); Louisa (*P. C. Myers*, Aug., 1897); Muscatine (*F. Reppert*, July, 1894); Johnson (*T. H. Macbride*, 1883; *Shimek*, Sept., 1895); Jones (*T. H. Macbride*, Aug., 1895; *J. E. Cameron*, June, 1895, young fruit); Delaware (*J. E. Cameron*, Sept., 1897, young fruit); Black Hawk (July, 1898, young fruit); Allamakee (*T. H. Macbride*, August, 1893; *T. E. Savage*, June, 1899, young fruit); Cerro Gordo (July, 1896, sterile); Emmet (*R. I. Cratty*, no date); Webster (July, 1897, sterile); Calhoun, (*G. B. Rigg*, July, 1895, sterile); Polk (*pupils of E. Des Moines High School*, no date); Adair (*J. E. Gow*, Aug., 1900); Pottawattamie (*J. E. Cameron*, June, 1897, young fruit); Shelby (*T. J. Fitzpatrick*, June, 1894, young fruit).

Class III. HYDROPTERIDES Willdenow, Sp. Pl., vol. V, p. XXXXII.

Order I. MARSILEACEAE R. Br., Prod. Fl. N. Holl., p. 166 (1810).

Genus MARSILEA *L.*, Sp. Pl., vol. II, p. 1099, (1753).

MARSILEA VESTITA *H. & G.*

This species was reported from Iowa by Arthur (*l. c.*), but no known specimens were extant in Iowa herbaria. In July, 1899, the writer re-discovered the species in the northwestern corner of Lyon county.* The specimens

*Reported in Rep. Iowa Geol. Sur., vol. x, p. 180, (1900).

were growing in a shallow pool on an exposure of Sioux Quartzite, and were all sterile. Several specimens are in the herbarium.

Order II. SALVINIACEÆ Bartling, Ord. Nat., Pl., p. 15 (1830).

Genus AZOLLA *Lam.*, Encyc. Bot. vol. I, p. 343 (1783).

AZOLLA CAROLINIANA *Willd.*

This interesting species was discovered by Mr. F. Reppert in Muscatine slough, Muscatine county, and has since been found in the lower portion of the slough in Louisa county. It begins to fruit in August. The sterile (young) fronds are green, the fertile red. The following sets are in the herbarium: Muscatine county (*F. Reppert*, Oct., 1895, many fertile); Louisa county (Aug., 1897, mostly sterile; *P. C. Myers.*, later in Aug., 1897, some fertile).

Class IV. LYCOPODINEÆ Swartz, l. c.

Order I. LYCOPODIACEÆ Mx., Fl. Bor. Am., vol. II, p. 281 (1803).*

Genus LYCOPODIUM *L.*, Sp. Pl., vol. II, p. 1100, (1753).

LYCOPODIUM LUCIDULUM *Mx.*

One Iowa specimen only is in the herbarium. It was

*Michaux wrote *Lycopodaceæ*, evidently a mistake.

collected by the writer on a wooded slope with sandstone outcroppings, along Pine creek, Muscatine county, in November, 1897, and is in fruit.

LYCOPODIUM CLAVATUM *L.*

Quite rare. The specimens in the herbarium are all from Johnson county (*T. H. Macbride*, no date, sterile; *Mary F. Linder*, no date, sterile; *Shimek* and *P. C. Myers*, March, 1897, sterile). They have been found in but two localities in the county,—both in rather low woods.

LYCOPODIUM COMPLANATUM *L.*

Found with the preceding species in Johnson county, and in a similar locality in Muscatine county. Rare in Iowa. The herbarium contains specimens from two counties: Johnson (*T. H. Macbride*, no date, sterile; *Shimek*, March, 1897, sterile); Muscatine (*F. Reppert*, Aug., 1894, in fruit.)

Order II. SELAGINELLACEÆ Underwood, Our Nat. Ferns, P. 103, (1881).

Genus SELAGINELLA *Beauv.*, Prod. Ae., p. 101, (1805).

SELAGINELLA RUPESTRIS (*L.*) *Spring.*

This species is found in several widely separated localities in the State, always in barren, sandy or rocky, soil. All the sets in the herbarium contain more or less fruit. They are from the following counties: Muscatine (*T. H. Macbride*, July, 1895; *Shimek*, Oct., 1896; both from sand along the Cedar river); Dubuque (*P. Bartsch*, 1895); Lyon (Aug., 1896; July, 1899; both from Sioux Quartzite exposures).

DESCRIPTIONS OF AMERICAN UREDINEÆ, III.

BY J. C. ARTHUR AND E. W. D. HOLWAY.

The species of *Uredineæ* to which this article is devoted embrace those forms whose teleutospores occur on grasses belonging to the tribes *Maydeæ*, *Andropogoneæ*, *Paniceæ*, *Oryzeæ*, and *Phalarideæ*. In studying the plant rusts it has been found very helpful to bring together all available material on closely related hosts. In this way we have been able to get a more comprehensive and accurate view of the limitations and variations of species, and, moreover, to detect a number of errors that have crept into the literature and led to misconceptions. To carry out this plan we have taken the material for this article from the hosts belonging to a circumscribed portion of the great family of the *Gramineæ*, rather than indiscriminately from the hosts of any part of the family, as in the previous article of the series.

The present article like the two preceding ones, is based upon the material in the authors' *Uredineæ Exsiccatæ et Icones*, each article corresponding to a fascicle. The first article was published in this journal (3:44–57) March, 1895, and the second (4:377–402) December, 1898. The first fascicle of the distribution was issued September, 1894, and the second, December, 1898.

The illustrations, which are the same for the *Descriptions* and the *Exsiccatæ*, are from camera-lucida drawings made directly from the material of the distribution. The figures and the packets have the same numbering, Arabic numbers being used to designate species, and letters to indicate the collections under each species.

The intimate association of host and parasite in case of

the *Uredineæ* makes the accurate determination of the host of the utmost importance: sometimes it is only necessary to know the genus, but more often the species must be unquestionably established in order to give full value to a specimen. But it is not enough that the name of the host should be written on the packet to make the specimen of greatest worth: there should be within the packet such fragments of the host, bits of inflorescence, fruits, leaves, stipules, or other parts not too bulky, and that may or may not be affected by the rust, as may furnish characters for independent verification, or strong presumptive evidence. Moreover, the limits of species and genera among flowering plants are not unchangeably fixed, and it sometimes becomes necessary to revise the nomenclature of the host as well as of the rust, when such characteristic fragments become very important. The more difficult the host the more imperative the need of such helps. Among grasses and sedges, especially, we have often had occasion to deplore their absence. The ligules of grasses should in particular be included, and bits of their inflorescence whenever possible.

We have experienced much difficulty in securing good material of the uredo stages for our distribution, and in some cases even for purposes of study. The idea that diagnostic characters are lacking in the uredo seems to be so widely and firmly established, that collectors do not search for this stage of a rust, and rarely collect it even when conspicuous. The idea is erroneous, however, although it seems to have support from the customary omission, or subordination, of such characters in technical descriptions. Sometimes the uredosori are much more distinctive of the species than the teleutosori, and rarely less so than are the æcidia. Specimens showing the best development of the spermogonia, æcidia, uredosori, and teleutosori should in most cases be independently collected for each species. The finest specimens are those which show one of these stages in optimum development, and

one or more of the others in much less abundance. either just beginning to appear, or nearly vanished.

Still another sort of spore sometimes occurs among grass-forms that has had special attention called to it lately by the researches of M. A. Carleton, until now only partially published (Science 13:250). It has long been recognized in *Puccinia vexans* Farl., and considered to be a peculiar teleutospore-like uredospore: but Carleton finds that it has, moreover, a peculiar manner of germination. He has given the name *amphispore* to it. We have ventured to apply the name to what has heretofore been called the uredospore of *Puccinia tripsaci*, both on account of the structure and texture, and of the association with the other spore-forms. But this assignment of its role must be accepted as somewhat tentative until opportunity is given for studying the mode of germination, which is at present unknown.

In this article we have extended and varied the use of signs for designating spore stages of the *Uredineæ*. For some time the Roman numerals, I, II, III, have been generally employed to indicate æcidial, uredo, and teleutosporic stages, respectively, and occasionally of late the spermogonial stage has been represented by O. To these we now add X for the amphisporal stage. When these signs are used in connection with specimens of *Exsiccatæ*, we have found it convenient to indicate the relative abundance of each stage by using capital forms for the dominant stages and lower case forms for deficient stages: thus ii, iii, X applied to a specimen of *Exsiccatæ*, means that it exhibits chiefly amphisporic sori, but that some more or less perfect sori of uredospores and teleutospores are present, or at least that some spores of these may be found by moderate search among the amphisori.

The first article of this series contained descriptions of species numbered from one to seventeen, the second article contained numbers eighteen to thirty-four, and the present article contains numbers thirty-five to forty-four.

35. PUCCINIA TRIPSACI *Diet. & Holw.* (1897. Bot. Gaz. **24**:27).

35*a*. On *Tripsacum dactyloides* L. X, iii. Near City of Mexico, Mex., *Holway*.

ORIG. DESC. "Sori on both sides of the leaves, at first covered by the epidermis, at length erumpent, somewhat linear: uredosori cinnamon-brown, spores globose or elliptical, 30-37 by 28-33μ, epispore up to 4μ thick, chestnut-brown, echinulate, with four germ-pores: teleutospores elliptic or obovate, rounded at both ends, with a hooded thickening at apex, slightly constricted, smooth, brown, 33-41 by 20-25μ: pedicel longer than spore, firm, brownish."

SYN:

1897. *Uredo pallida* D. & H. Bot. Gaz. **24**:37.

Sori amphigenous, but especially beneath, prominent, somewhat linear, 1-3 mm. long, tardily naked, encircling epidermis conspicuous.

II. Uredosori pale, uredospores nearly round to obovate, small, 13-18 by 20-26μ, colorless when dry, wall thin, echinulate, pores four, equatorial.

X. Amphisori cinnamon-brown, amphispores round or elliptical, wall thick up to 4μ, dark yellowish-brown, coarsely echinulate, 28-33 by 30-37μ, pores four, rather noticeable, equatorial; pedicel thick, fugacious.

III. Teleutosori dark brown, teleutospores elliptic or obovate, slightly or not at all constricted, smooth, dark golden-brown, 20-25 by 33-41μ, apex rounded, occasionally obtuse, considerably thickened, base rounded, pedicel as long or longer than the spore, colored, firm.

The apportionment between this species and the following one of the four or five forms of uredineous spores now known on *Tripsacum* is based upon their association in the material that has come to hand. The absolute proof of relationship must await careful field observation or

cultures. It is assumed in the first place that what were described originally as uredospores of this species are true amphispores. We use the name recently proposed by Carleton (Science 13:250) to designate a form of spore having definite physiological and morphological characters, intermediate in most respects between uredo and teleutospore, to which the uncertain term, mesospore, has heretofore been applied. In the specimens (35a) published with the present fascicle of *exsiccatæ*, the amphispores and teleutospores are well shown. In a specimen collected by Mr. Holway at Tizapan, near City of Mexico, Sept. 27, 1899 (No. 3504), the true uredospores (*Uredo pallida* D. & H.) and the amphispores are in similar manner associated. Other specimens in our possession show only one form of spore in each case. The specimens in this distribution are part of the type collection, and show amphispores and in some cases teleutospores.

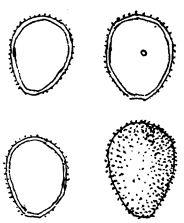


Fig. 1.
UREDO PALLIDA *D. & H.* From type collected at the City of Mexico, Oct. 1, 1896.

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36. PUCCINIA POLYSORA *Und.* (1897. Bull. Torr. Bot. Club. 24:86).

36*a*. On *Tripsacum dactyloides* L. II. Cuernavaca, Mex., *Holway*.

ORIG. DESC. "II, III. Amphigenous: sori very small, short, very numerous but irregularly scattered, remaining long enclosed by the tough epidermis of the host, at length rupturing by a narrow slit: uredospores large, broadly oval, 35×30μ, scarcely echinulate, the epispore of medium thickness, pale rusty-brown: teleutospores variable, usually short, irregularly oblong, often somewhat constricted at the septum, averaging 25×40μ, the cells often irregularly angled, the upper usually broader than long, blunt or rounded above; apex not thickened; pedicel short."

The gross appearance of this species is similar to that of the preceding, except that the sori are smaller, longer

time covered, and usually more abundant. The uredospores are thin-walled, closely and finely echinulate, and have four equatorial germ-pores. The specimens in this fascicle (36a) show only uredospores, as also does a specimen in the herbarium of Mr. S. M. Tracy, collected by him at Mobile, Ala., Oct. 17, 1886, but the type collection, made by B. M. Duggar at Auburn, Ala., Oct., 1891, shows both uredo- and teleutosori. The irregular, thin-walled teleutospores (fig. 2) are very different from the teleutospores of the preceding species.

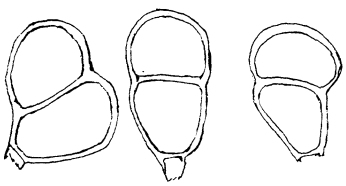

Fig. 2.
PUCCINIA POLYSORA *Und.* From type collected at Auburn, Ala., Oct. 1891.

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37. PUCCINIA VIRGATA *E. & E.* (1893. Proc. Acad. Nat. Sc. Phila. :154).

37*a*. On *Chrysopogon avenaceus* (Michx.) Benth. ii, III. Rooks Co. Kans., *Bartholomew.*

ORIG. DESC. "III. Sori amphigenous, but more fully developed on the lower side of the leaf, linear, often 1cm. or more long, erumpent and margined laterally by the ruptured epidermis, dark chestnut-brown, almost black. Teleutospores mostly wedge-shaped or clavate, but also some of them oblong, 40-70 × 18-22μ, the upper cell shorter and elliptical or subglobose and dark, the lower cell longer, narrower, and lighter colored, apex rounded and obtuse or subtruncate, and sometimes a little roughened. Epispore thickened at apex but without any distinct papilla. Has a general resemblance to *P. graminis*, but the spores are different."

SYN:

1834. *Caeoma (Uredo) andropogi* Schw. Trans. Amer. Phil. Soc. **4**:290.

1896. *Puccinia clavispora* Ell. & Barth. Erythea **4**:79.

1897. *Uredo alabamensis* Diet. Bull. Cornell Univ. **3**:22.

Sori amphigenous, but more abundant beneath, linear, elongated, early naked, ruptured epidermis prominent.

II. Uredospores obovate, rarely subglobose, 18-30 by 28-45μ, wall reddish-brown, deeper colored at the apex, also somewhat thicker at the apex (up to 4μ), strongly and closely tuberculate, pores distinct, four, equatorial; paraphyses numerous, light brown, somewhat capitate, usually curved, wall thickened above.

III. Teleutospores clavate, cuneate or oblong, 18-22 by 40-70μ, septum above the middle, lower cell pale, thin-walled, upper cell oblong or often subglobose, dark brown, apex much thickened, rounded, obtuse or nearly truncate, pedicel thick and short.

EXSIC:

Ellis & Everhart, N. A. F., 2888, 3476.
Sydow, Uredineen, 1066.
Seymour & Earle, Econ. Fungi, 535.

This rust has proved to be a puzzling species, and no one heretofore has wholly compassed its form and habit; even now the æcidial stage is not known. Still it possesses strongly marked characters in both its uredo- and teleutosporic stages. The structure and color of the uredospores, together with the clavate paraphyses, are strongly diagnostic, while the unequal and dissimilar-celled teleutospores are fairly distinctive. The uredo stage is often prolonged without intermixture of teleutospores, especially in the eastern states. Only uredospores were known to Schweinitz, and only uredospores occur in the collection made by B. M. Duggar in Alabama, which Dietel, sixty-five years later, made the basis of a new name. We have examined type material of these descriptions, and present herewith drawings of spores and paraphyses from each (figs. 3 and 4).

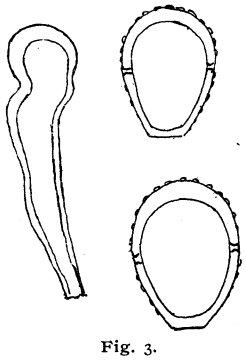

Fig. 3.
CAEOMA (UREDO) ANDROPOGI *Schw.* From type in Phila. Acad. Sci. collected at Bethlehem, Pa., 1829.

Puccinia virgata Ellis & Everhart was founded on material collected in Rooks Co., Kans., on Jan. 23, 1892

(see fig. 5), and the host determined as *Panicum virgatum*.

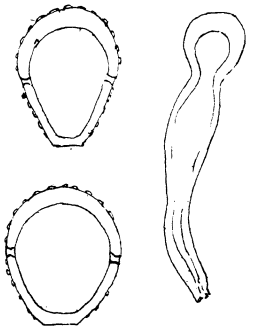

Fig. 4.
UREDO ALABAMENSIS *Diet.* From type collected at Auburn, Ala., Oct. 14, 1891.

A collection made from the type locality on May 21, of the same year, was distributed in Ellis & Everhart's N. Am. Fungi, as No. 2888. This is teleutosporic material, as would be natural in a winter collection, but a little search reveals the presence of uredospores and paraphyses, and these, together with the teleutospores, agree exactly with those of the type collection of *Puccinia clavispora* Ellis and Everhart, and of the two types already mentioned. The leaves of *Panicum virgatum* and of *Chrysopogon avenaceus* can not be certainly told apart by any characters derived from the color, texture or surface markings of the blades, but on the other hand the ligules are wholly distinct, those of the *Panicum* being prominent and fringed with long, white, silky hairs, and those of the *Chrysopogon* being still larger and entire. Diagnoses drawn from both rust and host show that these two Kansas collections supposed to be on *Panicum* are identical with *Puccinia clavispora* known to be on *Chrysopogon*, and that the host of the type of the earlier name was not a *Panicum* but was *Chrysopogon avenaceus*. It appears that with the possible exception of material found in the herbarium of the Kansas Agricultural College no collection of the supposed *P. virgata* on *Panicum* has been made since 1892, and it was then only found "on one solitary tuft of grass about two feet across" (see Bartholomew's "Kansas Uredineæ" in Trans. Kans. Acad. Sci. **16**:183).

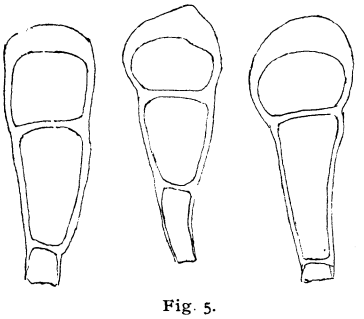

Fig. 5.
PUCCINIA VIRGATA *E. & E.* From type collected in Rooks Co., Kans., Jan. 23, 1892.

The published descriptions of *P. clavispora* and *P. virgata* also agree, except that in the latter the teleutospores are said to be "sometimes a little roughened." This can only be explained by supposing the statement to apply to the uredospores, which occur sparingly in the original material, and being colored like the teleutospores and of the same apical form, might easily be mistaken for them. So far as we know *Puccinia virgata* occurs only on *Chrysopogon avenaceus* (Michx.) Benth. (*Sorghum nutans* Gray, *Andropogon avenaceus* Michx.).

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38. PUCCINIA ELLISIANA *Thuem.* (1878. Bull. Torr. Bot. Club. 6:215).

38*a*. On *Andropogon scoparius* Michx. III. Rooks Co., Kans., *Bartholomew.*

38*b*. On *Andropogon scoparius* ii, III. Decorah, Iowa, *Holway.*

ORIG. DESC. "P. acervulis hypophyllis, gregariis, plus minusve lineariformibus, seriatis, elevatis, atro-fuscis, liberis; sporis ellipsoideis vel subclavato-ellipticis, septatis, medio vix constrictis, vertice rotundatis, incrassatis,apice rotundatis,ab pedicello separatis, episporio disseptimentoque crasso, obscuriore, 30-40 mm. long., 18-23 mm. crass., fuscis; pedicello subrecto, æquali, 18-22 mm. longo, pallidissime fusco; paraphysibus nullis — Certe a *P. andropogonis*, Fckl., diversa."

New Jersey: Newfield, in *Andropogonis virginiani* Lin., foliis aridis, Jan., 1877. Leg. J. B. Ellis."

SYN:

1895. *Puccinia andropogi* Lagerheim (non Schw.) Ured. Herb. Fries :45.

1898. *Dicæoma ellisianum* Kuntze, Rev. Gen. Pl. 3:468.

Sori as in *P. andropogonis* Schw. Uredospores yellowish-brown, thick-walled, (about 4μ), closely and finely tuberculate, subglobose, 16-24μ, mostly 20μ in diameter, pores four, equatorial, distinct: teleutospores elliptical to oblong or clavate, averaging larger than those of *P. andropogonis*, the elliptical ones 20-24 by 32-40μ, and others 16-20 by

44-52μ; apex thickened, rounded or often pointed in the oblong-clavate ones; pedicel nearly hyaline, frequently up to 80μ long.

EXSIC:

Thuemen; Myc. Univ. 1336.

That two species of rusts have been confounded under the name of *Puccinia andropogi* was first pointed out by Lagerheim in his account of the *Uredineæ* in the herbarium of Elias Fries, now in the Botanical Museum of the University of Upsala, Sweden. He was unfortunate, however, in assuming that the species having thick-walled uredospores was the true Schweinitzian *P. andropogi*.

The writers have not examined the type specimens of *Puccinia ellisiana*, but the examination of specimens in three sets of Thuemen's "Mycotheca universalis," viz., those in possession of the New York Botanical Gardens, of De Pauw University, and of Mr. Holway, which apparently contain part of the type collection, uniformly shows the presence of the characteristic uredospores. It is possible, however, that some of the following species may be intermixed, as is likely to be the case in almost any collection of this rust. It is doubtful if the host of the type collection, which was taken in mid-winter, is really *Andropogon virginicus*, as published, for the ligules of the leaves in specimens available are broad, entire, or slightly jagged, and correspond with those of *Andropogon glomeratus*, a species which grows in the type locality, instead of being narrow and ciliate, as in *A. virginicus*. But this is not a matter of moment as the species occurs upon *A. scoparius*, *A. furcatus*, and probably upon other native species of *Andropogon*, and might well occur on *A. virginicus*. The specimen in Ellis & Everhart's "Fungi Columbiana," No. 1376, on *Andropogon hallii*, is *Puccinia andropogonis*, and not *P. ellisiana* as labelled. The species doubtless ranges throughout the central and eastern United States, for specimens have been examined from different localities

in Kansas, Iowa, Indiana, Mississippi and New Jersey. It is far less abundant than the true *Puccinia andropogonis* Schw.

A rust which closely resembles *P. ellisiana* is the European *Puccinia cesatii* Schroeter (*P. andropogonis* Fckl.). This species was collected on *Andropogon furcatus* by A. B. Seymour on Aug. 22, 1884, at Brainerd, Minn., on his journey to Washington Territory, and also on *A. hallii*, by H. J. Webber, in Sept., 1889, in Howard Co., Nebraska. Both the teleutospores and uredospores resemble those of *P. ellisiana*, but the uredospores are much larger, having nearly twice the diameter, and the germ-pores, instead of being four and equatorial, are more than four and scattered. Both of the above collections have passed until now for *P. andropogi*.

The æcidia of both *P. ellisiana* and *P. cesatii* yet remain undetected.

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39. PUCCINIA ANDROPOGONIS *Schw.* (1834. Trans. Amer. Phil. Soc. **4**:295).

39*a*. On *Pentstemon hirsutus* (L.) Willd. o, I. Lafayette, Ind., *Stuart.*
39*b*. On *Pentstemon albidus* Nutt. I. Rooks Co., Kans., *Bartholomew.*
39*c*. On *Pentstemon grandiflorus* Nutt. o, I. Long Pine, Neb., *Bates.*
39*d*. On *Andropogon scoparius* Michx. II, iii. Spirit Lake, Ia., *Arthur.*
39*e*. On *Andropogon scoparius* III. Lafayette, Ind., *Stuart.*
39*f*. On *Andropogon scoparius* ii, III. Lafayette, Ind., *Miss Snyder.*
39*g*. On *Andropogon furcatus* Muhl. II, iii. Spirit Lake, Ia., *Arthur.*
39*h*. On *Andropogon furcatus* ii, III. Lafayette, Ind., *Miss Snyder.*
39*i*. On *Andropogon furcatus* III. Decorah, Ia., *Holway.*
39*j*. On *Andropogon furcatus* ii, III. Rockport, Kans., *Bartholomew.*
39*k*. On *Andropogon hallii* Hack. ii, III. Cody, Neb., *Bates.*

ORIG. DESC. "449. 20. Pentastemonis Sz. A. orbiculare minus crassum purpureum subtus luteum, peridiis candidis congestis.

Non infrequens in foliis et caulibus Pentastemonis hirsuti. Distincta species. Lineas duas latum. Peridia pro ratione plantæ magna. Sporidia luteo-fusca, simplicia, vesiculosa."

SECOND DESC. "*2911. 7. P. andropogi, L. v. S., frequentissima autumno in foliis culmisque etiam vaginis variarum specierum Andropogi, Bethl.

P. maculis obliteratis, acervis dense aggregatis, elevatis, fuscis,

obtusis, linearibus, abbreviatis. Sporidiis fuscis. Quamquam non confluit, tamen fere tota folia occupat."

SYN:

1822. *Aecidium pentastemonis* Schw. Schrift. d. Nat. Ges. zu Leipzig 1:68.

1895. *Puccinia americana* Lagh. Ured. Herb. Fries :45.

1898. *Dicæoma andropogonis* Kuntze. Rev. Gen. Pl. 3:467.

O. Spermogonia few, amphigenous, bright orange when fresh: spots none or colorless: spermatia elliptical or oblong, 3-4 by 5-7μ.

I. Spots circular, yellow and splashed with purple, or with a distant purple border: æcidia mostly hypophyllous, the border low, recurved and split into few segments: spores angular, 16-18 by 18-24μ, slightly tuberculate: peridial cells quadrangular, 16-20 by 24-32 μ.

II and III. Hypophyllous: sori small, elliptical, or confluent and linear, numerous, surrounded by the ruptured epidermis: uredospores yellowish-brown, echinulate, globose, mostly 20-24μ, membrane rather thin (about 2μ): teleutospores smooth, thickened above, obovate to elliptical, 20-24 by 28-32μ, dark brown, with apex rounded, or oblong to clavate, 16-20 by 36-44μ, color paler and with apex sometimes pointed: pedicel tinted, about the length of the spore.

EXSIC:

Ellis, N. A. F., 1470 III.
Carleton, Ured. Amer., 12 III.
Ellis & Everhart, Fungi Columb., 1376 III, 1457 III.
Sydow, Uredineen, 57 III.
Kellerman & Swingle, Kans. Fungi, 28 I.

The cultures on which the association of æcidia and teleutospores is based were made by Messrs. Arthur and Stuart in 1899 (Bot. Gaz. 29:272). The species is very abundant east of the Rocky mountains in both the æcidial

and teleutosporic stages, but the uredo stage is of brief duration and rarely collected. Specimens gathered as early as the middle of June in central Indiana show teleutosori.

In the teleutosporic condition it is difficult to distinguish this species from the preceding. Some search, however, will usually reveal at least a few of the characteristic uredospores, even in collections made in the winter season, and the chief reliance should be placed upon these. The thin-walled echinulate uredospores of *P. andropogonis* are wholly unlike the thick-walled, small, and finely tuberculate uredospores of *P. ellisiana*.

The type specimen of *P. andropogonis* Schw. is in the Schweinitz collection of the Philadelphia Academy of Sciences. It is an ample one, in the original packet, unmounted, and labeled in Schweinitz's handwriting. The sori are very numerous. The host is not named on the packet, but appears to be *Andropogon scoparius*. The type locality is not given, but it is probably Bethlehem, Pa., as stated in the author's list of N. Am. Fungi (Trans. Am. Phil. Soc. **4**:295). We have examined the type and find the characteristic, thin-walled, echinulate uredospores, and no other sort. There can be no question regarding the error of Lagerheim in supposing the Schweinitzian rust to be a thick-walled uredoform rather than a thin-walled one. No other specimen of rust on *Andropogon* occurs in the Schweinitz collection, unless one include his *Cæoma* (*Uredo*) *andropogi*, a very dissimilar form on *Chrysopogon avenaceus* (*Andropogon* of earlier authors). (See page 177.)

The specific name *Pentastemonis*, which Schweinitz gave to the æcidial form a dozen years before he employed the one we have adopted, can not be used, as there is already a *Puccinia pentstemonis* given by Peck in 1885, to a rust on *Pentstemon* found in western North America.

The form of the name as Schweinitz wrote it, was "*Puccinia andropogi*," but we have followed Schroeter, Saccardo, Kuntze, and many others in writing it *P.*

andropogonis. The Greek noun πώγων being in the third declension, a Latin derivative like *Andropogon* should be also in the third declension, and not in the second as assumed by Schweinitz and others.

The rust is very common, especially upon *Andropogon scoparius* Michx. We have examined specimens on this host collected in New York, Pennsylvania, Alabama, Louisiana, Indiana, Iowa, North Dakota, Nebraska, Kansas and Nevada. We have examined specimens on *A. furcatus* Muhl. (*A. provincialis* Lam.) from Mississippi, Indiana, Iowa and Nevada: on *A. virginicus* L. from Alabama: on *A. argyraceus* Schultes from Alabama: on *A. hallii* Hack. from Nebraska: on *Pentstemon hirsutus* (L.) Willd. (*P. pubescens* Sol.) from Alabama, Indiana and Kansas: on *P. albidus* Nutt. from Kansas: on *P. grandiflorus* Nutt. from Nebraska, and Iowa, and on *P. gracilis* Nutt. from Iowa.

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40. PUCCINIA VERSICOLOR *Diet. & Holw.* (1897. Bot. Gaz. **24**:28).

40*a*. On *Andropogon melanocarpus* Ell. III. Guadalajara, Mex., *Holway*.

40*b*. On *Andropogon melanocarpus* Ell. ii, III. Cuernavaca, Mex., *Holway*.

40c. On *Andropogon melanocarpus* Ell. II, iii. Cuernavaca, Mex., *Holway*.

40*d*. On *Andropogon contortus* L. II, III. Chapala, Mex., Holway.

ORIG. DESC. "Spots epiphyllous, purple-red, or brown and yellow; sori hypophyllous, oblong or linear; uredosori yellow, surrounded by the ruptured epidermis; spores ovate, 30-40 by 25-31μ, epispore very thick, colorless, with short spines, contents irregularly branched, or often star shaped; teleutosori firm, pulvinate, black, surrounded by the ruptured epidermis; spores elliptical, scarcely constricted, rounded at both ends, smooth, chestnut brown, apex variously thickened, (generally not over 8μ) 35-45 by 27-33μ; pedicel hyaline, firm, up to 130μ long."

This species has a uredospore of remarkable appearance. The walls are colorless and appear to be thickened like the sclerenchymatous cells of seed coats, thus forcing the

contents into star shaped forms. The scar made by the separation of the pedicel can rarely be detected. The germ-pores are also obscure. The collection on *Andropogon contortus* appears to differ from that on *A. melanocarpus*, by having more truly elliptical and thicker-walled teleutospores, but there appears to be no specific distinction. The specimens of this distribution collected at Guadalajara, Mex., are part of the type collection.

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41. PUCCINIA CENCHRI *Diet. & Holw.* (1897. Bot. Gaz. **24**:28).

41*a*. On *Cenchrus multiflorus* Presl. ii, III. Guadalajara, Mex., *Holway*.

ORIG. DESC; "Sori very small, hypophyllous, scattered; uredosori surrounded by the ruptured epidermis; spores obovate or elliptical, 36-45 by 30-35μ, brown, echinulate, with equatorial germ-pores; teleutosori covered by the epidermis, black; spores oblong, mostly clavate, apex truncate, or irregularly angled, sometimes constricted, narrowed or rounded at base, 40-53 by 18-25μ, epispore smooth, brown, strongly thickened at apex; pedicel very short, brown."

The specimens in this distribution are part of the type collection. This species has also been found on *Cenchrus echinatus* L., E. Ule, Herbarium Brasiliense, No. 2549.

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42. PUCCINIA SUBSTRIATA *Ell. & Barth.* (1897. Erythea **5**:47).

42*a*. On *Paspalum setaceum* Michx. II, III. Rooks Co., Kans., *Bartholomew*.

42*b*. On *Paspalum paniculatum* L. II, iii. Cuernavaca, Mex., *Holway*.

42*c*. On *Pennisetum mexicanum* Hemsl. ii, III. Patzcuaro, Mex., *Holway*.

42*d*. On *Pennisetum mexicanum* Hemsl. ii, III. Near Morelia, Mex., *Holway*.

ORIG. DESC. "II & III. Amphigenous. Uredospores globose or obovate, 19-23 by 22-30μ, ferruginous, very faintly echinulate, in minute (¼-1mm.) punctiform or elliptical sori, covered by the irregularly ruptured epidermis. Teleutospores obovate or clavate, rusty brown, distinctly constricted, upper cell mostly broader and very

slightly roughened, only moderately thickened at apex, which is regularly rounded or sometimes flattened, without any distinct papilla, very faintly striate, 27-52 by 19-23μ, on stout, short, (15-20μ) slightly colored pedicels. Sori mostly oblong and about 1mm. long, covered by the epidermis, which finally splits either along the top of the sorus, or oftener along one side, leaving it covered as if by a cap or lid.

Differs from *Puccinia paspali* Tracy & Earle in the shape of the sori, the slightly echinulate uredospores and the thick, short pedicels of the teleutospores."

Sori amphigenous, oblong, small, at first bulliform then tardily naked; ruptured epidermis prominent, sometimes stretched over the sorus in bands.

II. Sorus pale yellow; uredospores obovate or globose, 19-24 by 20-30μ; wall rather thin, yellowish-brown, finely and abundantly echinulate; pores four, equatorial.

III. Sorus brown; teleutospores oblong or obovate, dark brown, 19-24 by 28-50μ; apex more or less thickened, rounded, obtuse or slightly truncate; pedicel somewhat colored, firm, from short to the length of the spore or longer.

EXSIC:

Sydow, Uredineen 1080.

This appears to be a polymorphous species. The Kansas collections upon *Paspalum setaceum* have teleutospores with mostly broad and short pedicels, while the Mexican collections on *Pennisetum mexicanum* have mostly broad and long pedicels; otherwise the two forms appear essentially alike. But the form on *Paspalum paniculatum*, on the contrary, has smaller and more delicate spores of both uredo stage and teleuto stage, and the teleutospores are quite irregularly shaped, with short and more slender pedicels, which are sometimes attached obliquely.

Comparing this material with the type collection of *Puccinia paspali* Tracy & Earle, which was secured at New Orleans, La., upon *Paspalum virgatum* L., one is struck with the lack of distinctive characters. The uredospores of *Puccinia paspali* are like those on *Paspalum*

setaceum, only somewhat irregular in form, while the teleutospores are intermediate between those of *Paspalum setaceum* and *P. paniculatum*. The oblique irregular teleutospores of *Puccinia paspali*, and the linear sori, are the only marked characters with which to separate this species from *Puccinia substriata*, and these may be a local result of the influence of the host. We are inclined to think either that there is but one polymorphous species, or that the forms here included in *Puccinia substriata* on *Pennisetum mexicanum* and on *Paspalum paniculatum* are to be separated, making four species in all. The material at our disposal is inadequate for a definite conclusion, and it may be that cultures will be required for the final decision.

The markings on the teleutospores mentioned in the original description have not been detected by us. The upper cell is said to be "very slightly roughened" and the apex "very faintly striate." These characters do not appear in our material, either when viewed dry or wet.

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43. UROMYCES HALSTEDII *De Toni*. (1888. Saccardo, Syll. Fung. 7:557).

43*a*. On *Homalocenchrus virginicus* II, III, (Willd.) Britton. Dalles of the Wisconsin river, Wis., *Arthur*.

ORIG. DESC. "Sori mostly hypogenous, small, elongated, forming irregular rows; uredospores 22-25 by 26-30μ, elliptical, light yellow, indistinctly echinulate, tips dark; teleutosori shining black, spores wedge-shaped and quite irregular, 17-30 by 25-33μ, pedicel about one half the length of the spore. The broad free end of the spore is divided into 5-20 sharp or blunt projections, the longer with hyaline tips." Halsted, l. c.

SYN:

1887. *Uromyces digitatus* Halst. Jour. Myc. 3:138.
1889. *Uromyces halstedii* Ludw. Bot. Centrbl. 37:120.
1898. *Cæomurus halstedii* Kuntze. Rev. Gen. Pl. 3.450.

EXSIC:

Ellis & Everhart, N. Am. Fungi, No. 2227.

A very distinctive species, especially in the form of the teleutospores, and it is unfortunate that the descriptive name first given to it had to be abandoned, because already used. The sori are tardily naked: uredosori pale brown, the teleutosori blackish-brown.

The uredospores have thin walls with four to six scattered pores. The fine, abundant echinulation, although indistinct when wet, is very prominent when examined dry. Most of the spores come within 20-24 by 24-26 μ.

The teleutospores are amber-colored, with the upper part darker and brownish; lateral walls thin. The pedicels are slender and colored.

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44. PUCCINIA MAJANTHÆ (*Schum.*) *nom. nov.*

44*a*. On *Polygonatum commutatum* (R. & S.) Dietr. o, I. Decorah, Ia., *Holway*.

44*b*. On *Phalaris arundinacea* L. II, III. Sailor's Encampment, Mich., *Harper*.

ORIG. DESC. "1518. Æ. Majanthæ, macula orbicularis pallide-viridis centro flava; peridiis distantibus depressis primo flavis, demum subferrugineis, ore laciniato: laciniis subrotundis obtusis; pulvere primo aurantiaco demum cinereo ferrugineo.

In foliis Convalariæ bifoliæ. Æstate."

SECOND DESC. "47. Puc. sessilis n. sp. Schneider. Pucc. sitzend, keilförmig mit abgestützten Scheitel. In länglichen von der Oberhaut bedeckten Häufchen. An Phalaris arundinacea L. Neuhaus b. Pirscham. Sch. Schwarzwasserbruch b. Liegnitz."

1803. *Æcidium majanthæ* Schum. Enum. Pl. Saell. 2:224.

1824. *Cæoma elegans* Schlecht. in part. Fl. Berol. 2:115.

1825. *Cæoma convallariatum* Lk. in part. Sp. Plant. 2:42.

1827. *Uredo convallariarum* Spreng. Linnæi Syst. Veg. ed. sexta 4:573.

1869. *Puccinia sessilis* Schneider (as emended by Magnus). Schroeter's Brand- und Rostpilze Schlesiens :19.

1896. *Puccinia smilacearum-digraphidis* Kleb. Zeits. f. Pflkr. **6**:261.

O. Spermogonia epiphyllous in small clusters, punctiform, rather prominent, orange-colored; spermatia elliptical, about 3 by 5 μ.

I. Æcidia small,, hypophyllous on yellow spots, in circular clusters, often irregularly confluent; margin nearly entire, slightly recurved; spores subglobose, 20-26 μ in diameter, peridial cells subglobose, somewhat angular, 28-32 by 24-28 μ.

II and III. Sori numerous, very small, elliptical to shortly linear, on both sides of the leaf; uredospores yellowish-brown, echinulate, obovate to globose, 24-32 by 16-20 μ, pores scattered: teleutosori black, covered by the epidermis: teleutospores oblong or wedge-shaped, more rarely shorter and elliptical, apex sightly thickened, generally darker, rounded, truncate, oblique, or rarely pointed; smooth, brown, mostly 44-52 by 16-24 μ; pedicel short or wanting; paraphyses none.

EXSIC:

Ellis, N. A. F., 229 [1], 1421 [1], 1475 [111].
Sydow, Uredineen, 95 [1], 96 [1].
Rabenhorst-Winter, Fungi Europæi, 3024, 3026a, b & c.
Thuemen, Myc. Univ., 27 [1].
Kunze, Fungi secl. exsicc., 554 [1].

The Puccinias on *Phalaris arundinacea* have been divided into several so-called physiological or biological species. Dr. Dietel defines the former as species morphologically similar, but whose teleutospores are only able to produce the æcidium from which they themselves were derived. Klebahn describes biological species as fungi that are indistinguishable morphologically, but are clearly separated from each other by the choice of host plant upon which they develop. The question has been raised whether they are entitled to this designation, or whether they are to be regarded as "biological races."

Magnus has used the term "adaptive-races," meaning parasitic fungi which for several generations have become habituated to a particular host plant, and therefore more easily infect that species than another upon which the same parasitic fungus also occurs. Klebahn says: (translated) "I would speak of biological races, when among fungi that are morphologically similar, yet infect a series of host plants, there are those that infect one host easily and abundantly, and another host with difficulty and sparingly, and also others that, conversely, infect the latter readily and the former with difficulty, and still others that infect all equally. The totality of these fungi would form the species, the last being the typical form of it and the first two biological races. From this it will be seen that *Puccinia smilacearum-digraphidis* and *Puccinia convallariæ-digraphidis* as they have shown themselves in my experiments, are to be regarded as biological species."

The following forms on *Phalaris* having teleutospores nearly or quite identical, but having æcidia on different species of hosts, have been described:

1. *Puccinia phalaridis* Plow. 1888. Jour. Linn. Soc. —:88. Infects only *Arum maculatum*.

2. *Puccinia winteriana* Magn. 1894. Hedw. **33**:83. (*P. sessilis* Schneider, as used by Winter, Plowright, and Klebahn). Infects only *Allium ursinum*.

3. *Puccinia smilacearum-digraphidis* Klebahn. 1896. Zeits. f. Pflkr. **6**:261. (*P. sessilis* Schneider as used by Magnus and Dietel). Infects *Polygonatum*, *Majanthemum Convallaria* and *Paris*.

4. *Puccinia convallariæ-digraphidis* Klebahn. 1896. l. c. (*P. digraphidis* Sopp.) Infects only *Convallaria*.

5. *Puccinia paridis-digraphidis* Klebahn. 1896. l. c. (*P. paridis* Plow.). Infects only *Paris*.

6. *Puccinia schmidtiana* Dietel. 1896. Ber. d. Naturf.

Ges. zu Leipzig, Jahrg. 1895-6 :198. Infects *Leucojum vernum*.

7. *Puccinia orchidearum-phalaridis* Klebahn. 1898. Zeits. f. Pflkr. **8**:23, **9**:155. Infects *Orchis maculata*, *Platanthera chlorantha*, and *Listera ovata*.

Puccinia sessilis was the first of these species published, and the description, based upon teleutospores collected in Silesia, would apply to all. Dr. Winter in Saxony made the first cultures (Ber. d. Nat. Ges. zu Leipzig, 1874 :41), and showed that the teleutospores of a *Puccinia* not distinguishable from *Puccinia sessilis*, produced its æcidium on *Allium*, and the experiments were repeated by Plowright in England with the same result (1887. Jour. Linn. Soc. **24**:89). Magnus claimed (1894. Hedw. **33**:83) that as the æcidium on *Allium* and *Arum* did not occur in Silesia where the teleutosporic type material was collected, while an æcidium was common there on all the four hosts named above under "3", therefore the name *Puccinia sessilis* must apply to the *Puccinia* producing these latter æcidia. This would require a new name for the *Puccinia* infecting *Allium*, which he accordingly called *Puccinia winteriana*.

The culture experiments in Europe have been numerous and carried on for several years, and the results seem, in general, well established. Klebahn tried growing *Puccinia smilacearum-digraphidis* for a number of seasons on *Polygonatum*, to see whether it would develop a tendency to less easily infect the other hosts. He found that it did infect *Polygonatum* more strongly than other hosts, and in his last article he says that although it is wise to guard against too hasty conclusions, he thinks that his experiments appear to indicate the possibility of a change in the character of a fungus through cultures.

This species has been called *Puccinia striatula* Peck (*Puc. linearis* Pk.), a name of uncertain application, but which is probably not to be cited as a synonym.

No cultures of this species have been made in the United States, but the collections presented herewith are so clearly indistinguishable from what Klebahn has called *Puccinia smilacearum-digraphidis* that we do not hesitate to associate the American æcidia and teleutospores.

What will be the ultimate systematic standing of biological species among the *Uredineæ* is yet uncertain. There is no gainsaying the statement that "the races of one generation of botanists often become the species of the next generation, who as they study them more minutely and carefully, discover constant marks not previously recognized." In our opinion there appears to be considerable utility and no material harm in treating the biologically distinguishable forms of *Phalaris* rust as normal species. In an address on "The conception of species as affected by recent investigations on fungi" delivered by Dr. Farlow three years ago before the American Association for the Advancement of Science, the conclusion is reached, after reviewing many specific cases including the one in hand, that "as systematic botany develops in the future it may very well become the study of races rather than species as we now consider them. In some cases, as in the *Uredinaceæ*, the time may be not far distant when this condition of things will be reached." To meet the requirement of utility and the growing tendency in systematic work we have undertaken to select the name for the forms of rust presented in this fascicle in the same manner as we would for thoroughly distinct and unquestioned species. We therefore feel it incumbent upon us to recognize the law of priority, which at once compels us to ignore such a recent, but attractively descriptive name as *Puccinia smilacearum-digraphidis*. The earliest name that we have found is by Schumann, who cites for his name but the single host, *Convallaria bifolia*, since transferred to the genus *Smilacina*, and now resting under the genus *Unifolium*. Immediately following *Æcidium majanthæ*

on the page in Schumann's work is *Æcidium convallariæ* occuring on *Convallaria majalis*, which should clearly provide the specific name for Klebahn's *Puccinia convallariæ-digraphidis*. So far as we know the latter species does not occur in this country.

EXPLANATION OF PLATES.

The drawings have been made from a Zeiss microscope fitted with a D objective and No. 8 compensating ocular, and by the use of an Abbe camera lucida. They are uniformly drawn to a magnification of 625 diameters, and reduced in engraving to 470 diameters.

The essentially correct dimensions of the spores may be obtained from the plates by multiplying the measurements taken in millimeters by two, the results being in mucros (μ).

The pores shown for the uredospores do not always represent the full number, but only those that were evident. When the scar on the uredospores left by the separation of the pedicel is shown, it is placed lowermost.

EXPLANATION OF PLATE I.

35*a*. PUCCINIA TRIPSACI *Diet. & Holw.*
On *Tripsacum dactyloides* L., from Mexico.
Five amphispores and four teleutospores.

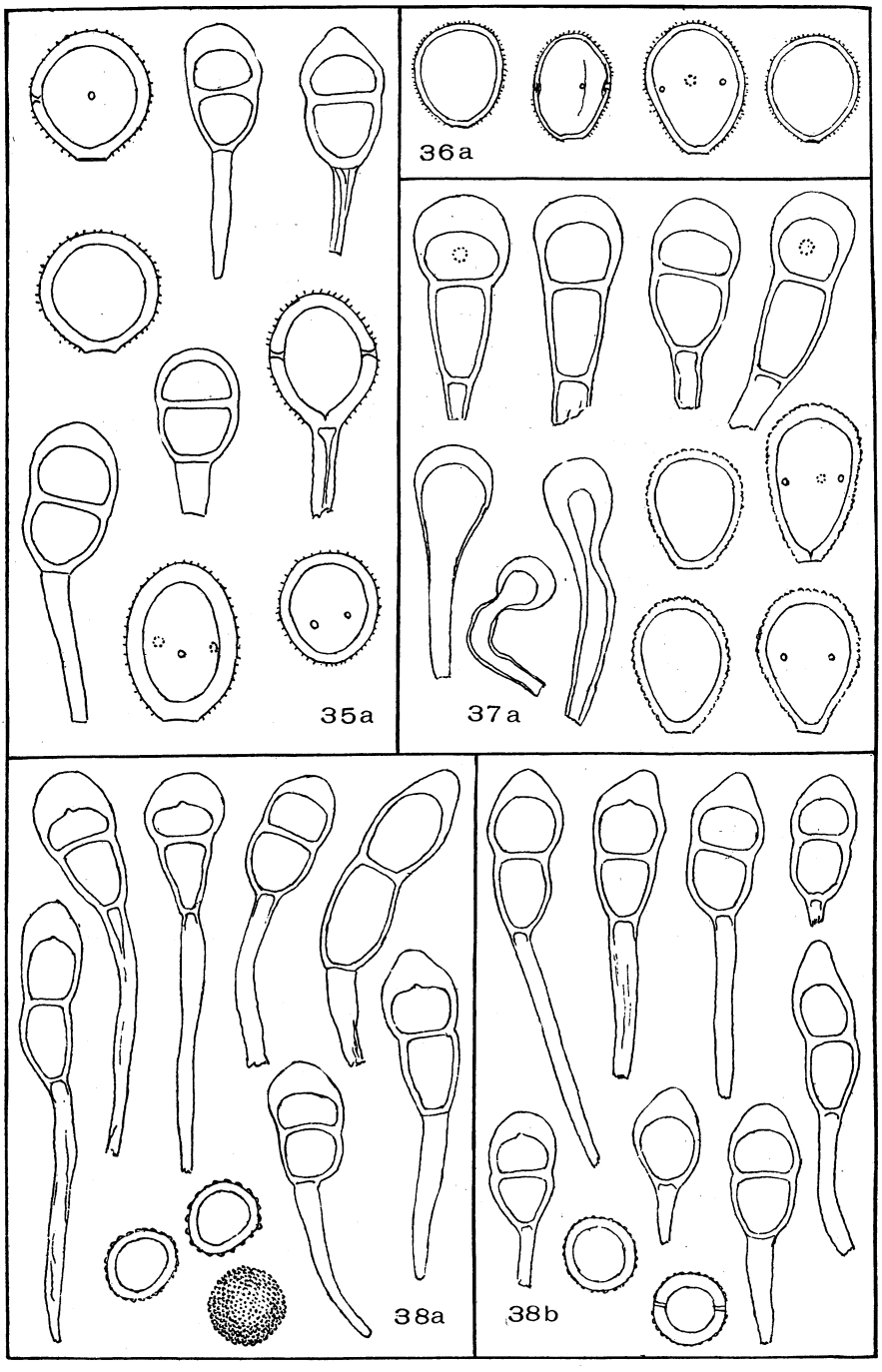
36*a*. PUCCINIA POLYSORA *Und.*
On *Tripsacum dactyloides* L., from Mexico.
Four uredospores.

37*a*. PUCCINIA VIRGATA *Ell. & Everh.*
On *Chrysopogon avenaceus* (Michx.) Benth., from Kansas.
Four uredospores, three paraphyses and four teleutospores.

38*a*. PUCCINIA ELLISIANA *Thuem.*
On *Andropogon scoparius* Michx., from Kansas.
Three uredospores, one drawn as if opaque, and seven teleutospores.

38*b*. PUCCINIA ELLISIANA *Thuem.*
On *Andropogon scoparius* Michx., from Iowa.
Two uredospores and eight teleutospores.

PLATE I.



Explanation of Plate II.

39*a*. Puccinia andropogonis *Schw.*
On *Pentstemon hirsutus* (L.) Willd., from Indiana.
Five spermatia and four æcidiospores.

39*b*. Puccinia andropogonis *Schw.*
On *Pentstemon albidus* Nutt., from Kansas.
Four æcidiospores.

39*c*. Puccinia andropogonis *Schw.*
On *Pentstemon grandiflorus* Nutt., from Nebraska.
Five spermatia and five æcidiospores.

39*d*. Puccinia andropogonis *Schw.*
On *Andropogon scoparius* Michx., from Iowa.
Four uredospores and one teleutospore.

39*e*. Puccinia andropogonis *Schw.*
On *Andropogon scoparius* Michx., from Indiana.
One uredospore and three teleutospores.

39*f*. Puccinia andropogonis *Schw.*
On *Andropogon scoparius* Michx., from Indiana.
Two uredospores and five teleutospores.

39*g*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Iowa.
Four uredospores and one teleutospore.

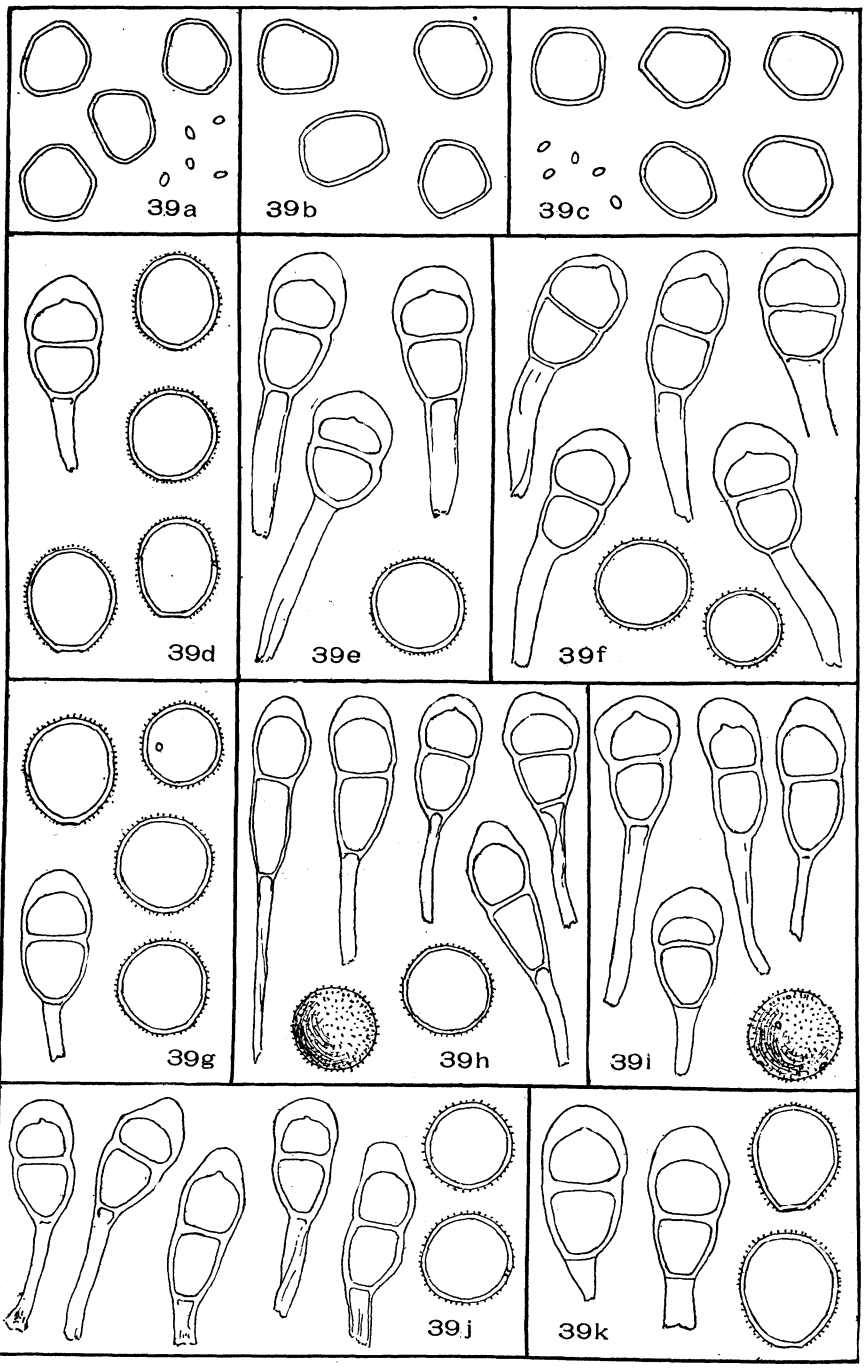
39*h*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Indiana.
Two uredospores, one drawn as if opaque, and five teleutospores.

39*i*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Iowa.
One uredospore, drawn as if opaque, and four teleutospores.

39*j*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Kansas.
Two uredospores and five teleutospores.

39*k*. Puccinia andropogonis *Schw.*
On *Andropogonis hallii*. Hack., from Nebraska.
Two uredospores and two teleutospores.

PLATE II.



Explanation of Plate III.

40*a*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon melanocarpus* Ell., from Mexico.
Two uredospores and four teleutospores.

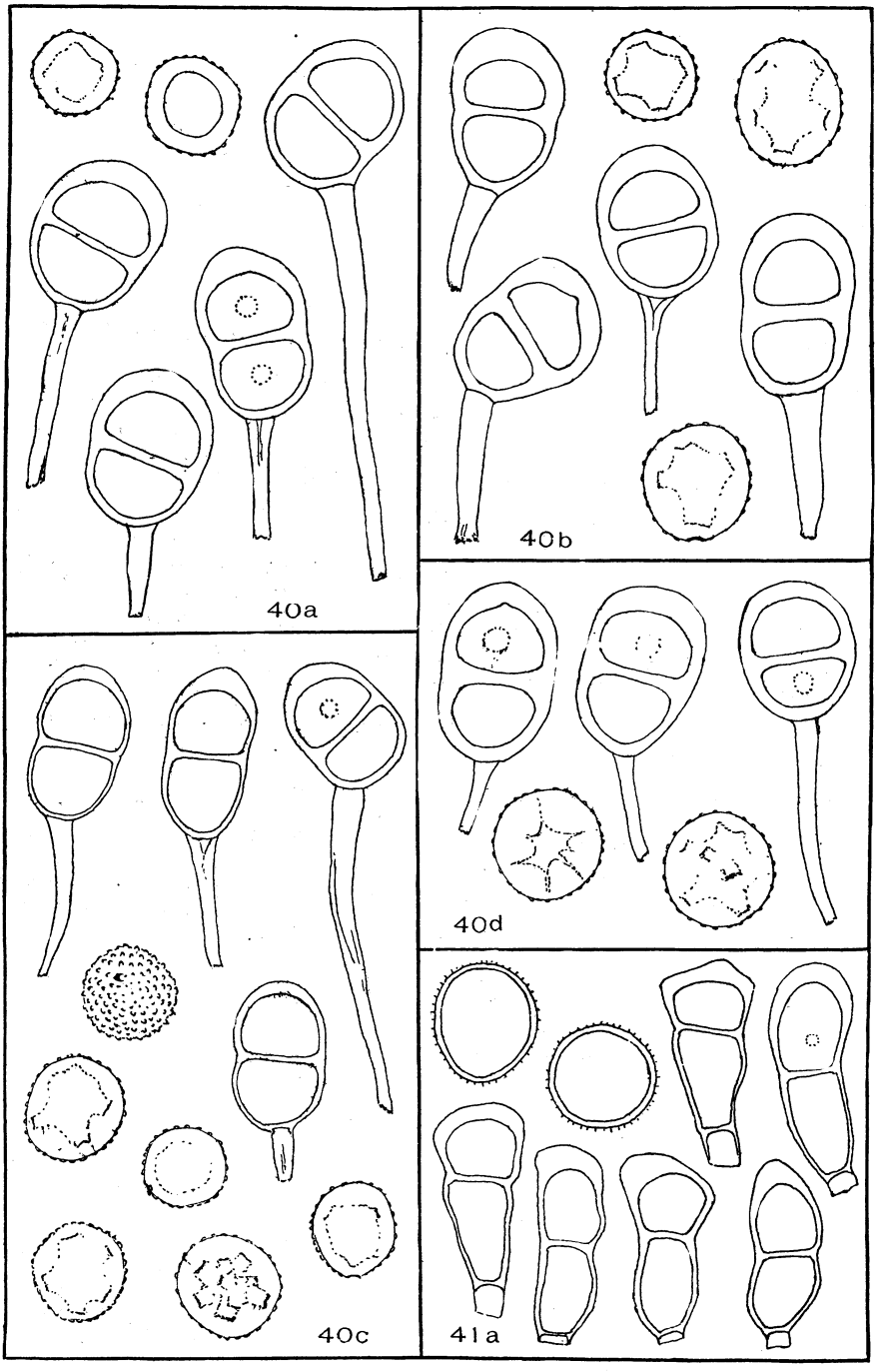
40*b*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon melanocarpus* Ell., from Mexico.
Three uredospores and four teleutospores.

40*c*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon melanocarpus* Ell., from Mexico.
Six uredospores, one drawn as if opaque, and three teleutospores.

40*d*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon contortus* L., from Mexico.
Two uredospores and three teleutospores.

41*a*. Puccinia cenchri *Diet. & Holw.*
On *Cenchrus multiflorus* Presl., from Mexico.
Two uredospores and six teleutospores.

PLATE III.



Explanation of Plate IV.

42*a*. Puccinia substriata *Ell. & Barth.*
On *Paspalum setaceum* Michx., from Kansas.
Four uredospores and four teleutospores.

42*b*. Puccinia substriata *Ell. & Barth.*
On *Paspalum paniculatum* L., from Mexico.
Four uredospores and six teleutospores.

42*c*. Puccinia substriata *Ell. & Barth.*
On *Pennisetum mexicanum* Hemsl., from Mexico.
Four uredospores and five teleutospores.

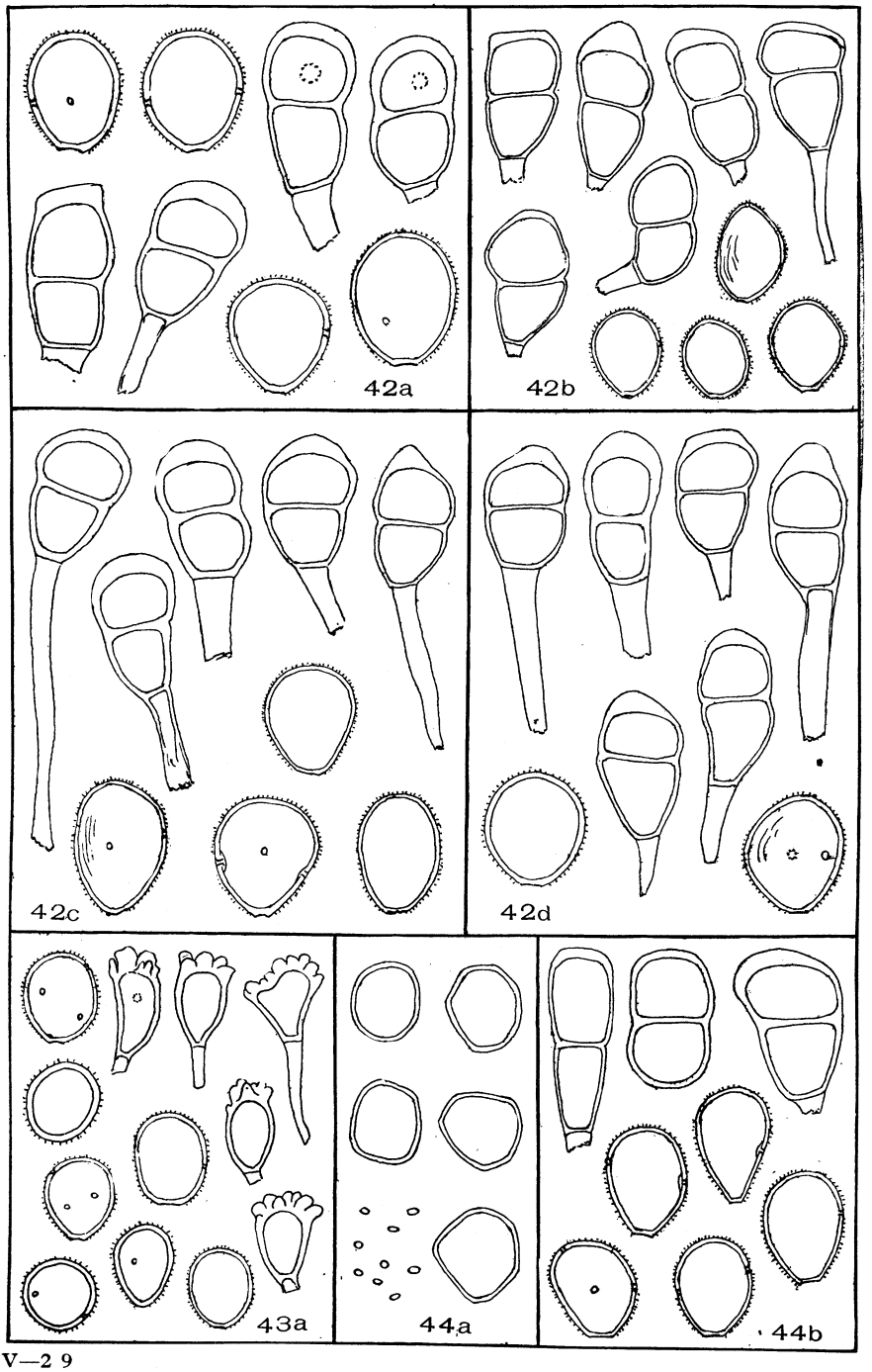
42*d*. Puccinia substriata *Ell. & Barth.*
On *Pennisetum mexicanum* Hemsl., from Mexico.
Two uredospores and six teleutospores.

43*a*. Uromyces halstedii *De Toni.*
On *Homalocenchrus virginicus* (Willd.) Britt., from Wisconsin.
Seven uredospores and five teleutospores.

44*a*. Puccinia majanthæ (*Schum.*) *Arth. & Holw.*
On *Polygonatum commutatum* (R. & S.) Dietr., from Iowa.
Nine spermatia and five æcidiospores.

44*b*. Puccinia majanthæ (*Schum.*) *Arth. & Holw.*
On *Phalaris arundinacea* L., from Michigan.
Five uredospores and three teleutospores.

PLATE IV.



THE LOESS OF IOWA CITY AND VICINITY.*

BY B. SHIMEK.

The loess of Iowa City presents no unique features. It is of the type which prevails in the eastern part of the state, being fine and homogeneous; found chiefly on highlands, especially in its undisturbed condition, and following their vertical contours, thus varying but little in thickness which seldom exceeds twelve or fifteen feet; containing both tubules and loess-kindchen in the usual varying proportions; and more or less fossiliferous. It has been quite fully discussed by McGee†. Lists of the fossils which are found about Iowa City have already been published,‡ and it is not the purpose of this paper to offer much that is new in this direction, but rather to present a detailed account of the habits of the local modern molluscs, and their bearing on the loess.

In probably no other locality in the country have these modern and loess faunas been studied side by side more fully than at Iowa City. Besides the early work of Witter, and that of Keyes (chiefly upon State University Museum specimens collected and identified by the writer), the efforts of Pilsbry and Bayard Elliott were especially noteworthy, though the former published but little, while the latter made no permanent record of his observations, but submitted a part of his collection to the present author, who has been engaged in loess and mollusc studies with

* This paper was presented in abstract to the Iowa Academy of Sci., December, 1900.

† U. S. Geol. Sur., vol. xi, pt. i, 1891.

‡ W J McGee, *l. c.;* C. L. Webster, Am. Nat., May, 1887, p. 419; B. Shimek, Am. Geol., vol. i, pp. 149-152, 1888; Bull. Lab. Nat. Hist., State Univ. Ia., vol. i, pp. 200–209, 1890; etc.

more or less interruption for many years, and has gathered together great numbers of both fossil and modern forms which bear on this question.

The lists representing these faunas are therefore more complete than is possible where resident observers are not engaged in the investigation of both branches of the subject, and this fact, coupled with the comparative richness of both faunas, makes a comparison of them especially interesting and suggestive. Since all of the fossils which have been found at Iowa City are molluscs, and belong with few exceptions to the local modern molluscan fauna, a study of the habits of the living species is of the highest importance because of the light which is thus thrown upon the conditions which existed during the deposition of the loess. The species included in this list are therefore grouped according to habit in order that comparisons and conclusions may be facilitated. All notes on distribution, etc. of both modern and fossil shells in the following list have reference to the vicinity of Iowa City only, unless otherwise specifically stated. "Western loess" means that of western Iowa and eastern Nebraska. The material was abundantly collected and studied in the field by the author, and is now in his private collection.

The names of the local fossil (loess) species are preceded by two asterisks. Those which have been found fossil in the loess in other localities, but not at Iowa City though now found living here, are marked by one asterisk. The latter series does not however include all the species of the modern fauna of Iowa City which were reported in the earlier Missouri and Nebraska lists of loess fossils, as no specimens are extant and the species are not now known to occur in undoubted loess. The species living near Iowa City but not represented in the loess are unmarked. The territory covered by this report is included within a radius of six miles from Iowa City.

RECENT AND FOSSIL MOLLUSCS AT IOWA CITY.

1. SPECIES HERE FOUND ONLY AS FOSSILS.

**PYRAMIDULA SHIMEKII (*Pils.*) *Shim.*

Quite common in the loess of Iowa City, which furnished the type specimens. A more complete discussion of this species is given on pp. 139–145 of this Bulletin.

**PYRAMIDULA STRIGOSA IOWENSIS *Pils.*

This variety is now extinct. All other forms of this extremely variable species however belong to the dry western plateaus and mountains. It is locally quite common in the loess, and the type specimens were from this locality.

**PUPA MUSCORUM (*L.*).

Now living in the U. S. from Maine to Montana, thence to Nevada. Also in Europe. Not rare in the loess.

**PUPA BLANDI (*Morse*) *Binn.*

Two specimens were recently found in the loess near Iowa City. It is not rare in the western loess, and is found living from New Mexico to Montana. The shells usually formerly reported under this name are *Bifidaria pentodon*(*?*). The easternmost localities from which fossils have been received are Muscatine and Stockton in Muscatine county, Iowa. They were erroneously reported as *P. muscorum*.*

**VALLONIA GRACILICOSTA *Reinh.*

Quite common in the loess. It is common in western

* Through the writer's error they were so reported in Prof. Udden's note on Hershey Ave. fossils in Leverett's Report in U. S. Geol. Sur. vol. xxxviii, p. 174, 1899. In that list *P. blandi* should be substituted for *P. muscorum*. Also in Udden's Report, Ia. Geol. Sur., vol. ix, p. 359, 1899, where the same substitution should be made in the Fulton township (Stockton) list. *P. muscorum* does however occur at Muscatine.

and northwestern Iowa, and thence westward, where it lives in high, dry situations. Its easternmost known station in Iowa is in Winnebago county.

**SUCCINEA GROSVENORII *Lea*. (*?*)

A form referable to this species is quite common in the local loess. The species now lives abundantly in the South, and in Nebraska and western Iowa, and is uniformly found (so far as the writer's experience shows) in situations which are exposed to severe drouth during at least a portion of each year.

The Succineas of this group, both recent and fossil, require further elaboration.

It is interesting to note that the foregoing species, now extinct at Iowa City, all belong to the modern terrestrial fauna of the dry west, from Montana to New Mexico, and that only two species extend eastward as far as Iowa.

2. TERRESTRIAL SPECIES, NOW LIVING AT IOWA CITY.

a. Species of higher, more or less exposed, and often rocky slopes.

*VALLONIA PARVULA *Sterki*.

Common on exposed rocky slopes, hence occuring in scattered colonies. Rare in the loess of western Iowa.

*LEUCOCHEILA FALLAX (*Say*) *Try*.

Locally common on higher exposed slopes, chiefly under fragments of limestone. Rare in the loess of western Iowa and eastern Nebraska.

**BIFIDARIA ARMIFERA (*Say*) *Sterki*.

Very common. Most frequent on more or less exposed slopes under limestone, among roots of grasses, etc. Sometimes also in deeper shade, and occasionally on lower

grounds, under logs, etc. Rare in the loess at Iowa City, but very common in the western loess at Council Bluffs, Iowa.

*BIFIDARIA HOLZINGERI (*Sterki*).

Quite common under stones, etc. on exposed hillsides. Rather rare in western loess.

**BIFIDARIA PENTODON (*Say*) *Sterki*.

Quite common on rather open rocky slopes, sometimes on lower grounds, under stones, etc. As a fossil this species is widely distributed, and in this locality is very common.

*BIFIDARIA CURVIDENS (*Gld.*) *Sterki*.

Not uncommon. It is rare in the loess of the west and south, but has not been found fossil at Iowa City.

*BIFIDARIA CORTICARIA (*Say*) *Sterki*.

Common in a few restricted localities among the roots of tufted grasses, etc. growing on exposed rocky slopes. Not found in the local loess, but reported from Des Moines by Keyes, from Muscatine by Witter and from Illinois by Leverett. It is not rare in the loess of Natchez, Miss.

*POLYGYRA LEAI (*Ward*) *Pils*.

Found here under sticks, etc. on slopes near a prairie swamp. Also more rarely on scantily wooded slopes. Rare in the loess of the west, etc.

*SUCCINEA AVARA *Say*.

Not rare on more or less exposed rocky slopes. This is the small, typical form which is now found on low grounds. The same form occurs abundantly as a fossil, being one of the most characteristic species of the loess. It occurs in all the fossiliferous exposures near Iowa City, being the only fossil found in some of them.

**VITREA INDENTATA (*Say*) *Pils*.

Not rare on rocky slopes. This, and the following

species, also occurs on lower grounds, but both are more common on drier slopes. Rare in the loess.

**ZONITOIDES MINUSCULUS (*Binn.*) *Pils.*

Common under stones, etc. on higher slopes, and under sticks, leaves, etc. on lower grounds. Rare in the loess.

b. Species of higher, more deeply shaded (often mossy and rocky) banks and slopes, sometimes in deep woods.

**HELICINA OCCULTA *Say.*

This species, though a prosobranch, is strictly terrestrial in its habits. It is found living in but one locality, a steep, rocky northern slope near Turkey creek, six miles north of Iowa City, the locality in which it was first discovered by the writer about twenty-two years ago. It is quite abundant in this very restricted locality, being found under stones and fallen leaves. It is very common in the loess, and is found in nearly all the exposures. The body-whorl of the fossil shell sometimes still contains the operculum.

The writer recently found this species (living) common on the rocky slopes along Pine Hollow creek in Dubuque county, and Little Turkey river and its small tributaries in Clayton county, Iowa localities not hitherto reported.

**POLYGYRA PROFUNDA (*Say*) *Pils.*

Common under sticks, stones, leaves, etc. on higher shaded slopes. It is found in but one loess-exposure in this vicinity, but is very common in the loess of Natchez, Miss.

*POLYGYRA CLAUSA (*Say*) *Pils.*

Widely distributed in deeper woods near Iowa City, but nowhere common. As a fossil it is rare, occurring occasionally in more southerly loess. None have been found at Iowa City.

*POLYGYRA HIRSUTA (*Say*) *Pils.*

Locally quite widely distributed in deeper woods, though never gregarious. Fossil shells are found sparingly in the western loess at Council Bluffs, Ia.

*POLYGYRA MONODON (*Rack.*) *Pils.*

This species is very similar to the preceding in its habits, and in the distribution of both the recent and fossil forms, both, however, being rather more abundant. Neither has been found fossil at Iowa City, though their discovery would not be surprising. Common in the loess at Natchez, Miss., and also fossil in Indiana.

*STROBILOPS VIRGO (*Pils.*).

Locally common on rocky, shaded slopes. It is occasionally found fossil in the western loess. This has ordinarily been reported as *Strobila labyrinthica* Say.

VERTIGO MILIUM (*Gld.*) *Binn.*

Not common, on mossy banks and slopes. Not found fossil. Its minute size might easily cause it to be overlooked.

**VERTIGO OVATA *Say.*

Rare, on mossy, shaded banks, sometimes on lower grounds. Somewhat more common as a fossil, occurring sparingly in several of the exposures.

*VERTIGO BOLLESIANA (*Morse.*)

Rare, on mossy banks, usually in shady places. It is rare in the western loess.

*VERTIGO TRIDENTATA *Wolf.*

Locally common, usually on rather exposed rocky, moss-covered banks. Found sparingly in the western loess.

**COCHLICOPA LUBRICA (*Müll.*).

Rare on rather open slopes, etc. It is more common as

a fossil, but is one of the rarer species of the local loess.

*CIRCINARIA CONCAVA (*Say*) *Pils.*

Widely distributed on shaded, especially rocky, slopes, but not gregarious. It is not found in the local loess, but is quite common southward. It is one of the common fossils at Natchez, Miss.

**CONULUS FULVUS (*Drap.*) *Müll.*

Not uncommon on shaded slopes in moss, and under sticks, leaves, etc. Fossil shells are not rare, and as a rule are better developed than the modern specimens.

*ZONITOIDES ARBOREUS (*Say*) *Sterki.*

Very common, usually under logs in high or low places, and not uncommonly in comparatively open woods. It can not yet be reported from the local loess, but has been found by Prof. Savage in the loess of Henry county, Iowa, and it is not rare in the western loess.

**PYRAMIDULA ALTERNATA (*Say*) *Pils.*

Locally common, usually on higher, deeply-shaded slopes under logs, stones, leaves, etc. Not common in the loess at Iowa City.

**PYRAMIDULA PERSPECTIVA (*Say*) *Pils.*

Common on shaded banks, etc. under decaying logs. This species is not generally distributed in the loess, though it is very common at Natchez, Miss. At Iowa City it occurs rather abundantly in but one exposure.

**HELICODISCUS LINEATUS (*Say*) *Morse.*

Scattered specimens are not infrequent. They are usually found in deeper shade under sticks and logs. Fossil shells are quite rare.

*PUNCTUM PYGMÆUM (*Drap.*) *Binn.*

This minute shell is easily overlooked, but is quite common under sticks and fallen bark on northerly shaded

slopes, and among clumps of hazel, etc. on lower grounds. The author collected fossil shells in the loess of Natchez, Miss., but none have yet been found in the northern loess.

**SPHYRADIUM EDENTULUM ALTICOLA (*Inger.*) *Pils.*

While this form scarcely deserves rank as a variety, the name is here retained to designate the common loess fossil which is identical with recent shells (commonly known under the varietal name) which are now found in Wyoming, Colorado, etc. This form is much elevated, and has a distorted body-whorl, which destroys the symmetry of the otherwise almost perfectly cylindrical shell. Typical *edentulum* is exactly like the upper part of the shell of the variety and is a less fully developed form. An occasional shell of the varietal form is found eastward with the type. Speaking of the recent shells Dr. Sterki says:* "There are, among the common form, high specimens with narrower penultimate and wider last whorl, found everywhere occasionally in this country as well as in Europe; and thus *P. alticola* Inger.† is not even a true var. here."

However in the Rocky Mountain region the variety is the common form, and it is likewise generally distributed through the northern loess, belonging to the category of the most common and most characteristic loess fossils.

Only two recent specimens have thus far been taken at Iowa City. As both are rather young shells it is impossible to determine whether they are the type or the variety. As the distinction between them, however, is not worthy of maintainance, they are here grouped together.

c. Terrestial species of lower, shaded, alluvial grounds, under sticks, leaves, etc.

**POLYGYRA MULTILNEATA (*Say*) *Pils.* (Large form).

Two forms of this species occur here. The larger, the

* Nautilus, vol. vi, pp. 6 and 7, May, 1882.

† First described as *Pupilla alticola* Ingersoll, in Bull. U. S. Geol. Sur. of the Terr., 2, p. 128,—1875.

more common form, lives on wooded alluvial bottom-lands which are not too dry, and may be found abundantly creeping or hiding among the smaller plants, under fallen leaves, etc. Four fossil specimens only were found in one of the exposures at Iowa City, and it is rare in the loess of the Missouri river in eastern Nebraska. The smaller form, discussed under (*d*), is much more common in the loess.

*BIFIDARIA CONTRACTA (*Say*) *Sterki.*

Very common on rather low grounds, under logs, etc., sometimes ascending to higher slopes. Absent from the local loess and rare westward. It is more common in the southern loess.

BIFIDARIA PROCERA (*Gld.*) *Sterki.*

Only one local specimen was collected on rather low ground. Westward this species is quite common in drier situations, under sticks and leaves in clumps of bushes, etc. None have yet been found in the loess.

**VITREA HAMMONIS (*Ström.*) *Pils.*

This name is used for the species commonly known as *Zonites viridulus* Mke. on the authority of Pilsbry. Binney refers *Helix hammonis* Ström. to *Zonites fabricii* Beck, —a species from Greenland.* Our species is quite common under logs, etc. on rather low, more or less wooded, grounds. Rather rare in the local loess, but more common westward.

**PYRAMIDULA STRIATELLA (*Anth.*) *Pils.*

Quite common on scantily timbered alluvial bottom-lands, under logs, fallen leaves, etc. Also on higher slopes. As a fossil it is very common, and is widely distributed, appearing almost universally in our northern loess deposits. Fossil eggs, agreeing exactly with recent eggs of this species, are also frequently found.

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* W. G. Binney: Terr. Air-Breath. Moll. U. S., vol. v, p. 127, 1878.

**SUCCINEA OBLIQUA *Say*.

Very common under leaves, etc. on timbered alluvial bottom-lands. Westward the species frequently appears on higher grounds. Quite common as a fossil.

*CARYCHIUM EXIGUUM (*Say*) *Gld*.

This species is common in damp places on rather low grounds, under logs, etc. No local fossil specimens have been found, but the species is rare in the western loess.

*POMATIOPSIS LAPIDARIA (*Say*) *Try*.

Locally common with *Pyramidula striatella*. This species, like *Helicina occulta* is a gill-bearing mollusc, yet it is strictly terrestrial in its habits. The author has collected living specimens in widely separated sections of the State, and found the habitat uniformly the same. Not found in the local loess, but reported from Memphis, Tenn.,* from Missouri† and from Arkansas.‡

While the species of this group are more common on lower grounds, most of them occasionally appear on higher slopes. Thus *Polygyra multilineata* (medium sized), *Bifidaria contracta*, *Vitrea hammonis*, *Pyramidula striatella* and *Succinea obliqua* are very common on a rather scantily wooded, rocky, steep slope in Iowa City at an altitude of from twenty-five to seventy-five feet above the Iowa river. Most of these species also occur sparingly at higher altitudes in the western part of the State. *Bifidaria contracta* is so common in such situations in all parts of the State, that it might well be classed in group (*b*).

d. Species of mud-flats, edges of swamps, etc.

ZONITOIDES NITIDUS (*Müll.*) *St*.

This species is locally not uncommon under sticks and

* James M. Safford: Geol. Tenn., p. 434; 1869. Reported as *Amnicola*.

† G. C. Swallow: Geol Sur. of Mo., vols. i and ii, p. 215. Also reported as *Amnicola*.

‡ R. E. Call: Rep. Ark. Geol. Sur., vol. ii, pp. 166, 167 and 179.

leaves in low, wet places. It has not been found in the loess.

**POLYGYRA MULTILINEATA (*Say*) *Pils*.

The smaller form, already mentioned, is not uncommon along the edges of a prairie swamp near Iowa City. It is almost exactly like the locally more common fossil form of this species. This small form is also common in other portions of the State,—especially westward.

*SUCCINEA RETUSA *Lea*.

This species is now common on mud, etc. among plants in swampy places. The large variety *magister* Pils. is the common form. A few fragmentary specimens of young shells from the loess of Nebraska are in the writer's possession. They are probably young shells of the variety. None have been found at Iowa City.

**SUCCINEA ——— *sp.* (?).

A rather large *Succinea*, which has not yet been satisfactorily placed, is quite common on bare mud-flats along streams, and also occurs in the local loess. In some respects it is intermediate between *S. avara* and *S. obliqua*, sometimes approaching the smaller, more slender forms of the latter species quite closely.

The foregoing species are wholly terrestrial in habit, and moreover, with few exceptions flourish in comparatively dry situations. While all require a certain amount of moisture when active, the lower surface of a fallen leaf, a stick, or a stone, even in a comparatively exposed place, furnishes all that is necessary.

The following summary of the preceding notes is of interest:

Species found at Iowa City only as fossils	6
Species found here both living and fossil	19
Species now found living here, but occurring as fossils in the loess of other localities	19
Species living here, but not yet reported from the loess	3
Total	47

These shells represent more than 90% of the fossils in the loess, and, the fossil fauna so far as it occurs, is very similar to the living surface fauna. The latter is richer in species, but this difference may be only apparent. A close study of the local living fauna shows that species frequently occur in very restricted areas. Different parts of the same slope, often but a few feet apart, not infrequently show much variation in the distribution of species. When we take this peculiarity of distribution of land-shells into account with the comparatively very small total area of all the loess exposures of this vicinity, we can readily see that the opportunities for finding the recent shells are much better.

While, as stated, the great majority of the local loess fossils belong to the preceding list of terrestrial forms, a few additional species of aquatic habit are also sparingly found. In no case, however, are they generally distributed in the loess, and with the possible exception of *Limnæa caperata* and *L. humilis*, very few individuals are found. In order that the comparative scantiness of the fossil aquatic molluscan fauna may be more fully appreciated a list of the local aquatic species is here given. Those which also occur in the local loess are marked by two asterisks, and those which are positively known as fossils only from other localities are marked by one asterisk.

2. AQUATIC SPECIES NOW LIVING AT IOWA CITY.

a. Species of smaller ponds, etc., which often become dry in summer.

*LIMNÆA REFLEXA *Say*.

Common some years in shallow ponds. Not found in the loess of Iowa and Nebraska, but reported from Missouri by Hambach.*

**LIMNÆA CAPERATA *Say*.

Locally very common. As a fossil it occurs in but few

* Geol. Sur. of Mo., Bull. no. 1, p. 82; April., 1890.

exposures, and in these is usually restricted to narrow bands or pockets, in which it is quite abundant.

**LIMNÆA HUMILIS *Say*.

Very common in shallow ponds, or on mud-flats. As a fossil it occurs with the preceding species, and is even more common.

**LIMNÆA DESIDIOSA *Say* (?).

Some of the smaller fossil shells of *Limnæa* may belong to this species. It is probably found in the loess westward, though in some cases at least the fossils reported under this name undoubtedly belong to the preceding species. Common in shallow ponds.

**PHYSA GYRINA *Say*.

Very common in shallow ponds. Two very small specimens, probably this species, were found in the loess at Iowa City.

PHYSA INTEGRA *Hald*.

Very common in ponds, etc. Hitherto reported as *P. heterostropha* Say. In a very large series of shells from Iowa and Nebraska not one specimen of the latter species was found.

PHYSA SAYI *Tap*.

Quite common locally. None fossil.

PLANORBIS CAMPANULATUS *Say*.

Rare locally in ponds. None fossil.

*PLANORBIS TRIVOLVIS *Say*.

Very common in shallow ponds. Reported from Missouri, but, if occurring at all, certainly not common.

*PLANORBIS BICARINATUS *Say*.

Common in shallow ponds. One fossil specimen was collected by Prof. Beyer at Ames, and the species has been reported from the loess of Tennessee.*

* Safford, Geology of Tenn., p. 434; 1869.

PLANORBIS EXACUTUS *Say*.

Locally common in shallow ponds.

*PLANORBIS PARVUS *Say*.

Very common in ponds, etc. Rare in the western loess.

*PLANORBIS ALBUS *Muell*.

Quite rare in rather more permanent ponds. Prof. Udden collected one specimen in the loess of Milan, Ill.

PLANORBIS DILATATUS *Gld.*(?).

Locally rather frequent. None fossil.

*SEGMENTINA ARMIGERA (*Say*) *H. & A. Ad.*

Common in ponds. Reported from the loess of Missouri, but not known as a fossil in Iowa and Nebraska.

ANCYLUS DIAPHANUS *Hald*.

Common on sticks, etc. in more permanent ponds.

*VALVATA TRICARINATA (*Say*).

Quite common. It also occurs in deeper ponds. Prof. Udden collected it in the loess of Milan, Ill., and it is reported from Missouri. It is, however, very rare as a fossil.

PISIDIUM COMPRESSUM *Prime*(?).

A few valves of this, or a closely related species, were found in the local loess. The species is now common, especially westward, in small prairie streamlets, etc.

All but the last two species in this list are air-breathing forms. The last one is a bivalve.

b. Species of deeper ponds, bayous, etc.

GASTEROPODS.

BITHYNELLA OBTUSA (*Lea*) *St.* Quite common.
AMNICOLA CINCINNATENSIS (*Anth.*). Very common.
AMNICOLA LIMOSA (*Say*) *Hald.* Quite common.

VALVATA BICARINATA *Lea*. Rather rare.

LAMELLIBRANCHS.

SPHÆRIUM RHOMBOIDEUM (*Say*). *Pr*. Quite common.
CALYCULINA PARTUMEIA (*Say*). Common.
CALYCULINA SECURE (*Prime*). Not common.
CALYCULINA TRANSVERSA (*Say*). Very common.
PISIDIUM ABDITUM *Hald*. Very common.
UNIO* SUBROSTRATUS *Say*. Quite common.
ANODONTA GRANDIS *Say*. Common.
ANODONTA IMBECILLIS *Say*. Common.

c. Species of the larger creeks and the river.

GASTEROPODS.

PLEUROCERA SUBULARE (*Lea*) *Try*. Common.
SOMATOGYRUS SUBGLOBOSUS (*Say*). Common.
SOMATOGYRUS INTEGER (*Say*) *Binn*.
CAMPELOMA SUBSOLIDUM (*Anth*.) *Call*. Very common.
CAMPELOMA ———. Two other possible species.
LIOPLAX SUBCARINATA (*Say*) *Tros*. Not common.
ANCYLUS RIVULARIS *Say*. Very common.

LAMELLIBRANCHS.

SPHÆRIUM SULCATUM (*Lam*.) *Pr*. Very common.
SPHÆRIUM SOLIDULUM (*Pr*.). Quite common.
SPHÆRIUM STRIATINUM (*Lam*.) *Pr*. Rather frequent.
UNIO ÆSOPUS *Green*. Common.
UNIO ALATUS *Say*. Common.
UNIO ANODONTOIDES *Lea*. Common.
UNIO CAPAX *Green*. Rather rare.
UNIO COCCINEUS *Hild*. Common.
UNIO CORNUTUS *Barnes*. Quite common.
UNIO DONACIFORMIS *Lea*. Quite common.
UNIO EBENUS *Lea*. Rare.
UNIO ELEGANS *Lea*. Common.
UNIO ELLIPSIS *Lea*. Rather rare.
UNIO FRAGOSUS *Con*. Quite common.
UNIO GRACILIS *Barnes*. Common.
UNIO LÆVISSIMUS *Lea*. Common.
UNIO LIGAMENTINUS *Lam*. Very common.

*For convenience the old generic names of this group are here retained.

UNIO LUTEOLUS *Lam.* Quite common.
UNIO METANEVER *Raf.* Common.
UNIO OBLIQUUS *Lam.* Not common.
UNIO ORBICULATUS *Hild.* Rare.
UNIO PARVUS *Barnes.* Common.
UNIO PLICATUS *Le S.* Very common.
UNIO PUSTULOSUS *Lea.* Very common.
UNIO RECTUS *Lam.* Common.
UNIO RUBIGINOSUS *Lea.* Not rare.
UNIO SECURIS *Lea.* Rare.
UNIO SPATULATUS *Lea.* Rather common.
UNIO TENUISSIMUS *Lea.* Rare.
UNIO TRIGONUS *Lea.* Very common.
UNIO TUBERCULATUS *Barnes.* Very common.
UNIO UNDULATUS *Barnes.* Quite common.
UNIO VENTRICOSUS *Barnes.* Very common.
UNIO VERRUCOSUS *Barnes.* Rare.
MARGARITANA COMPLANATA *Barnes.* Common.
MARGARITANA HILDRETHIANA *Lea.* Locally common.
MARGARITANA MARGINATA *Say.* Rather rare.
MARGARITANA RUGOSA *Barnes.* Quite common.
ANODONTA EDENTULA *Say.* Common.
ANODONTA FERUSSACIANA *Lea.* Not rare.

Probably other species of *Anodonta* occur.

A summary of the aquatic species here listed presents the following results:

Aquatic species found here both living and fossil . .	5
Aquatic species living here and occurring in the loess elsewhere	7
Aquatic species of the occurrence of which in undoubted loess no record exists	66
Total	78

It will be observed that the proportion of local aquatic shells found in the loess, here or elsewhere, is comparatively insignificant, and what is true of species applies with even greater force to individuals. The fossil shells of aquatic species, with the two exceptions already noted, occur very sparingly indeed. The writer's own sets of these fossils, a part of the fruit of twenty years of careful search, form such an insignificant part of his collection that they seem scarcely worthy of serious attention. But

it will be further noticed that even these aquatic fossils belong to the fauna of the small pond or streamlet which may, and often does, remain dry during the greater part of summer, and that their presence in no wise proves that large bodies of water existed where the loess was deposited. Indeed the total absence of species which are truly fluviatile, or which at least prefer larger bodies of water, would point to the contrary conclusion. These fluviatile species are today very abundant in this vicinity, and their shells are, for the most part at least, quite heavy, and often large. Had large streams or other bodies of water existed where the loess is deposited, thus furnishing conditions favorable to this fluviatile fauna, it is reasonable to suppose that some of these shells would be found fossil today to relate the story of the conditions under which they existed. Yet no such evidence has ever been found in undoubted undisturbed loess, and the conclusion that such bodies of water did not exist where loess is now found is irresistible. Indeed the molluscan fauna of the loess points to comparatively dry, upland, terrestial conditions such as exist over the greater part of Iowa today. It suggests land-surfaces clothed with vegetation offering shelter and food to terrestial snails,—a vegetation developed under medium conditions of moisture and temperature such as exist here today.

IOWA PTERIDOPHYTA (*Continued.*)

BY B. SHIMEK.

The writer's recent visit to Dubuque and Clayton counties, Iowa, a part of the time in company with Messrs. Anderson and Nelson of the Dubuque High School, resulted in interesting additions to the collection of Iowa Pteridophyta in the Herbarium of the State University, which were received too late for insertion in the main paper on pp. 145–170 of this Bulletin. The region in which these additional collections were made lies in Liberty township, Dubuque county and Millville township, Clayton county, and includes the interesting gorge known as Pine Hollow, together with smaller ravines of a similar nature which are tributary to the Little Turkey river. The collections were made May 10–13, 1901. A list of the additional material, with references to the main paper, is here given:

EQUISETUM ARVENSE *L.* (p. 154).

Common, and still fruiting in both counties.

EQUISETUM PRATENSE *Ehrh.* (Insert on p. 154).

Sterile specimens of this species were quite common on rocky slopes along Pine Hollow creek in both counties. The species has not been reported from this State.

EQUISETUM ROBUSTUM *A. Braun.* (p. 155).

Very common on lower ground in both counties. A few specimens are in fruit.

EQUISETUM HYEMALE *L.* (p. 155).

Quite common in low sandy soil along Pine Hollow creek in Dubuque county. None fruiting.

EQUISETUM LÆVIGATUM *A. Braun.* (p. 155).

No specimens were found in the counties under consideration, but sterile fronds were collected *en route* in Delaware county,—an additional locality.

BOTRYCHIUM VIRGINIANUM (*L.*) *Swz.* (p. 156).

Rather young plants with green fruit were quite common in both counties.

OSMUNDA CLAYTONIANA *L.* (p. 158).

Finely fruited plants were common in both counties.

ONOCLEA SENSIBILIS *L.* (p. 159).

Young sterile fronds were collected in Dubuque county.

STRUTHIOPTERIS STRUTHIOPTERIS (*L.*). (p. 160).

Young sterile fronds were rather common in both counties, and a last year's fruiting frond was taken in Dubuque.

CYSTOPTERIS FRAGILIS (*L.*) *Bernh.* (p. 160).

Plants with young fruit were common in both counties.

CYSTOPTERIS BULBIFERA (*L.*) *Bernh.* (p. 161).

Common in both counties. The fruit was just beginning to appear.

PHEGOPTERIS ROBERTIANA (*Hoffm.*) *Fee.* (p. 162).

A few sterile fronds were just beginning to appear in moss-beds on rocky slopes in Dubuque county.

NEPHRODIUM CRISTATUM (*L.*) *Mx.* (p. 162).

A few plants with partly unrolled fronds were found in a low swampy place in Dubuque county. Some of the fronds displayed very young fruit.

NEPHRODIUM SPINULOSUM (*Retz.*) *Desv.* (p. 163).

Rather rare, on rocky slopes in Dubuque county. Very young fruiting fronds were just appearing.

ATHYRIUM FILIX-FŒMINA (*L.*) *Roth.* (p. 163).

Sterile immature fronds were common in both counties.

ATHYRIUM THELYPTEROIDES (*Mx.*) *Desv.* (p. 164.)

Young sterile fronds were not rare in Dubuque county.

CAMPTOSORUS RHIZOPHYLLUS (*L.*) *Link.* (p. 165).

Common in both counties. Last year's proliferous fruiting fronds were in excellent condition.

PTERIDIUM AQUILINUM (*L.*) *Kuhn.* (p. 166).

Very young fronds were common in higher woods in Dubuque county.

PELLÆA ATROPURPUREA (*L.*) *Link.* (p. 166).

Well-fruited last year's fronds were rather common in both counties.

CRYPTOGRAMMA STELLERI (*Gmel.*) *Prantl.* (p. 167).

Very common in both counties. Young fruiting fronds were abundant.

ADIANTUM PEDATUM *L.* (p. 167).

Very young fronds were common in both counties.

NOTE: The following locality-specimens, collected by Mr. Herbert Goddard in Winneshiek county, should also have been noted on pp. 162 and 163.

Phegopteris robertiana (Hoffm.) Fèe. (June, 1896). Very close to *P. dryopteris*,—too close. Some are well-fruited.

Nephrodium goldieanum (Hk.) H. & G. (July, 1896). Well-fruited.

ADDENDA TO THE FLORA OF LYON COUNTY.

BY B. SHIMEK.

As a result of a brief visit made in August, 1900, to the large grove occupying the southwestern corner of Lyon county, Iowa, the writer is enabled to add several species of flowering plants to his recently published list.*

One additional native tree, *Juglans nigra* L., the Black Walnut, occurs sparingly on lower slopes, and should be

* "*Flora of Lyon county*," *Iowa Geol. Sur.* vol. x, pp. 157-184, 1900.

inserted on p. 162 of that paper. The remaining additional species are herbs, and should be classed with the *Mesophytic species of wood and meadow.***

They are as follows:

VIOLA CANADENSIS *L.* Canada Violet.

One specimen in flower was collected on a wooded slope. The lower surface of the leaves, the petioles, stipules and peduncles in this specimen are more pubescent than in typical forms of the species.

IMPATIENS FULVA *Nutt.* Spotted Touch-me-not.

Not rare in marshy, shaded places.

SICYOS ANGULATUS *L.* Star Cucumber.

Not rare on wooded alluvial bottoms along the Big Sioux river in the large grove.

EUPATORIUM AGERATOIDES *L.* White Snake-root.

Not rare on the shaded slopes.

BIDENS CONNATA *Muhl.* Swamp Beggar-ticks.

The typical form was rather common on shaded lower slopes.

CHENOPODIUM HYBRIDUM *L.* Maple-leaved Goosefoot.

Quite common on lower wooded slopes.

CHENOPODIUM BOSCIANUM *Moq.* Goosefoot.

More common than the preceding species, and growing with it, though usually selecting rather more open tracts in the woods.

ARISÆMA TRIPHYLLUM *Torr.* Indian Turnip.

A few large fruiting specimens were found in rich soil on the shaded lower slopes.

PANICUM CRUS-GALLI MUTICUM. Awnless Barnyard Grass.

This awnless form of a species already reported, was found in some numbers in a little swamp surrounding a spring, and both the locality and the surroundings indicated that it is native. The plants were very vigorous, the culms reaching a half-inch in thickness at the base, and six to seven feet in height.

** See ibid., p. 175 *et seq.*