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VOLUME V.

VOL V. NO. I.

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

By PROFESSOR A. E. VERRILL

PUBLISHED

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IOWA CITY, IOWA:

SEPTEMBER, 1899.

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.

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

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[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*.

Ophiopœpale 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, triangular, and then disappear. Two very small, conical, subequal arm-spines are present on the proximal joints; they decrease rapidly in size farther out, and soon become abortive.

Diameter of disk 9 mm.; the longest broken stump of an arm is 17 mm. long; this has sixteen joints.

Off Havana, 110 to 260 fathoms, four examples.

This species is allied to *O. acuferum*, but differs in having smaller dorsal arm-plates; only two arm-spines; smaller radial shields; more numerous central disk-plates; more strongly bilobed marginal plates. In one instance one of the latter plates is broken up into four or five parts, probably due to the repair of an injury.

OPHIOCONIS MILIARIA *Lyman.*

Ophioconis miliaria Lyman, Bull. Mus. Comp. Zool., V, p. 221, pl. III, figs. 49–51, 1878; Voy. Chall. pp. 106, 109, pl. XXXIX, figs. 7–9, (structure); Three Cruises of the Blake, II, p. 112, fig. 395, 1888.

The single specimen obtained is somewhat smaller than Lyman's type and differs in some respects from his figures, especially in having shorter spines, longer tentacle-scales and narrower under arm-plates. It is probably the same species, however.

Disk covered everywhere, above and below, with minute rounded granules, which conceal minute, round, thin scales. Arm-spines 5 to 7, long, slender, acute, flattened, partially translucent, finely serrulate; the two upper are longer than the rest, rather longer than two arm-joints; the lowest two are shortest and most slender. Tentacle-scales two, nearly equal, elongated, flattened, blunt, more than half as long as the under arm-plates. Upper arm-plates in contact, strongly arched, top-shaped, the outer end convex, the sides a little incurved. Under arm-plates shield-shaped, longer than broad, with the sides incurved, the outer end rounded, the inner end angulated.

Diameter of disk, 6 mm.

Sta. 13, off Havana, 200 fathoms. West Indies, 163 to 450 fathoms, (Blake Exp).

Family, OPHIOTHRICHIDÆ *Ljung.*

Ophiothricidæ Ljung., Oph. Viv., 1866.

Ophiothrichidæ Lutken, Addit., III, 1869.

Ophiothrichinæ Ljung., Joseph. Exp., 1871.

The family is characterized by the well defined group of true tooth-papillæ; by the absence of mouth-papillæ; by the usually numerous, long, slender, generally rough and glassy arm-spines; * and internally by the complex, interlocking articulations of the arm-bones, and the strong mouth-frames and large radial shields. The peristomial plates, in the typical genera, are in three parts; of these the middle one is large, like an oral shield. The dental plate or apical jaw-plate is a separate piece.

Nearly all the genera and species of this family live clinging closely to various sponges, gorgonian corals, crinoids, hydroids, or even to other ophiuroids. Many of them are more active in their movements than is usual among *Ophiuroidea*, and many are bright colored when living. They are mostly found in the warmer seas and in shallow water, and they are most abundant and most diversified in the East Indies. Brock enumerates fifty-six species of this family from the Indo-Pacific region. Several of the genera are known only from the East Indies or Australia.

OPHIOTHRIX ANGULATA (*Say*) *Ayres.*

Ophiothrix angulata Ayers, Proc. Bost. Soc. N. Hist., IV, p. 249, 1852.

Ophiothrix angulata Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 162, pl. I, figs. 1–3, 1865; Report Voy. Challenger, Zool., Ophiuroidea, V, pp. 216, 219, 1882; Bull. Mus. Comp. Zool., X, p. 267, 1883.

Ophiura angulata Say, Journ. Phil. Acad. Nat. Sci., V, p. 145, 1825.

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*The genus *Ophiopteron* Ludw. is very remarkable for having a broad membranous web between the arm-spines, and appears to be a free-swimming form. It is from Amboina.

Ophiothrix violacea Mull. & Trosch., Syst., p. 115, 1842. Lyman, Ill. Cat. Mus. Comp. Zool., I. p. 164. Lutken Add. ad Hist. Oph., Pt. II, p. 150, pl. IV, figs. 1—1d, 1859. Verrill, Trans. Conn. Acad., I, p. 342, 366, 1868.

Ophiura hispida Ayers, Proc. Bost. Soc. Nat. Hist., IV, p. 249, 1852.

Ophiothrix caribæa Lutken, Vid. Meddel., p. 14, Jan., 1856.

Ophiothrix kroyeri Lutken, Vid. Meddel., p. 15, Jan., 1856.

Some examples from Bahia Honda have more numerous long disk-spines than usual. The same peculiarity occurs in specimens in the Museum of Yale University from Tortugas and Rio Janeiro (Univ. Mus. of Copenhagen). From Bahia Honda there are 19, partly young and half grown specimens About one-half of these have a narrow white dorsal line on the arm, bordered by a narrow dark line of the same color as the general surface, but more intense; outside of these there is a row of irregular, angular, whitish spots, separated by dark, narrow, irregular, transverse lines; dark and light radial lines extend inward from the base of the arms over the radial shields. The rest agree with the variety *violacea* (M. & Tr.), the back of the arms being irregularly marked and spotted with whitish and dark grayish blue or brown, according to the general color. Most of these specimens have a ground-color of pale violet or grayish blue, but some are light brown; in some the arms are broadly banded with a darker tint; the under arm-plates are generally pale.

A specimen from the Tortugas is dark violet-brown with a dark brown disk and with a white dorsal stripe, but without any bordering line of darker, and without white spots except on the bases of the spines. The specimens from other localities are pale grayish or yellowish, sometimes with a pink tint, with only indistinct dorsal markings.

From Egg Key and from Station 68 there are a few young examples (disk 3 mm. to 5 mm. in diameter) in which the whole disk (including the radial shields) is closely covered with minute rough thorny spinules, without any larger spines. In the character of the arm-spines, in general coloration, and in the mottling of the arms, they agree with the ordinary varieties of the species.

A young one, with similar disk-spinules, has the disk deep red-brown with the arms deep pink, and mottled above with whitish, in the usual manner. Those from Station 39 are pale pink with yellowish white disk; the dorsal white arm-stripe is distally bordered with red, the disk bears minute, elongated, thorny spinules, mixed with a few long, very slender, thorny spines, but the radial shields are naked, triangular, with their outer ends in contact, narrow, upturned, and prominent even in young specimens only 4 to 5 mm. in diameter.

Sta. 13, off Havana, in 200 fathoms, two examples; Sta. 39, 20 fathoms, off Key West; Sta. 68, 69, 74, off Little Cat I., 3 to 13 fathoms, three examples; Egg Key, two examples; Bahia Honda, nineteen examples; Tortugas, one example. A common species, from Cape Hatteras and Bermuda to Bahia Brazil, and throughout the West Indies, in shallow water. Colon (coll. Bradley). Fernando de Noronha (Chall. Exp.) Rio de Janeiro (Lütken).

The most northern locality recorded is N. Lat. 35°, 21′, in 16 fathoms (U. S. Fish Com).

It frequently occurs in the interstices of coarse sponges.

OPHIOTHRIX ŒRSTEDII *Lütken.*

Ophiothrix orstedii Lütken, Vid. Meddel., p. 15, 1856; Lutken, Add. ad Hist. Oph., Pt. II, p. 149, pl. IV, fig. 3, 1859. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 154; Bull. Mus. Comp. Zool., V, 9, p. 233. Verrill, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 226, 1882. Nutting, Narrative, Bahama, Exp., pp. 132, 211.

Those from Egg Key are mostly dark brown or dark gray, in alcohol, but all have the arms transversely banded with narrow blackish lines, narrowly bordered on each side by white lines. These triple bands alternate with the rows of spines. Narrow radial lines of the same colors extend inward on the disk, along the radial shields. The lower side of the disk is paler brown, more or less speckled with darker brown. The under arm-plates are often bordered by whitish. Those from Tortugas are mostly larger and appear stouter, with more crowded spines on the disk. The colors are mostly greenish blue or cobalt-blue, but some are reddish brown. All are banded on the arms with triple bands of white, with darker on each side, as above. Usually the intervening bands are speckled with white or pale gray. The number of spines on the disk is variable.

According to Prof. Nutting, those dredged off Little Cat Island, in 3 to 13 fathoms, in life had the disk bluish violet, marked with radial lines of purple and white, and the arms were banded with pairs of pure white lines, enclosing bands of deep cobalt-blue.

Tortugas, forty examples; Egg Key, eight examples; Bahama Banks, eight examples; Bahia Honda, one example; Sta. 68, off Little Cat Island, 3 to 13 fathoms, one example. Common at the Florida Keys and throughout the West Indies and to Cumana in shallow water.

OPHIOTHRIX SUENSONII *Lütken.*

Ophiothrix suensonii Lütken, Vid. Meddel., p. 15, 1856; Add. ad Hist. Oph., Pt. II, p. 148, pl. IV, fig. 2. Lyman, Bull. Mus. Comp. Zool., V, 9, p. 232; op. cit., X, p. 267. Verrill, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 222, 1882. Nutting, Narrative Bahama Exp., p. 221 (colors).

According to Prof. Nutting, in life the colors are very elegant. The disk is delicate lavender color, with ten sharp radiating lines of purple, running in pairs from the center to the margin, each pair enclosing a light violet stripe; four concentric purple lines run around near the upper edge of the disk; the lower side is marked by similar concentric lines of purple and white alternating; along the median dorsal surface of the arm there is a purple stripe bordered on each side by a fine white line; on the under side of the arms a similar line runs from the mouth to the tip of the arm. He states that the glassy arm-spines are nine times as long as an arm-joint. In preserved specimens these spines are generally much broken. The pattern of the color is usually preserved, but the colors are altered.

Station 4, off Havana, 110 fathoms, one young; Sta. 41, off Sand Key, 20 fathoms, one young; Sta. 68, 69, off Little Cat I., 3 to 13 fathoms, many adult; Egg Key, three adult. Common at the Florida Keys and throughout the West Indies in shallow water. Bermuda (Goode), Brazil (Rathbun). Low water to 262 faths. (Lyman).

Family, OPHIOCOMIDÆ *Ljung.*, 1867.

OPHIOCOMA ECHINATA (*Lam.*) *Agassiz.*

Ophiocoma echinata L. Agassiz, Mem. Soc. Sci. Nat. Neuchatel, I, p. 192, 1835. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 81, fig. 5, 1865; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 171, pl. XLII, fig. 12, 13, 1882, anatomy. Verrill, Trans. Conn. Acad., Vol. I, p. 321, 1868.

Ophiura echinata Lamarck, Hist. Anim. sans. Vert., II, p. 543, 1816.

Ophiura crassispina Say, Journ. Phil. Acad. Nat. Sci., V, p. 147, 1825.

Ophiocoma crassispina Mull. & Trosch., Syst. Ast., p. 103, 1842. Lütken, Add. ad Hist. Oph. Pt. II, p. 142, pl. IV, fig. 7, 1859.

Ophiocoma tumida Mull. & Trosch., Syst. Ast., p. 100, 1842.

Ophiocoma serpentaria Mull. & Trosch., Syst. Ast., p. 98, 1842.

Sta. 76, off Little Cat Is., 3 to 13 fathoms, one example; Tortugas, one example. Common from Florida to Colon, and Cumana and throughout the West Indies, in shallow water. Bermudas (Goode; Verrill). Parahyba do Norte, Brazil (R. Rathbun).

OPHIOCOMA RIISEI *Lütken.*

Ophiocoma riisei Lütken, Vid. Meddel., p. 14, Jan. 1856; Add. ad Hist. Oph., Pt. II, p. 143, pl. IV, fig. 6. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 76. Verrill, Trans. Conn. Acad. I, pt. 2, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 171, 1882.

Tortugas, two large examples. Common from Florida and Bermudas to Colon and Cumana, and throughout the West

Indies, in shallow water. Fernando de Noronha, Brazil (R. Rathbun).

OPHIOCOMA PUMILA *Lütken.*

Ophiocoma pumila Lütken, Vid. Meddel., p. 13, Jan. 1856; Add. ad Hist. Oph., Pt. II, p. 146, pl. IV, fig. 5, 1859. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 71, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 171, 1882.

Sta. 15, off Havana, 200 fathoms, one example; Sta. 67, 74, 76, off Little Cat I., in 3 to 13 fathoms, eighteen examples; Tortugas, eleven examples. Common from the Florida Keys to Colon, and throughout the West Indies, in shallow water, to Brazil. Bermudas (Lyman; Goode).

OPHIOPSILA RIISEI *Lütken.*

Ophiopsila riisei Lütken, Add. ad Hist. Oph., Pt. II, p. 136, pl. V, fig. 2, 1859.

Ophiopsila riisei Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 150, figs. 16, 17, 1865; Bull. Mus. Comp. Zool., V, 9, p. 228. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 160, pl. XL, figs. 1–3, 1882, anatomy.

I have found it desirable to separate *O. fulva* Lym. and allied species from *Ophiopsila*, as a new genus (see p.).

O. riisei appears to be closely related to the type (*O. aranea* Forbes), and like the latter, has a compact cluster of special tooth-papillæ within the margin of the jaw.

Station 13, off Havana, 200 fathoms, two examples. Bahama Banks, in shallow water, two examples; Egg Key, one example.

Throughout the West Indies and Florida Reefs. Common in shallow water. Also at Colon and Cumana, Ven. Brazil (Ljungman). Dredged by the Blake Exped. in 37 to 50 fathoms.

Family, AMPHIURIDÆ *Ljung.*, 1867.

AMPHIURA of authors, sens. ext.

In the report on the *Ophiuroidea* of the Voyage of the Challenger, Mr. Lyman recognized about ninety species of *Amphiura*. In subsequent papers by him and others, about thirty additional species have been described. This very extensive assemblage of species is evidently capable of being divided into several natural groups, in addition to the several minor groups already separated by Mr. Lyman and others. Indeed Mr. Ljungman, as long ago as 1867, set off a large number of species as a natural generic group, under the name of *Amphipholis*. At a still earlier date, Lütken had indicated this and other natural sections of the genus, without naming them.

Mr. Lyman, however. did not recognize *Amphipholis* and some other good divisions in any of his works, except as sections of the genus.

Subdivisions of Amphiura.

The species of *Amphiura*, as adopted by Lyman, mostly fall into four large groups, which seem to be natural divisions of generic value. They are best characterized by the structure, number and arrangement of the mouth parts, as in most other ophiuran families. A few aberrant species, not found in American waters, must be referred to other groups.

I. *Amphiura* (restricted). Type, *A. chiajei* Forbes.

One apical or subapical mouth papilla. One (rarely two) small, distal papilla (oral tentacle-scale); middle of jaw-edge without papillæ; mouth-slits gaping. Four to seven or more (rarely three) arm-spines. Radial shields divergent.

II. *Amphipholis* (restricted). Type, *A. squamata* (or *A. elegans*.

Two small lateral mouth-papillæ and one broad operculiform, distal one, forming a continuous series along the entire jaw, and capable of nearly or quite closing the mouth-slits. Radial shields in close contact.

III. *Amphiodia*, gen. nov. Type *A. pulchella* (Lym.)

Three (rarely four) small subequal mouth papillæ, none of them operculiform; they form a regular series, attached mostly to the side jaw-plate. Three (rarely four) arm-spines. Radial shields often more or less joined.

IV. *Amphioplus*, gen. nov. Type *A. tumida* (Lym.)

Four or five small mouth-papillæ, none operculiform, arranged in a continuous series, of which the outermost, at least, arises from the adoral shield and is really an oral tentacle-scale. Arm-spines three, (rarely four). Radial shields generally quite separated Disk scales naked.

AMPHIURA *Forbes* (restricted sense).

Amphiura Forbes, Trans, Linn. Soc., Vol. XIX, pp. 149, 150, 1842, (type *A. chiajei*) Ljungman, Ophiur. Viv., p. 318, 1867.

Amphiura (section B.) Lutken, Addit. Hist. Oph., II, p. 114, 1859.

Amphiura (*pars*) Lyman, Bull. Mus. Comp. Zool., I, pp. 335, 338; Voy. Challenger, V, pp. 122, 124, 1882.

Owing to the small number of mouth-papillæ and their peculiar arrangement, the mouth slits cannot be closed, but appear always gaping, more or less.

Only one true mouth papilla, which is placed on each side of the apex of the jaw. A single, usually spiniform, papilla, sometimes with a smaller one by its outer side, is situated at the distal end of the mouth-slit, usually attached to the edge of the adoral shield. This is really the outer oral tentacle-scale.

The edge of the jaw-plate, along its middle portion, is naked. Higher up in the mouth-slit, there is a small spiniform papilla, usually visible from below; this is the tentacle-scale of the first oral tentacle. It is often shown in published figures as if it were a true mouth-papilla. Tentacle-scales usually one or two, sometimes lacking (section *Ophiopelte*).

Arm-spines short, usually four to seven or more, (rarely three). Radial shields naked, small, generally divergent, with the distal ends either in contact or somewhat separated by small scales. The disk is usually covered with small naked scales.

In one group the under side is without scales (*Hemilepis*). In a group referred by Lyman to *Ophiocnida*, the disk is covered with small spinules, but as the mouth-parts and other organs agree with typical *Amphiura*, it might better be regarded as a distinct genus, or else as a subgenus of *Amphiura*. To this I have given the name of *Amphiocnida*. (See p.).

The genus *Amphiura*, as here adopted, agrees nearly with the typical genus, as restricted by Ljungman in 1867. Mr. Lyman also stated that this should be the typical group, in case the genus were to be divided. This restricted genus still includes over sixty species, with a considerable diversity of structure. The species are found in all seas and in all depths.

AMPHIURA GRANDISQUAMA *Lyman*.

Amphiura grandisquama Lyman, Bull. Mus. Comp. Zool., I, p. 334, 1869; op. cit., p. 252; Illust. Cat. Mus. Comp. Zool., vol. VIII, pl. V, fig. 65; Voy. Challenger, Zool., V, pp. 124, 143, 1882.

Several specimens of this species in the collection have been compared with some sent by Mr. Lyman from the Blake Exp. They agree in most respects, but none of those in either lot agree perfectly with the original description.

The arms are of moderate length, slender and tapered. The disk is covered with very fine, thin, closely imbricated scales, which become still finer below. Radial shields small, longer than wide, inner end widest, adjacent edges nearly straight, outer ones curved; they are nearly in contact at the distal end, divergent proximally, separated by a long wedge-like scale and several smaller ones more proximal; the disk scaling overlaps and conceals more or less of the radial shields, in one case leaving very little exposed. Arm-spines five or six on the basal half of the arms; they are of moderate length, rather slender, tapered; the lower one, especially on the middle part of the arm, is longer than the others, sometimes twice as long, and somewhat bent downward; the upper one on this part of the arm is often stouter and a little longer than the intermediate ones. Upper arm-plates rather broader than long, in contact, somewhat trapezoidal, with the distal end convex and the angles rounded, the lateral edges convergent, the inner end narrower and truncated; the extreme outer edge is sharp, thin, and microscopically serrulate. Under arm-plates oblong, longer than broad, with rounded corners and concave lateral edges, opposite the tentacle-pores, outer end convex, inner end subtruncate. Tentacle-scale single, rather large for the genus, thick, rounded or broad-ovate, obtuse. Oral shield small, transversely broad elliptical, evenly convex distally, inner side with a slight obtuse angle.

Adoral shields small, triangular, inner end acute; generally the inner ends are not in contact. Inner mouth-papilla short, thick, conical; outer one, (oral tentacle-scale) thicker, short-conical, obtuse; sometimes there is another rudimentary one alongside of the latter, and like it arising from the adoral shield. The inner oral tentacle has a small, thick, acute papilla in the middle of the mouth-slit, above the level of the others.

Diameter of the disk of the largest specimen, 7 mm; length of arms, about 25 mm.

Stations 54 and 58, off Florida, 130 fathoms. Taken by the Blake Exped. in 10 to 262 fathoms.

The specimens from the Blake Exped., station 319, in 262 fathoms, differ from the above in some minor points. The disk-scaling is a little less fine; the radial shields a little broader, and the arm-spines a little smaller, but they vary among themselves in these characters.

This species is allied to *O. otteri*, but has much shorter, more delicate and more tapered arms, and the lower spine is more curved. The latter has true tentacle-scales and the disk scales are larger and more regular.

AMPHIPHOLIS GOESI *Ljung.*

Amphipholis goesi Ljungman, Dr. Goes Oph., Kong. Acad., 1871, pp. 635, 648. Verrill, Expl. of Albatross in 1883, Annual Rep. U. S. Fish Com. for 1883, p. 549, 1885.

Amphiura goesi Lyman, Voy. Challenger, Zool., V, pp. 125, 146, 1882.

A single mutilated specimen, without the upper side of the disk, was obtained.

Mouth papillæ three, forming a close series, the outer one flat, much the largest, as broad as the other two together, so that it occupies more than half the length of the edge of the jaw; the inner two are thick, obtuse, angular. Oral shields rather large, top-shaped, about as broad as long; the outer end is strongly convex, the sides distinctly incurved, forming an acute inner angle. Lateral oral shields crescent-shaped, rather large and thick, with concave side next the oral shields. Tentacle-scales two, oblong, rather stout, blunt, nearly equal.

Arms long, tapering but little; under arm-plates rather large, thick, in contact with each other, about as long as broad, five-sided with rounded corners; the outer edge is strongly convex and often slightly angulated and prominent in the middle, or has a slightly raised umbo, the inner end is angulated and usually has a small, rough, median projection or lobe, where it articulates with the preceding one.

Arm-spines three, short, tapered, subequal, about half the length of arm-joint. Dorsal arm-plates in contact with each other; thick, transversely subelliptical, distinctly wider than long, with the outer end broadly rounded, and the inner end obtusely angulated.

Diameter across the scar left by the disk on the arms, 10 mm; length of the longest arm (not entire) 35 mm.

Off Havana, 110 to 200 fathoms. West Indies, 280 fathoms (Lyman). Off Cape Hatteras, 14 fathoms (Verrill).

Amphipholis tenera (*Ltk.*) *Ljung.*

Amphiura tenera Lütken, Addit. ad. Hist. Ophiur. Pt. II, p. 124, pl. III, figs. 5*a*, 5*b*, 1857. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 123.

Amphipholis tenera Ljung., Ophiur. Viv., Kong. Akad., 1866, p. 312; op. cit., 1871, pp. 634, 645.

Disk rounded, thin, flat, covered with numerous small rounded scales, regularly arranged. Those along the margins with their edges a little turned up, so as to form a slight border. Radial shields rather crescent-shaped, in close contact. Arm-spines three, slender, tapered, nearly equal in length, but the middle one is distinctly swollen toward the base; they are about as long as the length of an under arm-plate. Tentacle-scales two, small, oblong, blunt, about equal in size. The outer mouth papilla is flat, much the broadest, occupying about half the length of the mouth-slit; the middle one is small, subconical; inner one a little larger.

Oral shields top-shaped, about as long as broad, the outer end strongly rounded, the inner sides nearly straight and convergent to an acute angle. Lateral oral shields relatively large, oblong, a little wider distally, the inner ends largely in contact.

Under arm-plates oblong shield-shaped, decidedly longer than wide, outer end convex, sides nearly straight, inner end angulated; they are strongly separated by the side-plates.

Upper arm-plates relatively large, rather broader than long, subtriangular, the outer end broadly rounded, the inner end obtusely angulated; they are well separated by the side plates.

Diameter of the disk of the specimen described, which is not full grown, 2 mm; length of arms (broken at tips), 9 mm.

Off Havana, 100 to 200 fathoms. Charleston, S. C., to West Indies, in shallow water.

Mr. Lyman, in the Voyage of the Challenger, united this species and several other forms that have been described as distinct species from various regions, with *A. squamata* of Europe.

This West Indian form appears to me to be distinct, though very closely allied to *A. squamata.* I have described, above, a small but characteristic specimen, which agrees very closely with Lütken's original figures.

AMPHILIMNA, gen. nov. Type, *A. olivacea.*

Mouth papillæ four or five in a series. Tooth papillæ two to four. Arm-spines six to ten, of moderate length. Tentacle-scales usually two. Disk swollen dorsally, with a notch over the base of each arm, and covered with spinules. Radial shields parallel, largely in contact. This genus includes, besides the type, only *A caribea* Ljung.

AMPHILIMNA OLIVACEA *Ver.*

Ophiocnida olivacea Lyman, Bull. Mus. Comp. Zool., I, 10, p. 340, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. I, figs. 7, 8; Bull. Mus. Comp. Zool., V, 9, p. 227; op. cit., X, p. 253. Verrill, Amer. Journ. Sci., Vol. XXIII, p. 219; Ann. Rep. U. S. Fish Com., Vol. X, p. 661; op. cit., Vol. XI, p. 549; Lyman, Report Voy. Challenger, Zool. *Ophiuroidea*, V, p. 156, 1882.

Sta. 61, off Key West, in 75 to 80 fathoms, one example.

Taken by the U. S. Fish Comm. at numerous stations off the east coast of the United States, from off Martha's Vineyard to Cape Hatteras, in 63 to 192 fathoms, and by the "Blake" from off Rhode Island to the West Indies, in 40 to 126 fathoms.

It is possible that *A. caribæa* (Ljung.) from the West Indies, is the young of this species.

OPHIONEREIS RETICULATA *Lütk.*

Ophionereis reticulata Lütken, Add. ad Hist. Oph. Pt. II, p. 110, pl. III, figs. 6*a*, 6*b*, 1859. Lyman, Ill. Cat. Mus Comp. Zool., I, p. 141, 1865; Bull. Mus. Comp. Zool., V, 9, p, 224; op. cit. X, p. 253. Verrill, Notes on Radiata, Trans. Conn. Acad., I, pp, 342, 366, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 162, pl. XL, figs. 13–15, 1882, anatomy.

Ophiura reticulata Say, Jour. Phil. Acad. Nat. Sci., V, p. 148, 1825.

Ophiolepis nereis Lütken, Vid. Meddel., p. 11, March, 1856.

Tortugas, four examples; Bahama Banks, two examples; Egg Key, one example; off Havana, 110 fathoms, 1 example.

Common in shallow water from Florida to Colon; Cumana, and throughout the West Indies. Bermudas (Coll. Goode); Abrolhos Reefs, Brazil, (Coll. Hartt). Bahia and Rio de Janeiro (Rathbun).

Ophioplax ljungmani *Lym.*

Ophioplax ljungmani Lyman, Ill. Cat. Mus. Comp. Zool., Vol. VIII, p. 22, pl. II, figs. 24, 25, 1875; Voyage Challenger, pp. 164, 314, pl. XLI, fig. 7 (anatomy).

Sta. 13, off Havana, 200 fathoms, 6 examples.

Taken by the Blake Exped. in 80 to 250 fathoms.

Ophiactis dispar *Verrill*, sp. or var. nov.

Plate VIII; Figures 3—3*e*.

Arms five. Radial shields large, elongated, semielliptical, separated by a single narrow row of small plates, except distally; their inner edges nearly straight, diverging but little; distal end thickened, bearing a small round knob; lateral edges convex. Central and interradial areas covered with pretty regular, small, very distinct scales, many of which bear small conical spinules, especially near the center and close to the margin. Arm-spines, six to eight; four, or sometimes five of the lower ones are white, short, subequal, flat at tip, blunt, nearly parallel, and close together, two or three of the upper ones are decidedly longer, abruptly different in color and form, divergent, tapered, acute. Mouth-papillæ two, small, flat, placed close together, on each side of the distal part of the mouth angles, just above the outer oral tentacle; one small, oblong, flat, blunt tentacle-scale. Under arm-plates about as long as broad, with the outer edge subtruncate or rounded and with a thickened and raised rim; distally they become longer than broad. Upper arm-plates transversely elliptical, short, with the outer edge evenly convex; they are somewhat thickened and broadly joined.

Oral shields small, transversely broad-elliptical, convex and slightly angulated distally, obtusely angulated on the inner end. Madreporic shield decidedly larger and more rounded. The large genital slits nearly reach the oral shields; their inner ends are separated only by a narrow isthmus, covered by two narrow genital scales, which join the outer end of the oral shield. Adoral shields small, trilobed, the acute inner ends separate, or sometimes barely touching.

Color of one example deep green above, with small white spots on the outer end of the radial shields, on the central part of the disk, and on the upper arm-plates Under side whitish, the arms becoming greenish distally. The four lower arm-spines are white; the two or three upper ones are green. Another example, from station 69, is greenish black above, with fewer white markings, but whitish below.

Diameter of disk, 7.5 mm.; length of longest arm, broken at tip, 44 mm.

Stations 69 and 74, Bahama Banks, in shallow water.

Mr. Lyman sent to me, several years ago, several specimens essentially like those described above, but of still larger size, as "*O. mülleri, var. quinqueradia.*" This variety name, first given in 1878, appears in the Voyage of the Challenger (pp. 113, 115), but with no definite description nor figure.* I am not aware that it has been described elsewhere under that name. In his earlier work † Mr. Lyman described a

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*This name appears without description in Bull. Mus. Comp. Zool., vol. V, p. 224, 1878. The specimens were from Key West and vicinity in shallow water (shore to 37 fath).

In the Voy. Challenger, p. 113, in the analytical table, it is mentioned as the *adult* of *O. mülleri*, and is said to have: "Upper arm-plates transverse oval and not thickened; three or even four mouth-papillæ on a side." In the specimens sent to me the upper arm-plates are thickened and there are three small mouth-papillæ.

†Illust. Catal. Mus. Comp. Zool., I, p. 109, 1865.

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.—*Ophiosculus* (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 inner 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 subtruncate; 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.

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*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 fath-fathoms. (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 narrower; 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.

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*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 proximai 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, sub-truncate.

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. tenuispina* 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.

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*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, fourteen 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*

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*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 elevated 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) Ljüng., 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, or *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.

Gorgonocephalus 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.

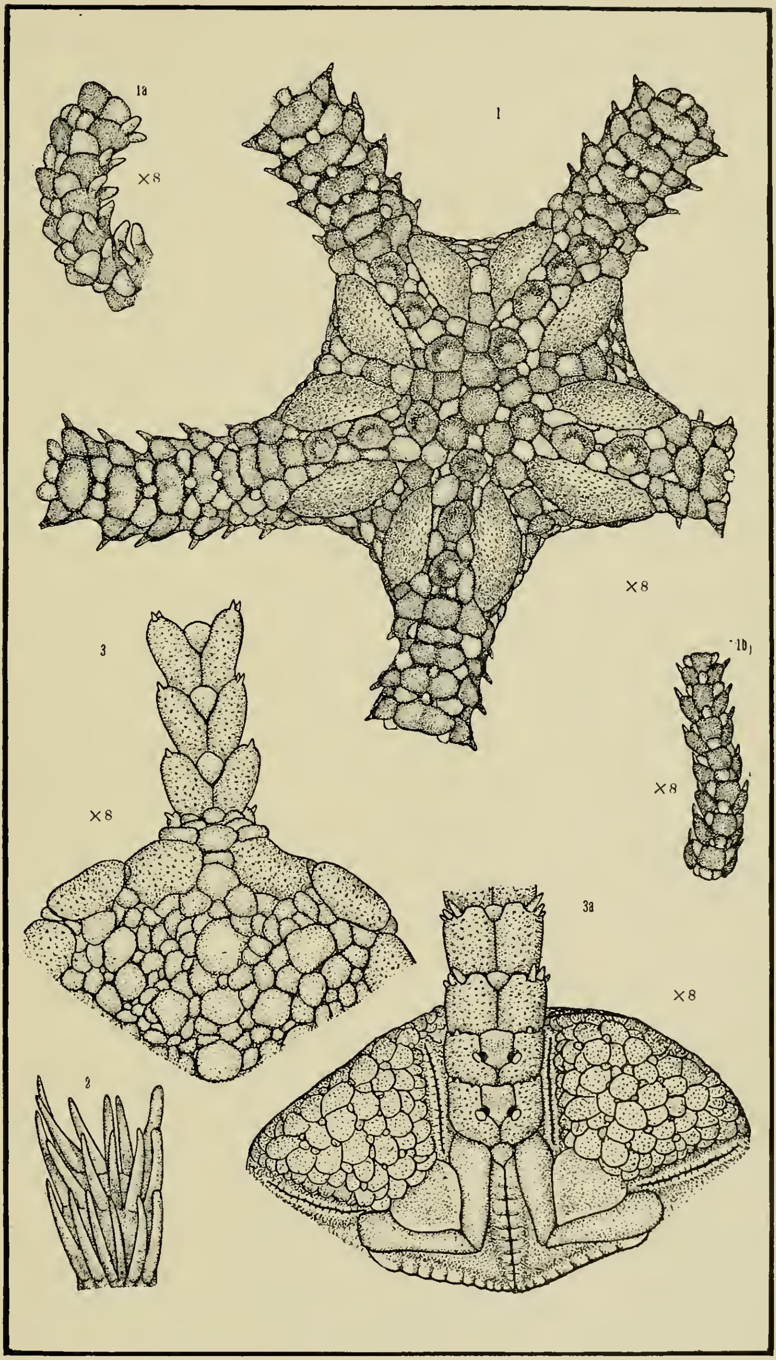
Fig. 1*b*. The same. Distal part of an arm, dorsal view. × 8.

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.

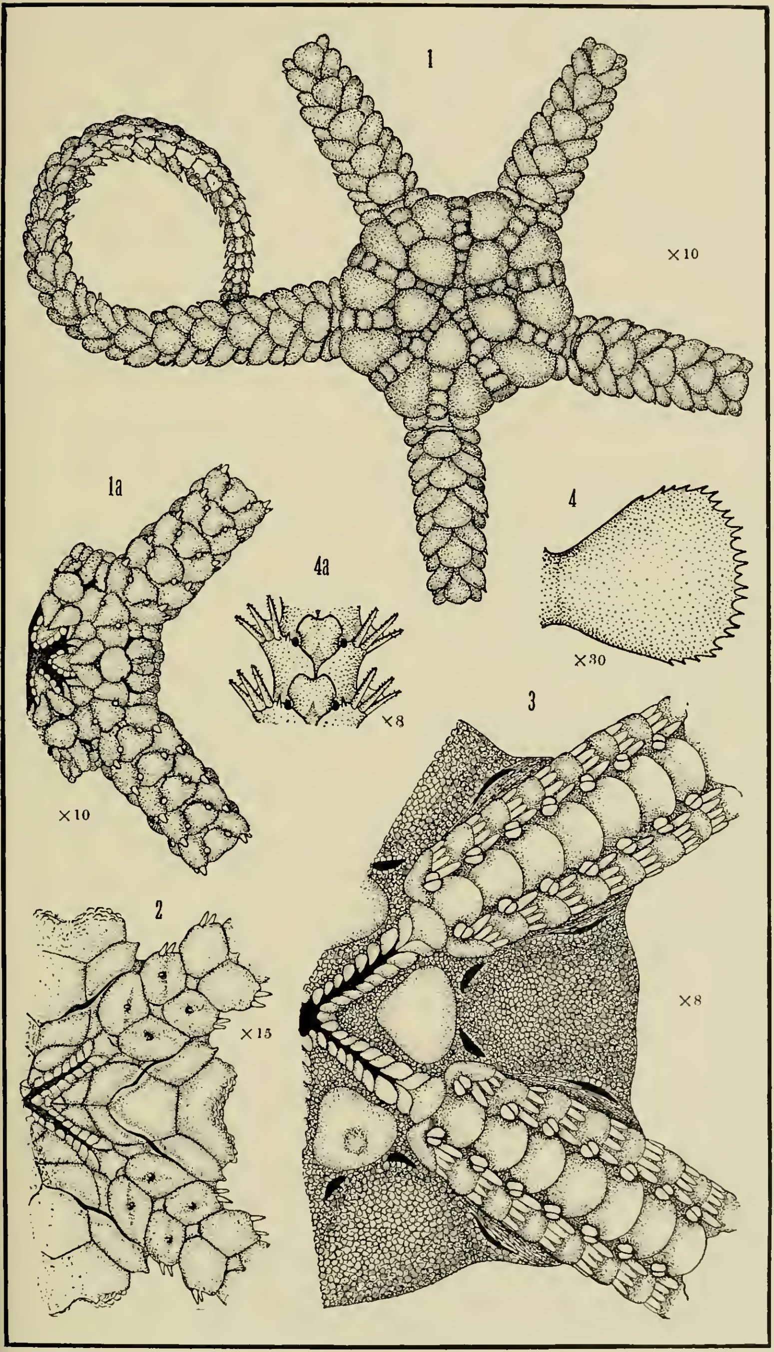
Fig. 2. *Ophiomusium sculptum* Ver. Oral side of part of the disk, and bases of two arms. × 15.

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.

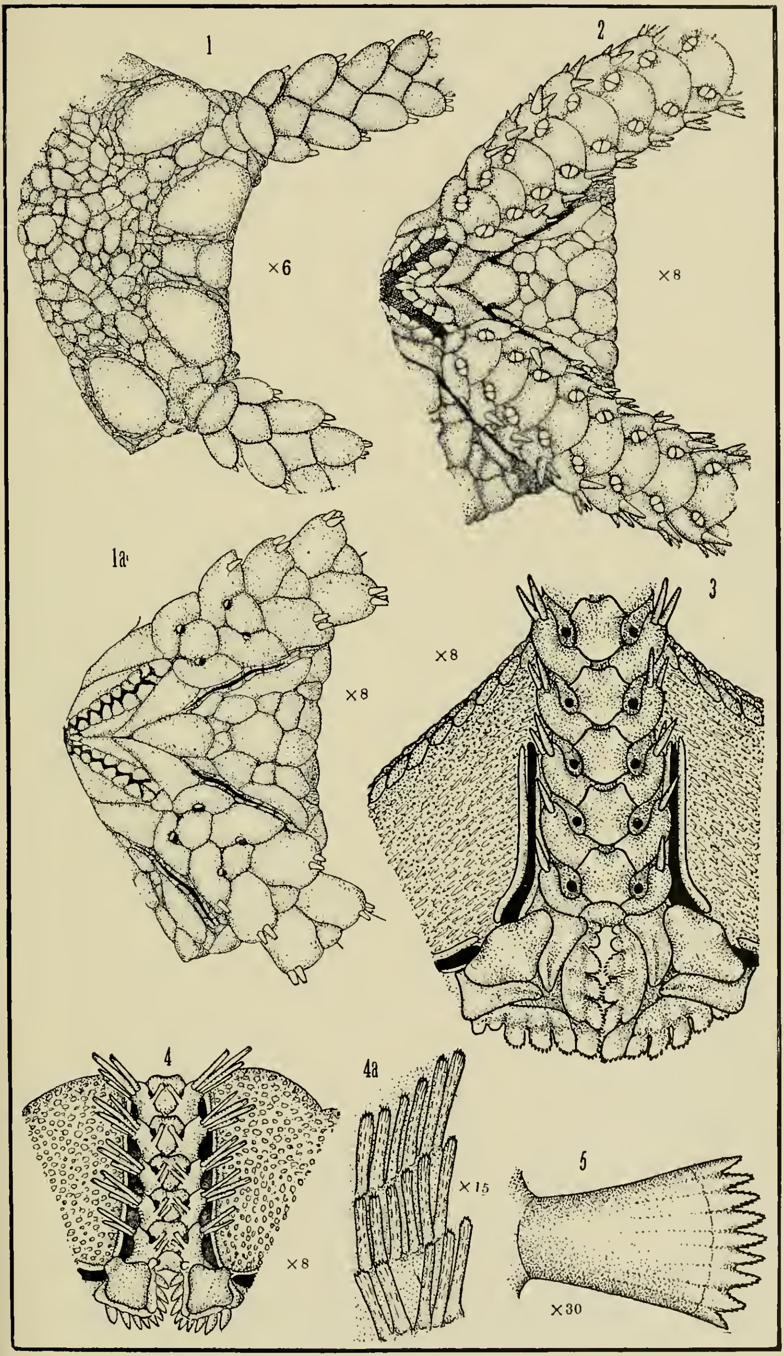
FIG. 3. *Ophiomyxa brevicauda* Ver. Ventral side of a part of the disk and bases of two arms. × 8.

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.

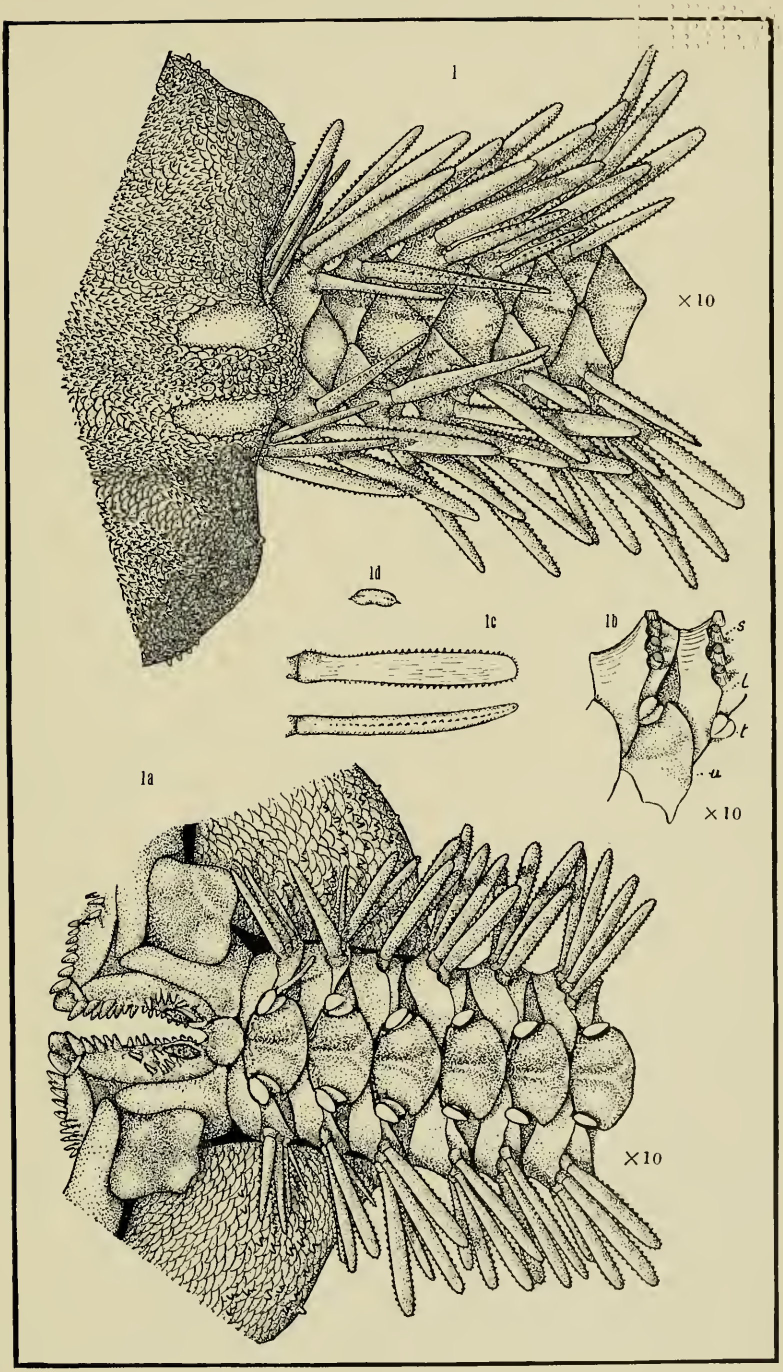
Fig. 1*a*. The same specimen. Oral side. × 10.

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.



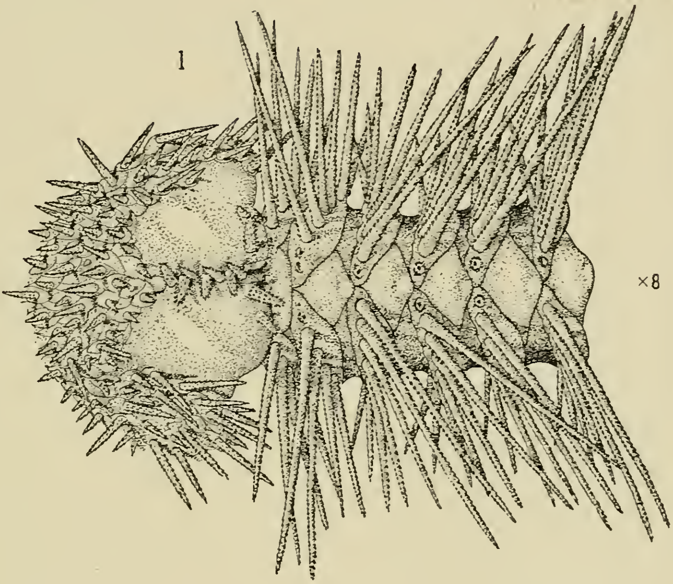
Explanation of Plate V.

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

Fig. 1*a*. The same specimen. Ventral view; *m*. madreporic plate. $\times 8$.

Plate V.

1



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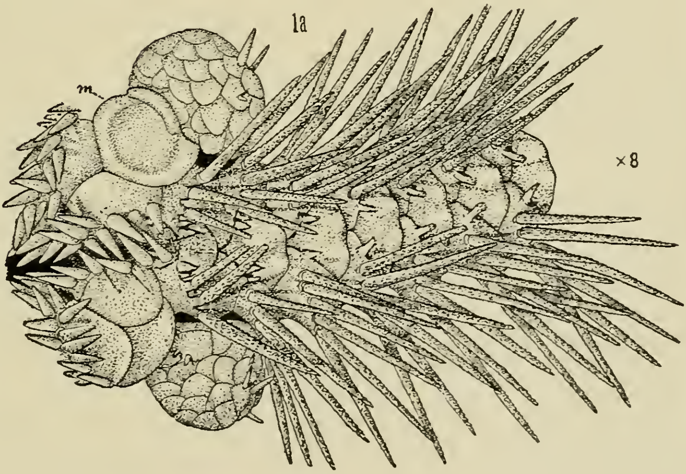


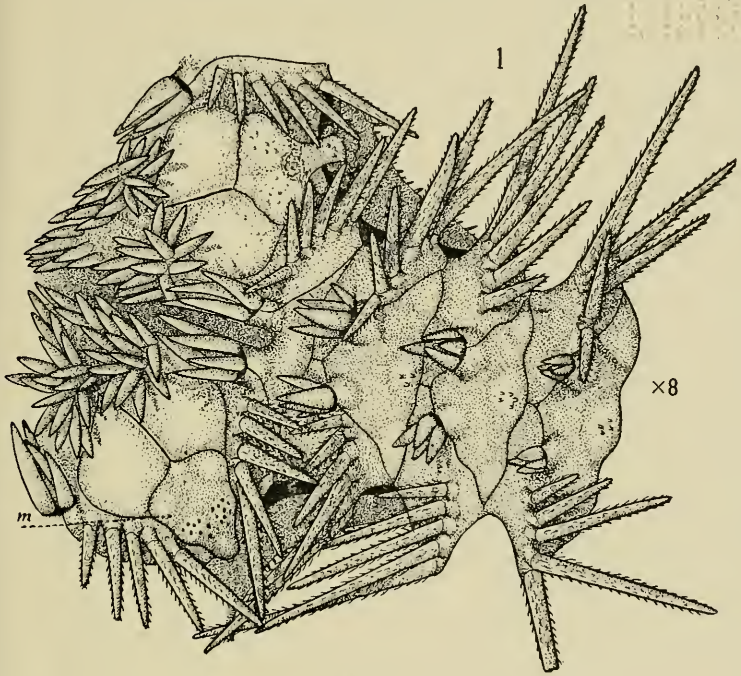
×8

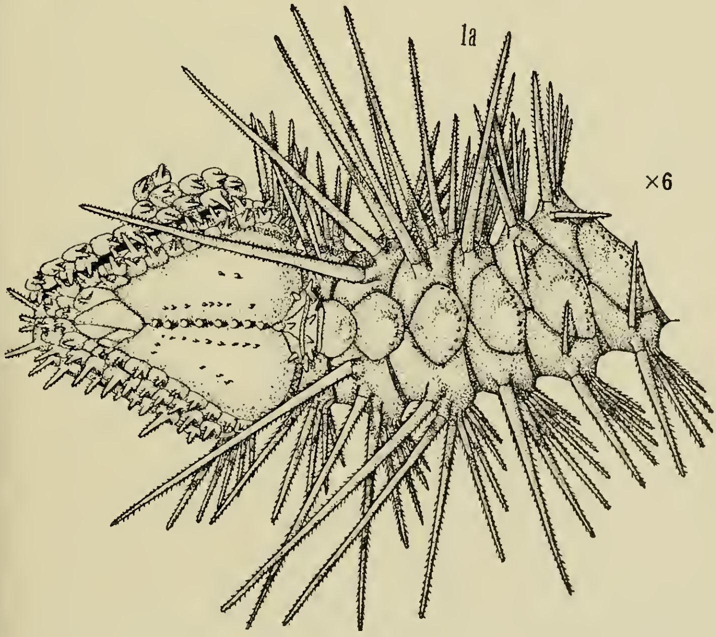
Explanation of Plate VI.

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.

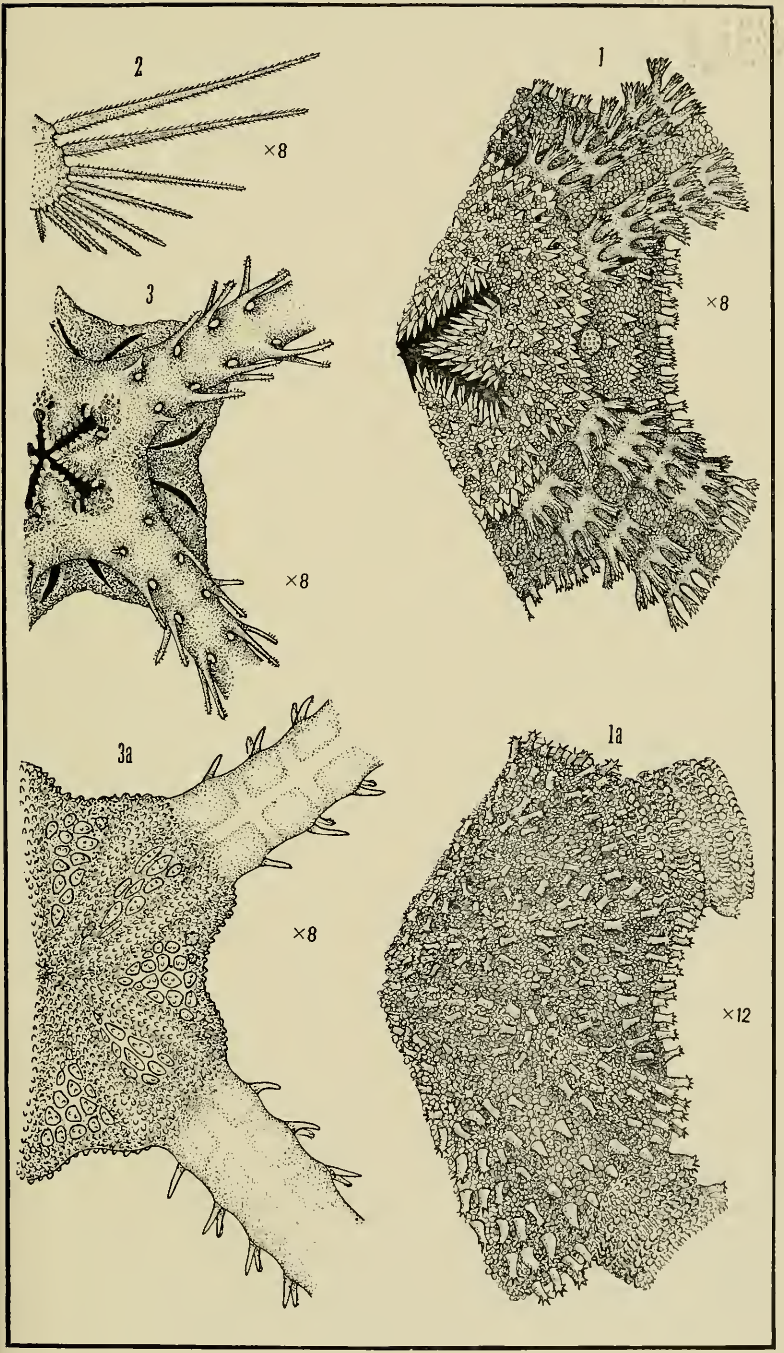
FIG. 1*a*. The same specimen. Dorsal side. × 12.

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.

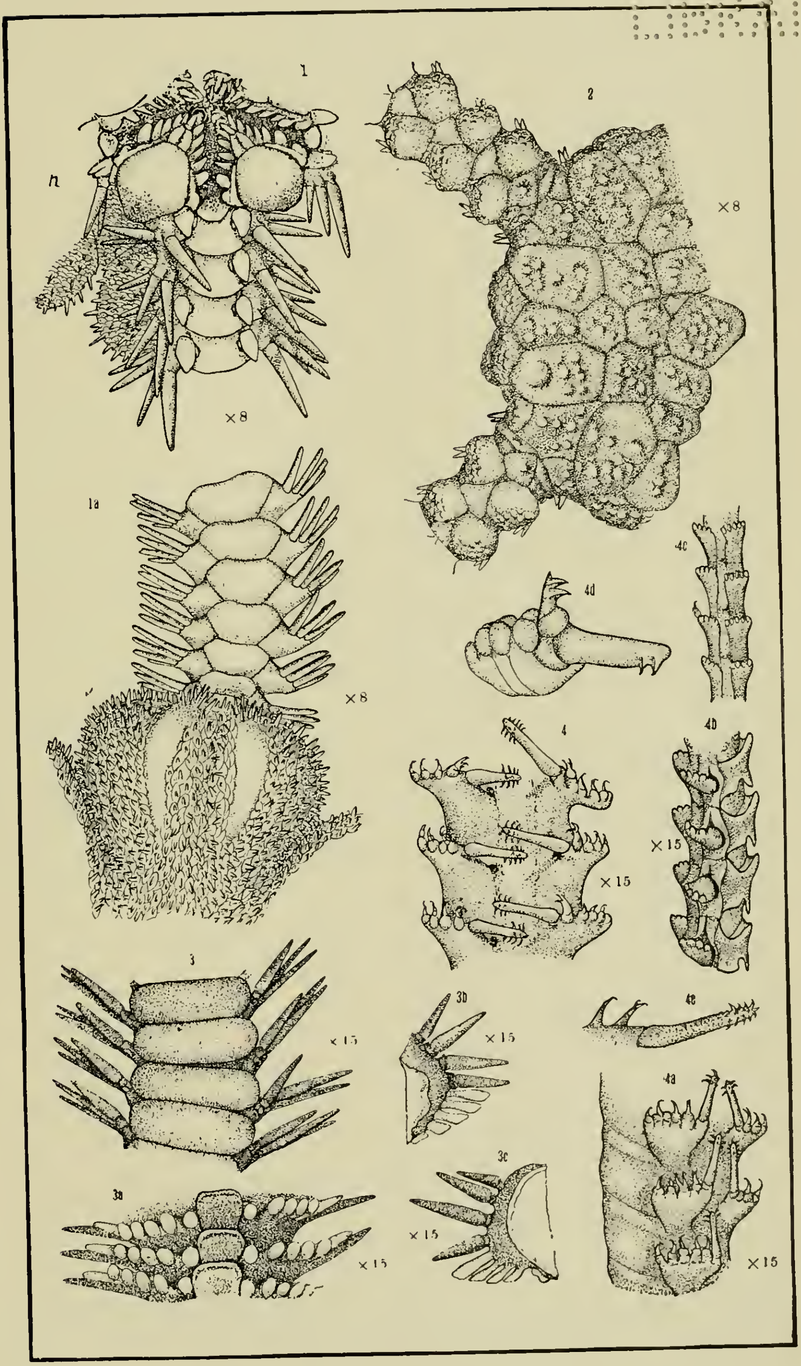
Fig. 4*b*. The same. Nearly side view of some of the more distal joints, after treatment with potash, to show the plates. The spines and hooks are removed. × 15.

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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BULLETIN OF THE UNIVERSITY OF IOWA.
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VOL. V. NO. 2.

BULLETIN

FROM THE

LABORATORIES OF NATURAL HISTORY

OF THE

STATE UNIVERSITY OF IOWA.

PUBLISHED

BY AUTHORITY OF THE REGENTS.

IOWA CITY, IOWA

MAY, 1901.

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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.

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 Proceedings 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, blooming 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 Britton 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 pubescent, 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 observed 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 exists 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 rèpens* 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.

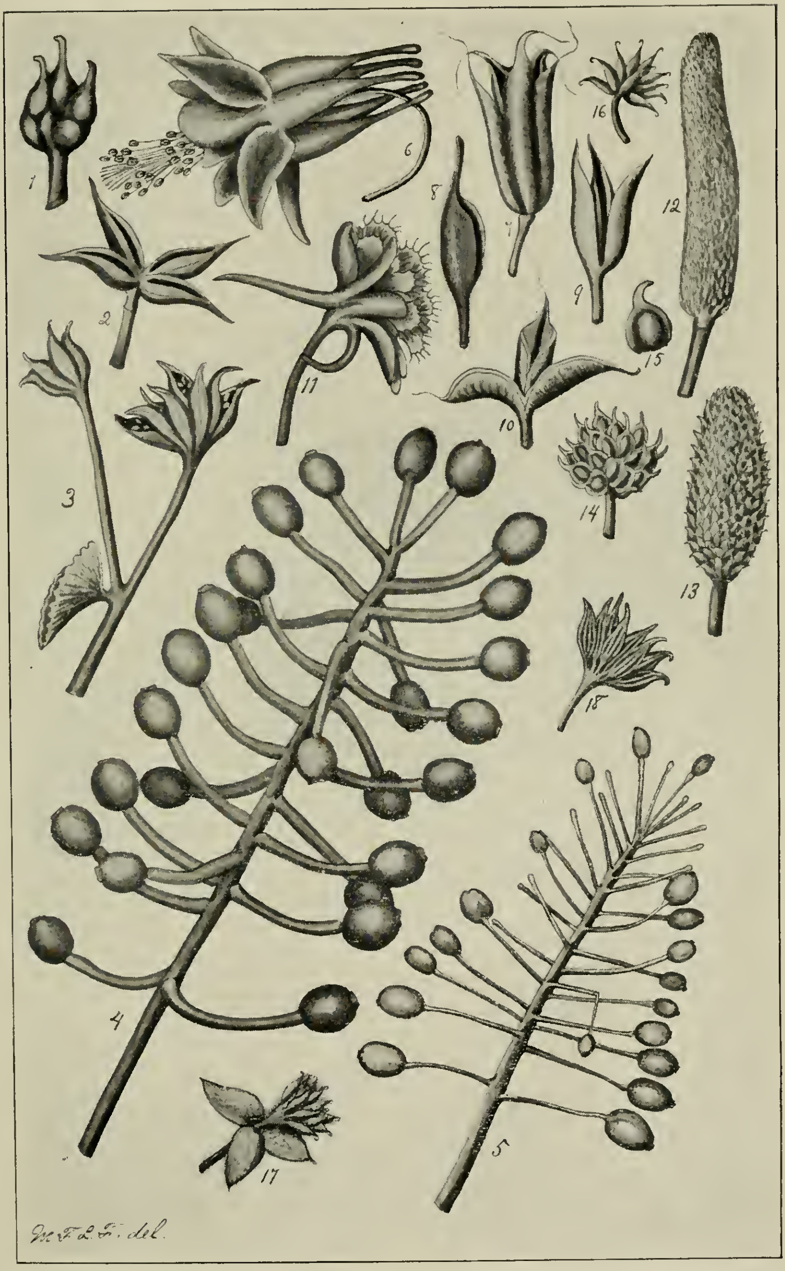
Very similar to the preceding but differing in having no glandular or waxy pubescence, while the filaments are broadened. Torrey and Gray in Flora of North America, vol. 1, p. 38, 1838, referred this species to *Thalictrum cornuti* L., a species entirely distinct, hence this name becomes a synonym. In 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.

PLATE I.



Explanation of Plate II.

PLATE II.

Explanation of Plate III.

1. *Pulsatilla hirsutissima* .... p. 115.
2. Head of fruit of *Pulsatilla hirsutissima* .... p. 115.
3. Head of fruit of *Astragene americana* .... p. 119.
4. Achenes of *Thalictrum dioicum* .... p. 134.
5. Head of fruit of *Clematis virginiana* .... p. 117.
6. Head of fruit of *Clematis simsii* .... p. 118.
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 4½.
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,

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*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 represented: 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 POLYPODIUM *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 WOODSIA *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 identification 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 ONOCLEA *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 P H E G O P T E R I S *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 teleuto-spore, to which the uncertain term, meso-spore, 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.

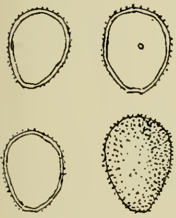

Fig. 1. UREDO PALLIDA *D. & H.* From type collected at the City of Mexico, Oct. 1, 1896.

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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, $35 \times 30\mu$, scarcely echinulate, the epispore of medium thickness, pale rusty-brown: teleutospores variable, usually short, irregularly oblong, often somewhat constricted at the septum, averaging $25 \times 40\mu$, 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.

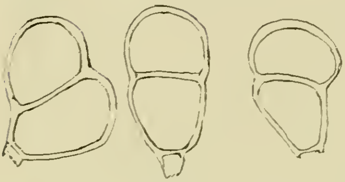

Fig. 2.
PUCCINIA POLYSORA *Und.* From type collected at Auburn, Ala., Oct. 1891.

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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).

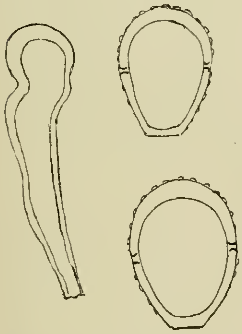

Fig. 3.
CAEOMA (UREDO) ANDROPOGI *Schw.* From type in Phila. Acad. Sci. collected at Bethlehem, Pa., 1829.

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*. 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).

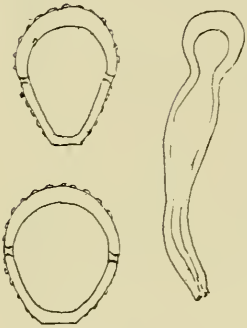

Fig. 4.
UREDO ALABAMENSIS *Diet.* From type collected at Auburn, Ala., Oct. 14, 1891.

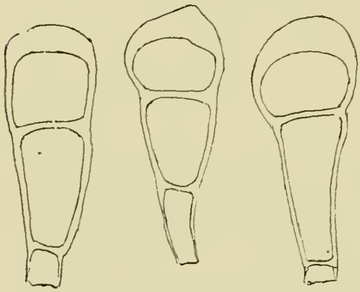

Fig. 5.
PUCCINIA VIRGATA *E. & E.* From type collected in Rooks Co., Kans., Jan. 23, 1892.

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 minusveleariformibus, 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 24-32μ.

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 *Dict. & 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 [I], 1421 [I], 1475 [III].
Sydow, Uredineen, 95 [I], 96 [I].
Rabenhorst-Winter, Fungi Europæi, 3024, 3026a, b & c.
Thuemen, Myc. Univ., 27 [I].
Kunze, Fungi secl. exsicc., 554 [I].

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.

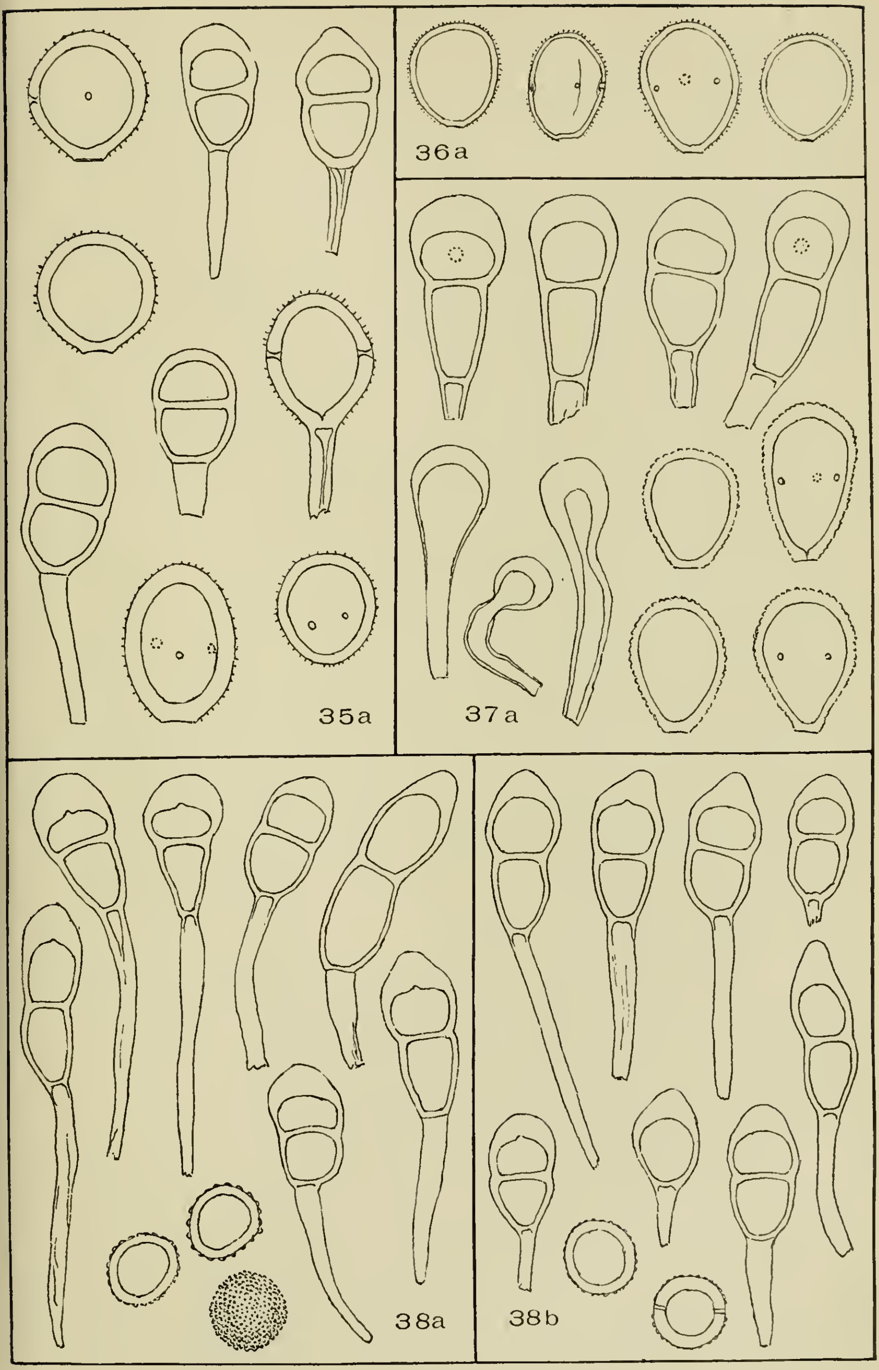
36*a*. Puccinia polysora *Und.*
On *Tripsacum dactyloides* L., from Mexico.
Four uredospores.

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 aud five teleutospores.

39*g*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Iowa.
Four uredospores and one teleutospore.

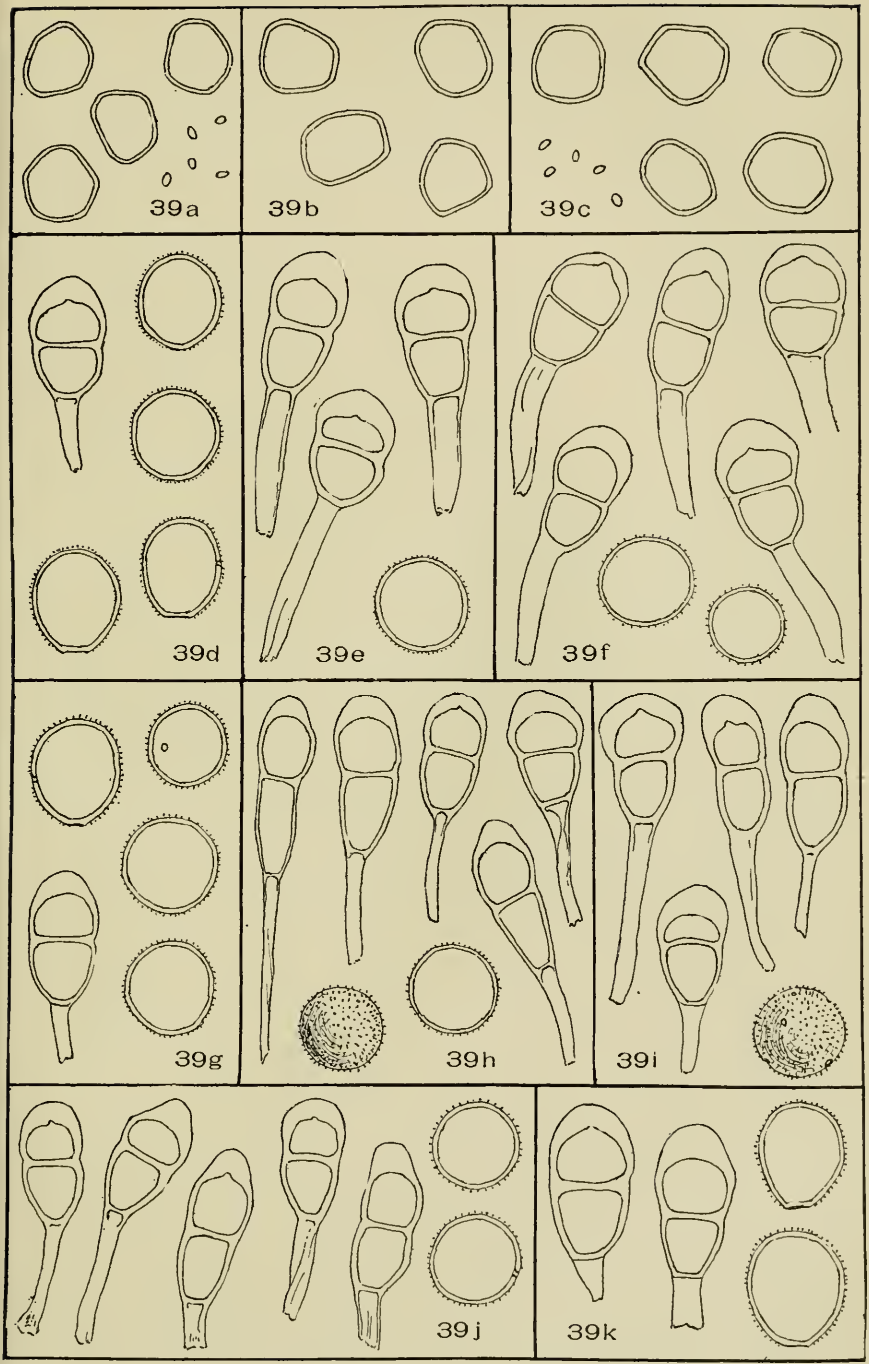
39*h*. Puccinia andropogonis *Schw.*
On *Andropogon furcatus* Muhl., from Indiana.
Two uredospores, one drawn as if opaque, and five teleutospores.

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.

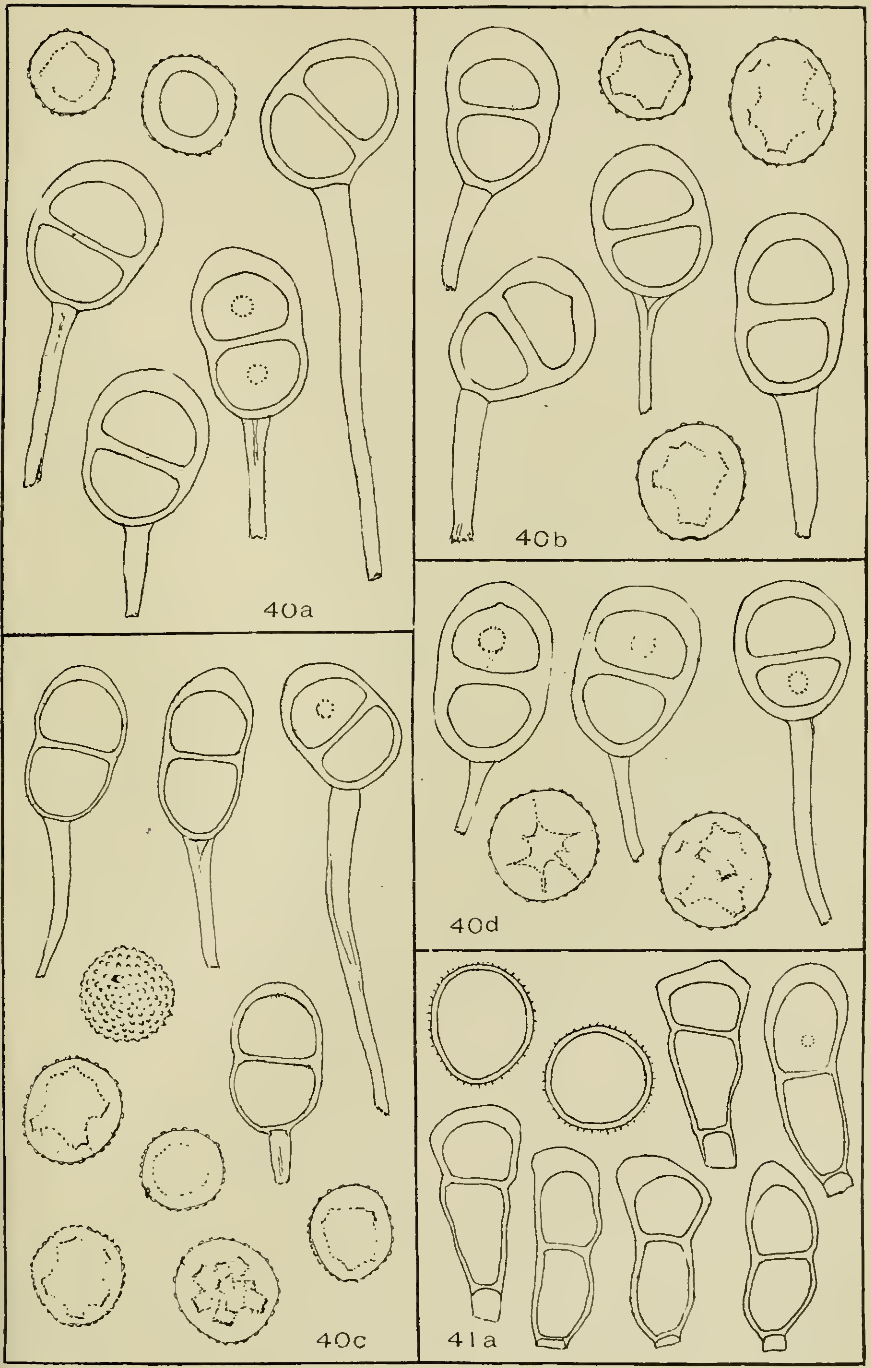
40*b*. Puccinia versicolor *Diet. & Holw.*
On *Andropogon melanocarpus* Ell., from Mexico.
Three uredospores and four teleutospores.

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.

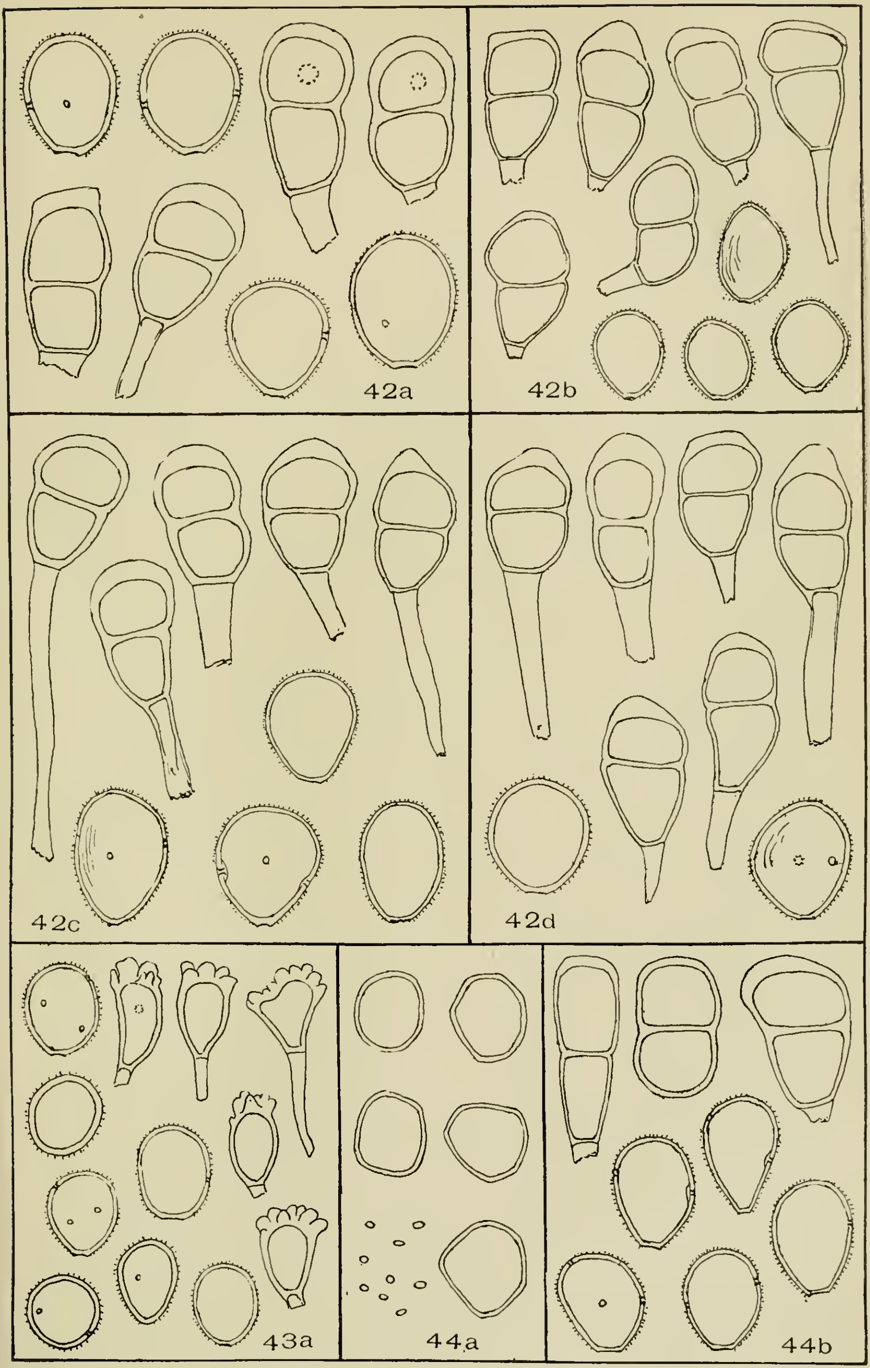
42*d*. Puccinia substriata *Ell. & Barth.*
On *Pennisetum mexicanum* Hemsl., from Mexico.
Two uredospores and six teleutospores.

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.



V—2 9

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.*

This Bulletin, as all the preceding, is sent free to all institutions and individuals from whom the University of Iowa receives similar publications in exchange; to other recipients the price will be fifty cents.

BULLETIN OF THE STATE UNIVERSITY OF IOWA.
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VOL. V. No. 3

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FROM THE

LABORATORIES OF NATURAL HISTORY

OF THE

STATE UNIVERSITY OF IOWA

PUBLISHED

BY AUTHORITY OF THE REGENTS

IOWA CITY, IOWA
OCTOBER, 1902

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October, 1902

Secretary WM. J. McCHESNEY:

We take pleasure in submitting herewith Bulletin No. 3, of Vol. V, from the Laboratories of Natural History, of the State University of Iowa.

THE EDITORS.

October, 1902.

A Catalogue of the Coleoptera of Colorado.

By H. F. Wickham.

The Coleoptera of Colorado have been made the subject of numerous memoirs, of more or less importance, since Congress gave the region its name and territorial standing in 1861. Most of the earlier explorations were made under the auspices of the Federal Government, and the results were published in the reports of the department which had the expedition in charge. A short sketch of these papers may not be out of place.

In the year 1869, C. Thomas made a collection which was reported upon by Dr. G. H. Horn.[1] The route followed ran from Cheyenne, along the eastern flanks of the Rocky Mountains, to Denver, whence side trips were made to Georgetown, Central City and the Middle Park. The party then went southward, through Colorado City, Soda Springs, Cañon City, and Trinidad, across the Raton Mountains into New Mexico. Returning, Colorado was again entered and collections made in the San Luis Valley, Poncha Pass, Arkansas Valley, South Park and Denver. No records of localities were kept and consequently the list has little value to the student of distribution.

A few years later, Lieut. W. L. Carpenter, U. S. A., collected some beetles at various points, among which may be noted Colorado Springs, Fairplay, Twin Lakes, the South

[1] A List of Coleoptera collected by C. Thomas in Eastern Colorado and Northwestern New Mexico during the Survey of 1869. By Dr. G. H. Horn. Hayden's Preliminary Report of the U. S. Geol. Survey of Wyoming and portions of contiguous Territories, for 1870. Washington, 1872.

Park and Estes Park. Unfortunately but few of the locality records were preserved. The list is from the pen of Henry Ulke.[1] Lieut. Carpenter added to Mr. Ulke's paper a separate account of some forms taken at an altitude of more than 12,000 feet. A number of Colorado records are contained in an article by Mr. Ulke that appeared at a later late.[2]

The next contribution is by Mr. J. Duncan Putnam.[3] He publishes a list of some two hundred and fifty species taken by himself, chiefly near the sources of Clear Creek, in the neighborhood of Empire City; a few are from the Middle Park, others from the base of the mountains at Denver, Boulder and Cañon City. The determinations are credited to Mr. Ulke. Exact localities are not quoted, and as he made excursions to the summits, the collection represents a mixed fauna and gives no data on vertical distribution.

Mr. P. R. Uhler follows with a report which is of interest and importance on account of the notes regarding localities and habits; his paper[4] deals with what is now well-trodden ground,—the valley of Clear Creek, through Golden and Beaver Brook. He also spent some time in the Arkansas valley near Cañon City as well as at Denver, Manitou and Colorado Springs. All of this work was done in the month of August. Dr. A. S. Packard made a collection in the valley of Clear Creek and on Gray's Peak during the same summer, and has given careful records.[5]

[1] List of Species of Coleoptera collected by Lieut. W. L. Carpenter, U. S. A., for the U. S. Geological Survey of Colorado. By Henry Ulke. Seventh Annual Report of the U. S. Geological Survey, for 1873. Washington, 1874.

[2] Report on the collections of Coleoptera made in portions of Nevada, Utah, California, Colorado, * * * * * during the years 1871, 1872, 1873 and 1874. Report of the Geographical and Geological Explorations and Surveys west of the 100th meridian, Vol. V, Washington, 1875.

[3] List of Coleoptera collected in the Rocky Mountains of Colorado in 1872. Proceedings of the Davenport Academy of Natural Sciences, 1876.

[4] Report upon the Insects collected by P. R. Uhler during the Explorations of 1875. Coleoptera. Bulletin of the Geological and Geographical Survey, 1877, Vol. III.

[5] Ninth Annual Report of the U. S. Geological and Geographical Survey, for 1875. Washington, 1877.

The University of Kansas Expedition, in charge of Prof. F. H. Snow, made large collections in 1876, chiefly in the neighborhood of Colorado Springs, whence trips were made to the surrounding plains and mountains. The South Park was visited by way of the Ute Pass and a stay was made in Engelmann's Cañon on the Pike's Peak trail. The results were published by Prof. Snow.[1] The omission of locality from many of the records detracts much from the value. Two years later, another party from the same University camped near Dome Rock in the Platte Cañon and took nearly a hundred species. This collection was also reported upon by Prof. Snow.[2] About this time a list was published by Dr. H. Strecker, on a series of Coleoptera taken in the San Juan region.[3] No definite localities are affixed to any of the names, but from a perusal of the accompanying notes on Lepidoptera it is evident that the expedition worked about Pagosa Springs and along the small rivers flowing southward out of the San Juan Continental Divide through Hinsdale, Archuleta and La Plata counties into the Ute reservation. Some may be from the adjacent regions of New Mexico.

Dr. J. L. Leconte is the author of some important memoirs on the Rocky Mountain fauna, though the material on which they are based was obtained by others. In the first of these papers[4] no localities are cited for most of the species other than saying that they came from Southern Colorado and Northern New Mexico, chiefly from the eastern foot hills of the Rocky Mountains. The second and third papers appeared under

[1] List of Coleoptera collected in Colorado in June, July and August, 1876, by the Kansas University Scientific Expedition. Transactions of the Kansas Academy of Science, Vol. V, 1877.

[2] List of Coleoptera collected near Dome Rock, Platte Cañon, by the Kansas University Scientific Expedition for 1878. Transactions of the Kansas Academy of Science, Vol. VI, 1877-1878.

[3] Coleoptera. Annual Report of the Chief of Engineers for 1878.

[4] Report upon new species of Coleoptera collected by the expeditions for Geographical Surveys West of the 100th Meridian. Annual Report of the Chief of Engineers for 1876, Appendix jj.

one title[1] and treat respectively of collections made by Mr. Fred C. Bowditch and Mr. E. A. Schwarz. Mr. Bowditch collected mostly in the vicinity of Georgetown, in the Leavenworth Valley, the South Park and near Florissant. A number of records, however, are of species taken at Alma, Garland and Manitou, or on high mountains. The collections of Mr. Schwarz are from the southern part of the state—Alamosa, Garland, La Veta and Veta Pass. These papers are of the highest scientific value.

Finally we have the publications of Prof. T. D. A. Cockerell, who resided for some time at West Cliff, in Custer county, and who printed several articles on the insect fauna of Colorado, the most important being one dealing with the entomology of Custer county.[2] This memoir is not a mere list of species but contains numerous valuable notes on habits together with a discussion of several distributional problems. Other papers by this author treat of the insects of different parts of the state.

The amount of work done by investigators who have not published the results is very considerable and probably their records would more than equal those which have appeared in print. Some of the more important trips may be noted here. In 1877, the late Mr. H. K. Morrison spent three months in the state, making collections in all orders, but I believe that he did not furnish accurate localities with his material; at any rate I have seen nothing more definite than "Colo. Morr." on any of the labels. In 1885, Messrs. Roland Hayward and Fred. C. Bowditch made a long journey on horseback from Gunnison to Montrose, thence through part of the Uncompahgre country to Placerville, Rico, Durango and Northern New Mexico. Returning, they went back to Durango, thence eastward to Pagosa Springs, up the valley of the San Juan to

[1] The Coleoptera of the Alpine Regions of the Rocky Mountains. Part I. Bulletin of the U. S. Geological and Geographical Survey, Vol. IV, No. 2, 1878. Part II., t. c. Vol. V, No. 3, 1879.

[2] The Entomology of the Mid-Alpine Zone of Custer County, Colorado. Transactions of the American Entomological Society, Vol. XX, 1893.

Summitville, down to Del Norte, through the San Luis Valley to Saguache and from there to Gunnison. Accurate records were kept and through the kindness of Mr. Hayward and Mr. Bowditch I am able to include them in this paper. The work done at the Colorado Agricultural College by Prof. C. P. Gillette and his assistants is very important, since they have brought together a great number of species from Fort Collins as well as many from other parts of the state. Having seen practically all of these collections, which were kindly sent me for study by Prof. Gillette, the data are now made available for reference. Mr. E. J. Oslar has sent me collections from the neighborhood of Denver, as well as some from other localities which have been useful. My own work as a collector in Colorado may be stated briefly as follows,—a stop at Greeley during the early part of May, 1889; a visit to Cañon City, Salida, Red Cliff and Grand Junction in May, 1891; about two months at Colorado Springs, Buena Vista, Leadville and Breckenridge in 1896, followed the next summer by a trip of several weeks duration to Denver, Georgetown, the Leavenworth Valley, Silver Plume and Ouray.

From the foregoing remarks it will be seen that nearly all of the collecting has been done in a strip extending north and south, embracing the territory covered by the principal mountain chains and their foot-hills, while the great slope of plains lying east of the longitude of Pueblo is practically untouched. Nothing is known of the extreme northwestern corner and in fact most of the region west of the 108th meridian is still waiting to be worked. Further study should be made of the very high peaks, in search of remnants of the Arctic fauna.

The phenomena of distribution in Colorado are of much interest. Within a radius of a few miles we may find assemblages of species representing at least three distinct faunæ. The first, that of the great plains surrounding the mountains, is marked by a great development of wingless or imperfectly winged forms, probably largely invaders from the south where we may suppose that the arid deserts first made their appearance and where this characteristic feature is more in evidence among the beetles. Good examples may be found among the Meloidae, Tenebrionidae and epigæal Rhynchophora. Occasionally these forms leave their natural haunts and extend for long distances up the river valleys. Thus Eleodes may sometimes be met with at altitudes exceeding ten thousand feet. As we enter the timbered country on the higher foot-hills and lower mountain sides, we encounter a fauna which while not unmixed with species that have come up from the plains, shows a strong affinity to the life about our Great Lakes. Higher still—that is to say from about eight thousand to nine thousand feet, according to the exposure, presence or absence of near-by snow-fields and so on—we meet with many species of genera still more boreal in habits. We may mention Nebria with its many species, usually taken along the coldest mountain streams, the flattened Bembidia, and the large Aphodii. Above timber line the peaks sustain a few beetles which seem to be of arctic origin, left, probably, by the retreating ice-sheets of the Glacial period.

I cannot agree with Prof. Cockerell[1] who claims that the Glacial epoch would, for the time being, result in the almost complete extermination of the insect fauna of Colorado and the adjacent table-lands. He assumes that the arid region "where not actually glaciated would be a frozen desert," something which I think is not indicated by such geological evidence as we possess. The glaciation of Colorado was apparently not particularly extensive. Neither does it seem likely that the western ice-sheet went so far south as San Diego; at any rate the indications seem to show that along the highlands of Southern California only the loftier mountains were glaciated at all. Today great glaciers exist in the immediate vicinity of well-wooded districts rich in animal life. The same phenomenon may have occurred during ancient times.

For the present I refrain from discussing the correlation between alpine and isothermal life-zones; the more readily as I hope soon to treat the matter from a standpoint different

[1] Transactions of the American Entomological Society, Vol. XX, p. 319.

from that usually taken. There is of course that parallelism between alpine and boreal productions which is due to conditions of climate and temperature, so that generally speaking, the ascent of a mountain takes us through a series of plants and animals corresponding more or less closely to what we should see in passing from south to north along the base of the chain. However, migration up or down a mountain-side is easy — often enforced by freshets or high winds — and insects may occasionally occur in great numbers in situations where they could not possibly breed.

LIST OF LOCALITIES CITED, WITH APPROXIMATE ALTITUDES.

While many of the altitudes here cited are not quite exact, they are sufficiently accurate for our purpose. Some of the data are drawn from the publications of the United States Geological Survey, others from various railroad maps, and the remainder are estimates or measurements furnished by the collectors themselves. It must not be forgotten that the actual altitude at which a specimen was collected may differ by several hundred feet from that cited for the station, since many of the towns are built on mountain-sides and a collector, in order to save trouble, may label all of his captures alike. Others adopt the plan of inclusive labelling, giving the extremes of altitude reached during work in a certain neighborhood.

In addition, I have appended to each station of importance the name of the investigator, and where one of these localities is cited in the following pages the credit of collecting must be allotted accordingly. Some instances occur where a different plan had to be adopted and in these cases the collector or authority is mentioned directly in the proper connection.

Alamosa. 7,500. Schwarz.
Alma. 10,250. Bowditch.
Arapahoe Peak. 11,000–12,000. Summit 13,520.
Argentine Pass. 13,286. Bowditch and Wickham.
Arkins. 6,000. O. E. Buffum.

Aspen. 7,874. W. W. Willard.

Bailey's. 7,714.

Beaver Brook. 6,391. Uhler.

Beaver Creek. Flows into the Poudre. Gillette.

Berkeley. Suburb of Denver. Oslar.

Big Narrows of Poudre. 6,800. C. F. Baker.

Boulder. 5,500.

Breckenridge. 9,674. Wickham. July.

Buena Vista. 7,925. Wickham. July.

Cañon City. 5,400.

Cañon of Big Blue. 8,500. Hayward and Bowditch. July.

Cerro Summit. Above Montrose, on D. & R. G. R. R. Gillette.

Cheyenne Cañon. 6,200.

Chimney Gulch. 5,909. Oslar.

Cimarron. 6,874. Gillette.

Clear Creek Cañon. Near Denver, 6,000–8,000.

Cochetopa Pass. 10,000. Bowditch and Hayward. August.

Colorado Springs. 6,000.

Cusack Ranch. In Wet Mountain Valley. 8,192. Cockerell.

Delta. 4,950. Gillette.

Dolores. Gillette.

Dome Rock. 6,200. Snow. July.

Durango. 5,500–7,000.

Engelmann's Cañon. 6,000–8,000. Snow.

Estes Park. 8,600. The toll road runs between the Park and Lyons.

Florence. 5,199.

Florissant. 8,184. Bowditch.

Fort Collins. 5,000. The collections from this vicinity were made by Professor C. P. Gillette together with his collaborators or assistants, C. F. Baker, E. J. G. Titus, E. D. Varney and Miss Emma A. Gillette. The same parties also took the species recorded from the following points in the same general neighborhood, at altitudes ranging from 5,000 to 6,000 feet. Dixon, Rist, Owl, Soldier's, Poudre and Spring cañons; Howe's Gulch, Horsetooth Gulch, Pleasant Valley, Baxter's Ranch, Bellevue, Laporte, Warren's Lake, New Windsor and Redstone.

Garden of the Gods. 6,100.

Garland. 7,900. Schwarz. (List by Leconte.)

Georgetown. 8,500.

Glenwood Springs. 5,758. Gillette.

Golden. 5,690.

Gore Pass. 10,000. Gillette.

Grand Junction. 4,561. Wickham. May.

Grape Creek. In Wet Mountain Valley. Cockerell.

Gray's Peak. Summit, 14,348; Kelso's Cabin, 11,200. Packard.

Greeley. 4,642. Wickham. May.

Gunnison. 7,500. Hayward and Bowditch.

Happy Hollow. Gillette.

Holly. 3,377. Gillette.

Horsefly Peak Divide. 8,000. Hayward and Bowditch. July.

Horseshoe Park. In Estes Park. Gillette.

Horsetooth Mountain. 8,000. C. F. Baker, J. H. Cowan.

Hotchkiss. 5,000. Gillette.

Hourglass Lake. Almost at timber line, near Little South. Gillette.

Idaho Springs. 7,500.

La Junta. 4,000. June.

Lamar. 4,000. Gillette.

La Veta. 7,000. Schwarz. (List by Leconte.)

Leadville. 10,178. Wickham. July.

Leavenworth Valley. 9,000–10,000. Bowditch and Wickham.

Little Beaver. Gillette.

Little Willow Creek. 8,000. Bowditch and Hayward. July.

Little South. Small stream about thirty miles west of Fort Collins, flowing into the Poudre. Gillette.

Livermore. 6,000. E. D. Varney.

Long Gulch. 6,000–6,500. About six miles west and north of Stove Prairie. Gillette.

Longmont. 4,935. Gillette.

Long's Peak. Summit, 14,271; Lamb's Ranch over 9,000. Gillette.

Manhattan. 7,500. Gillette.

Manitou. 6,300.

Marshall Pass. 10,850. Gillette.

Micawber Mine. In Custer county, about 10,000. Cockerell.

Mineral Point Trail. Above Ouray, 9,000–10,000. Wickham. July.

Montclair. Suburb of Denver. Oslar.

Montrose. 6,000. Bowditch and Hayward. July.

Monument Gulch. 7,000–9,000. Bowditch and Hayward. July.

Moose Mountain. Above Leadville; about 11,000–12,000. Wickham. July.

Morrison. 5,753. Oslar.

Mountains southwest of Montrose. 9,000–10,000. Hayward and Bowditch. July.

Mount Abrams. In the vicinity of Ouray, about 11,000–12,000. Wickham. July.

Mount Lincoln. 11,000–12,000. Bowditch.

Nathrop. 7,673. Cockerell.

North Park. 8,000–9,000. Gillette.

Ouray. 7,640. Wickham. July.

Pagosa Springs. 7,100. The records sent by Mr. Hayward, for himself and Mr. Bowditch, call for 8,000–9000.

Palmer Lake. 7,238. Gillette.

Peak Eight. 10,000–12,000. In the Ten Mile Range near Breckenridge. Wickham. July.

Pike's Peak. Summit, 14,147.

Placerville. 8,388. Hayward and Bowditch.

Platte Cañon. Station, 5,492.

Poncha Springs. 7,480. Oslar.

Poudre Cañon. N. Anderson.

Pueblo. 4,669.

Red Cliff. 8,650. Wickham. May.

Red Mountain Road. 8,500–10,000. Above Ouray. Wickham. July.

Rico. 8,500–10,000. Bowditch and Hayward. July.

Rocky Ford. 4,160. F. A. Huntley.

Rustic. 7,000. Summer resort 50 miles west of entrance to Poudre Cañon, on river. Gillette.

Salida. 7,028.

San Luis Valley. 7,700. Hayward and Bowditch. August.

Short Creek. In Wet Mountain Valley. Cockerell.

Silver Plume. 9,176. Wickham. Most of my collections with this label were made in the creek valley a mile or two above the town. June.

Silverton. 9,400. Gillette.

South Fork of San Miguel. 8,500. Bowditch and Hayward. July.

South Park. 8,000–10,000.

Steamboat Springs. 6,500. Gillette and Baker.

Stove Prairie. 6,000. Eighteen miles west of Fort Collins. Gillette and Baker.

Summitville. 10,000–11,500. Hayward and Bowditch. August.

Swift Creek. In Wet Mountain Valley. Cockerell.

Texas Creek. Also in Wet Mountain Valley. Cockerell.

Trinidad. 5,900.

Trout Lake. 9,700.

Twin Lakes. 9,357. Ulke.

Ula. In Wet Mountain Valley. Cockerell.

Ute Pass Road. 7,000–9,000. Snow.

Upper San Juan. 7,000–10,500. Bowditch and Hayward

Veta Pass. 9,500. Schwarz. (Leconte list.)

West Cliff. 7,842. Cockerell.

West Las Animas. 3,886. Hayward.

Wet Mountain Valley. 8,000–10,000. Cockerell.

Williams River Valley. Bowditch.

The preparation of this paper was begun five years ago and has proceeded with more or less interruption up to the present. My thanks for aid are due to most of the active Coleopterists of the country, since help in one form or another has been rendered by nearly all. I wish, however, to acknowledge special indebtedness to these: the late Dr. Geo. H. Horn, who was always ready to examine puzzling forms; Mr. Henry Ulke, who gave me names of many species during the earlier years of my entomological studies; Major Thos. L. Casey and Mr. Chas. Liebeck for identifications in special groups; Mr. Roland Hayward for names of Bembidium and for a very large number of manuscript records; Mr. Fred. C. Bowditch and Prof. T. D. A. Cockerell for manuscript records; Prof. C. P. Gillette for allowing me to examine the entire collection of the Colorado Agricultural College and afterwards sending data corresponding to the accession numbers; and finally to my wife who has done the major part of the bibliographical and clerical work in connection with the preliminary construction of the catalogue.

LIST OF SPECIES.

CICINDELIDÆ.

AMBLYCHILA CYLINDRIFORMIS Say. One specimen, found dead in spider's web. Webster Park, Snow.

TETRACHA CAROLINA Linn. Colorado, Ulke.

CICINDELA OBSOLETA Say. Southeastern Colorado, Horn.

C. VULTURINA Lec. Durango, July 23–August 8, Hayward and Bowditch.

C. PRASINA Lec. Colorado, Ulke.

C. LONGILABRIS Say. Near Long's Peak; Bellevue and Rist Cañon, June; Stove Prairie and Little South, July; West Cliff; Brush Creek, 10,000 to 12,000 ft., June.

C. LAURENTII Schaupp. Estes Park, Snow; Hall Valley, South Park, July, Oslar; Dolores and Silverton, June; Leadville and Breckenridge, July; Toll Road above Ouray, July; Georgetown and passes in mountains above, 8,500 to 11,500 ft., Packard; Bowditch, Wickham.

C. PERVIRIDIS Schaupp. Red Mt. Road, July; Silverton, June; Horsefly Peak Divide, July; Rico, July; Pagosa Springs, August.

C. SCUTELLARIS Say. Cañon City, May, Denver, June, Wickham; Bear Creek Cañon, Jefferson Co., April, Oslar; Bellevue and Lamar, May.

C. NIGROCŒRULEA Lec. Colorado, Leconte.

C. PULCHRA Say. South Park, Ulke; Pueblo, June, San Luis Valley, August, Hayward; Chimney Gulch, May; Cañon City, August, Uhler; Lyman Junction, August, Bruner; Fort Collins, June and August.

C. PATRUELA Dej. West Cliff.

C. PURPUREA Oliv. In the Putnam list and both of Ulke's reports; Veta Pass; Fort Collins, March and May. A variety was taken by H. G. Smith, Jr., at Denver, (Cockerell *in litt.*).

C. AUDUBONII Lec. Bear Creek Cañon and Denver, Oslar, April; Fort Collins, April and May; Dome Rock, Snow; South Park, Snow and Bowditch.

C. GRAMINEA Schaupp. Northern Colorado, August, Gillette; Lamar and Fort Collins, June; Denver, July, Wickham; Clear Creek, Oslar.

C. CIMARRONA Lec. Southern Colorado or Northern New Mexico, Leconte; South Park, Snow.

C. DECEMNOTATA Say. Colorado, Schaupp.

C. LIMBALIS Klug. Horsefly Peak Divide, one specimen, July.

C. AMŒNA Lec. Southern Colorado, and Northern New Mexico, Leconte.

C. SPLENDIDA Hentz. Denver, July, Wickham; a record, with doubt, is given from the South Park in the Bowditch list.

C. DENVERENSIS Casey. All of the specimens that I have seen were collected by Mr. Oslar. He has sent it to me from Platte Cañon, Boulder Cañon, Chimney Gulch and Denver. The dates are April and May.

C. FORMOSA Say. Salida, May, Denver, June, July, Wickham; Rist and Poudre Cañons, April; Lamar, May.

C. GENEROSA Dej. Colorado, Leng and Beutenmueller, Jour. N. Y. Ent. Soc., I, p. 92.

C. VENUSTA Lec. Near Colorado Springs, Snow; same place, June, Wickham; Trinidad, May, Gillette.

C. TENUICINCTA Schaupp. Colorado, Schaupp.

C. FULGIDA Say. Cañon City, May, Wickham; Fort Collins, June; Banks of the Platte, South Park, Snow.

C. VULGARIS Say. Cañon City, Grand Junction, Denver and Buena Vista, Wickham; Gunnison; Lamar, May; Trinidad, May, Montrose, June, Gillette.

C. REPANDA Dej. Cañon City, Colorado Springs, Buena Vista, Wickham; Boulder, Packard; Arvada, Oslar; Lamar, Dolores, Trinidad and Poudre Cañon, Gillette. The dates run between the last week in April and the middle of June.

C. OREGONA Lec. Gunnison, June; South Fork of San Miguel, July; Cañon City, May, Wickham; South Park, Bowditch; West Cliff.

C. GUTTIFERA Lec. Manitou, Snow; South Park, Bowditch; Southern Colorado and Northern New Mexico, Leconte.

C. 12-GUTTATA Dej. Manitou, Snow; Beaver Brook Gulch, Uhler; Plateau Creek, near Eagalite, Mesa Co., September, Cockerell; Dome Rock; Gunnison; road from Gunnison to Montrose; South Fork of San Miguel. I doubt if all of these records refer to the true 12-*guttata*.

C. HIRTICOLLIS Say. Colorado, Ulke. I have seen a specimen from Trinidad, collected in May by Prof. Gillette which might possibly belong here, but seems to me more like a slightly abnormal *repanda*.

C. PUSILLA Say. Colorado, Ulke. Buena Vista, July, Wickham. In a swarm of Cicindelas taken at the place mentioned, I found a great variety of forms running from *pusilla* to *cinctipennis*.

C. CINCTIPENNIS Lec. Buena Vista and Leadville, Wickham; Horsefly Peak Divide, July; Fort Collins, June, specimen of the green variety.

C. PUNCTULATA Fabr. Fort Collins; Denver, July, August, September; Garden of the Gods, Packard; Clear Creek Cañon, Uhler; San Luis Valley, La Junta, Durango, Hayward; Colorado Springs, Pike's Peak, 9,000–10,000 feet, Wickham.

C. MICANS Fabr. Red Creek, Custer Co., Cockerell; La Junta, June, Hayward; Denver and Colorado Springs, Wickham.

C. MACRA Lec. "This species and *sperata* Lec., will undoubtedly, occur in Colorado, as I have them from a few miles south of the southern boundary" (Bowditch).

C. LEPIDA Dej. Colorado, Leng and Beutenmueller, Jour. N. Y. Ent. Soc., II, p. 95.

C. HÆMORRHAGICA Lec. Colorado, Ulke.

CARABIDÆ.

OMOPHRON AMERICANUM Dej. Bellevue, May; Berkeley; La Veta.

O. TESSELLATUM Say. Fort Collins, at light, July.

TRACHYPACHYS INERMIS Mots. Argentine Pass, Bowditch; Ouray; Veta Pass; West Cliff; Breckenridge, in moss under log.

CYCHRUS ELEVATUS Fab. Reported from Colorado by Ulke, (coll. Carpenter) and by Leconte; Fort Collins, Wm. Fairfield, June; Engelmann's Cañon.

C. SNOWI Lec. Durango, Bowditch and Hayward.

CARABUS MÆANDER Fisch. West Cliff.

C. TÆDATUS Fabr. This species and its varieties occur at many points in the state, but it seems likely that different recorders have carried their determinations to different grades of completeness. Under the name *tædatus*, we find the following localities:—Above 12,000 feet, Carpenter; Dome Rock; West Cliff; Kelso's Cabin, foot of Gray's Peak; Idaho Springs, Packard; Wales Cañon, Pueblo Co., Cockerell; Plains south of Denver and Roaring Fork, Ulke; Argentine Pass, 13,000 feet, Bowditch; Elk River, ten miles north of Steamboat Springs, Baker; vicinity of Fort Collins, April, May, July and August; Little Willow Creek; Cañon of Big Blue; Rico; Upper San Juan; Summitville; Mountains southwest of Montrose; South Park. For the variety *agassii* we have Leconte's record, Southern Colorado, and Putnam's record, with Ulke as authority. The localities credited with *oregonensis* are: Rist Cañon, June; Silver Plume; Leavenworth Valley (above Georgetown), 10,000 to 11,000 feet; Argentine Road and Argentine Pass, 12,000 to 13,500 feet; Georgetown; Ouray; Buena Vista, wooded bottoms; Leadville, along mountain streams; Moose Mountain (near Leadville), above timber line; Breckenridge, in deep woods.

C. SERRATUS Say. Near Manitou, Wickham; Buena Vista, in wooded creek bottom; Rist Cañon, April and June; Fort Collins, July; Denver, Ulke; Mace's Hole, Pueblo Co., Cockerell; West Cliff.

CALOSOMA SCRUTATOR Fab. Southern Colorado, Leconte.

C. PEREGRINATOR Guer. La Junta, Hayward.

C. TRISTE Lec. Colorado, Ulke; Estes Park, August, Varney; vicinity of Fort Collins, July.

C. OBSOLETUM Say. South Park, Ulke; plains west of Denver, Uhler; West Las Animas, Hayward; Dixon Cañon, September; Fort Collins, May; Greeley; Salida, Wickham.

C. MORRISONII Horn. Colorado, Horn.

C. HAYDENI Horn. Southern Colorado, Horn; Durango, Hayward and Bowditch.

C. CALIDUM Fab. Plains south of Denver, Ulke; Southern Colorado, Leconte.

C. TEPIDUM Lec. This name occurs in the Putnam list.

C. LUXATUM Say. Denver; Fort Collins, April and June.

ELAPHRUS CLAIRVILLEI Kirby. Leavenworth Valley, 9,000-10,000 feet; Georgetown; Buena Vista; Leadville.

E. LECONTEI Crotch. Buena Vista.

E. RIPARIUS Linn. Manitou, Snow; South Park, Ulke; Berkeley, Oslar; Garland; Alamosa; Placerville; Gunnison; Georgetown; Leavenworth Valley.

E. RUSCARIUS Say. Warren's Lake, October.

LORICERA CÆRULESCENS Linn. South Park; Georgetown; Cochetopa Pass.

OPISTHIUS RICHARDSONII Kirby. Kemmling, Grand Co., Cockerell; Red Cliff; Ouray; Fort Collins, June; Trout Lake, Bowditch; Rico; South Fork of San Miguel; Gunnison; Pagosa Springs; Upper San Juan.

NOTIOPHILUS SEMISTRIATUS Say. Southern Colorado, Leconte.

N. SIBIRICUS Mots. West Cliff; Leadville; Veta Pass, 9,000 to 9,500 feet.

N. HARDYI Putz. Georgetown; Silver Plume; Argentine Pass, 13,000 feet, Bowditch; Leavenworth Valley, Wickham; Breckenridge; Veta Pass; Cochetopa Pass; Rico; Little Willow Creek; Mountains southwest of Montrose; Durango; Little Beaver Creek, July.

NEBRIA PURPURATA Lec. First taken above Georgetown, in the Leavenworth Valley, by Mr. Bowditch; afterward found in the cañon of the Big Blue by Hayward and Bowditch. As the stream was very high and the beaches covered, specimens were found under the bark of half-submerged logs. San Juan river, 9,000 feet, August; South Fork of San Miguel; I took it at various points above Georgetown, representing altitudes from 9,000 to 11,000 feet.

N. OBTUSA Lec. North Fork of the South Platte, 6,000 to 7,000 feet, Bowditch; South Fork of San Miguel; Upper San Juan; Garland, Bowditch; Ouray, and points above, Wickham.

N. OBLIQUA Lec. North Fork of the South Platte, Bowditch; Gunnison; Monument Gulch; South Fork of San Miguel; Upper San Juan; San

Luis Valley; Garland; La Veta; Georgetown; Leavenworth Valley; Ouray; Leadville.

N. longula Lec. Colorado, Leconte.

N. sahlbergi Fisch. Peaks above 12,000 feet, Carpenter; Rico; Summitville; Upper San Juan; Trout Lake; Leavenworth Valley; Silver Plume; Argentine Road and Pass.

N. trifaria Lec. Leadville; Red Cliff; Ouray; Red Mountain Road, 10,000 to 11,000 feet; Leavenworth Valley, 9,000 to 11,000 feet; Foot of Mam Mountain, Mesa County, Cockerell; Durango; Cañon of Big Blue; Mountains southwest of Montrose; South Fork of San Miguel; Rico; Upper San Juan; San Luis Valley.

N. mannerheimii Fisch. Mr. Hayward writes that he has a specimen from the South Fork of the San Miguel which he refers to this species.

N. eschscholtzii Men. I have taken a series of Nebria at various points which Mr. Hayward has compared with specimens in the Leconte cabinet and pronounces the opinion that they are a small race of this species. Silver Plume; Leavenworth Valley, 9,000 to 11,000 feet; Red Mountain Road and Mineral Point Trail, 9,000 to 11,000 feet.

Pasimachus duplicatus Lec. Southern Colorado, Leconte.

P. obsoletus Lec. Colorado Springs, Wickham; recorded from the state without definite locality by Leconte and Ulke.

P. elongatus Lec. Colorado Springs; Denver; La Junta, Hayward; Durango, Bowditch and Hayward; Golden, Oslar; La Veta; Larkspur, Uhler; Vicinity of Fort Collins, May to September.

P. californicus Lec. Colorado, Leconte.

Dyschirius æneolus Lec. Garland; Alamosa.

D. globosus Say. Rico.

D. sphæricollis Say. Southern Colorado, Leconte.

D. truncatus Lec. West Cliff; Garland; La Junta, Bowditch.

D. erythrocerus Lec. A specimen from the Leavenworth Valley is referred here with some doubt.

D. montanus Lec. Garland; Alamosa.

D. setosus Lec. One specimen marked Colorado is in my collection.

Schizogenius sallei Putz. A record, with the mark of doubt, is given in the Schwarz list, for the locality La Veta.

S. amphibius Hald. Durango, Hayward. I have an undetermined species from Colorado Springs.

Bembidium nitidum Kirby. Gunnison; North Fork of South Platte, Bowditch; Dixon Cañon; Salida, Wickham; Buena Vista; Colorado Springs; West Cliff.

B. inæquale Say. Rocky Mountains, Leconte, Ann. N. Y. Lyceum, IV, 452.

B. littorale Oliv. Dolores; Gunnison; South Fork of San Miguel; Upper San Juan; Red Cliff.

B. lorquini Chaud. South Fork of San Miguel; Upper San Juan.

B. coxendix Say. La Junta, Hayward; Delta, April, Gillette.

B. confusum Hayward. Colorado, Putnam. Mr. Hayward also gives me a state record.

B. BIFOSSULATUM Lec. Warren's Lake, October; Clear Creek Cañon, August; Beaver Brook Gulch; South Platte River, west of Denver, Uhler; Colorado Springs, Wickham; Denver, Packard; Alamosa; Garland; La Veta; Gunnison; Durango; West Las Animas; La Junta, Hayward.

B. AMERICANUM Dej. Near Sloan's Lake, west of Denver, Uhler.

B. CHALCEUM Dej. Greeley, Wickham.

B. LONGULUM Lec. Georgetown; Leavenworth Valley, 9,000 to 10,000 feet; Garland; La Veta; Gunnison; Cañon of the Big Blue; Horsefly Peak Divide; Durango; Pagosa Springs; Cochetopa Pass.

B. QUADRULUM Lec. Gunnison; Placerville; Red Cliff.

B. RECTICOLLE Lec. Gunnison; Monument Gulch; Mountains southwest of Montrose; Durango; Upper San Juan; Florissant.

B. PLANATUM Lec. Red Cliff; Gunnison; South Fork of San Miguel; Pagosa Springs; Upper San Juan; Ouray; San Luis Valley; Ironton, Gillette.

B. PLANIUSCULUM Mann. Trout Lake; Ouray; Red Mountain Road, 9,000 to 10,000 feet; Gunnison; Cañon of the Big Blue; Pagosa Springs; Upper San Juan; San Luis Valley; South Fork of San Miguel; Leavenworth Valley; Silver Plume.

B. COMPLANULUM Mann. Upper San Juan.

B. MÆKLINI Lec. San Miguel County, Hamilton; Red Cliff.

B. INCERTUM Mots. Plentiful above Leadville, along little streams; South Park; Alma; Mountains southwest of Montrose; Williams River Valley; Alamosa; Ouray; Leavenworth Valley; Argentine Road, 12,000 to 13,000 feet.

B. BREVE Mots. Silver Plume.

B. NEBRASKENSE Lec. Cochetopa Pass; Gunnison; Cañon of Big Blue; Mountains southwest of Montrose; Horsefly Peak; Durango; South Fork of San Miguel; Leadville; Colorado Springs; Buena Vista.

B. FUGAX Lec. Red Cliff.

B. TRANSVERSALE Dej. Pueblo and Trout Lake, Bowditch; Colorado Springs and Cañon City, Wickham; Spring Cañon; Georgetown; Ouray; Red Cliff; Garland; La Veta; Gunnison; Upper San Juan; a common species found indiscriminately on alkaline flats and margins of streams.

B. LUGUBRE Lec. Cañon City and Colorado Springs, Wickham; La Veta; Pagosa Springs; vicinity of Fort Collins, March and April.

B. CONSANGUINEUM Hayward. Cañon City, Wickham.

B. STRIOLA Lec. Cañon City; Mountains southwest of Montrose; specimens which Mr. Hayward doubtfully refers here were taken at Ouray and in the Leavenworth Valley.

B. BIMACULATUM Kirby. West Cliff; Idaho Springs, Packard; South Park, 8,000 to 10,000 feet; Gunnison; Leavenworth Valley; Garland; Buena Vista; Breckenridge; Leadville.

B. USTULATUM Linn. Cañon of Big Blue; Upper San Juan; Gunnison; South Fork of San Miguel; Florissant; Idaho Springs.

B. LUCIDUM Lec. Near Fort Collins, March and April; Dome Rock; West Cliff; Garland; La Veta; Veta Pass; Florissant; Ouray; Georgetown; Leavenworth Valley; Buena Vista; Breckenridge; Leadville; Colorado

Springs; La Junta; Gunnison; Cañon of Big Blue; South Fork of San Miguel; Durango; Pagosa Springs; Upper San Juan; Salida; Cañon City.

B. FUSCICRUM Mots. Salida; Leavenworth Valley; Poudre Cañon; Florissant; Gunnison; San Luis Valley; Buena Vista; Breckenridge; Leadville.

B. SCOPULINUM Kirby. Vicinity of Fort Collins, March and April; Georgetown; Leavenworth Valley; Mountains southwest of Montrose; North Fork of South Platte; Garland; Colorado Springs; La Veta; Veta Pass, 9,400 feet.

B. GRAPII Gyll. Leavenworth Valley, 10,000 to 11,000 feet; Alma; Rico; Cañon of Big Blue; Dolores, June; Breckenridge; Leadville; Peak Eight, above timber.

B. CONSIMILE Hayward. Colorado Springs, Wickham, on alkaline mud.

B. CORDATUM Lec. Warren's Lake, October; Colorado Springs; La Junta; West Las Animas; La Veta; Veta Pass, 9,400 feet.

B. DENTELLUM Thunb. Garland; West Cliff; both of these records are under the name *arcuatum* Lec.

B. COLORADENSE Hayward. Mountains southwest of Montrose; Monument Gulch; Horsefly Peak; South Fork of San Miguel; Rico; Upper San Juan; Williams River Valley, 9,000 feet.

B. INDISTINCTUM Dej. West Cliff; Little Blue Creek, Gunnison County, Cockerell.

B. UMBRATUM Lec. Montrose; Durango; Garland.

B. ÆNEICOLLE Lec. Garland; Mr. Hayward writes that a single specimen from Colorado is in the Horn collection.

B. VARIEGATUM Say. Vicinity of Fort Collins, March, April, June, July, October; Manitou; Colorado Springs; Denver; Ouray; Leavenworth Valley.

B. NIGRIPES Kirby. Buena Vista; Leadville; Gunnison; Little Willow Creek; Mountains southwest of Montrose; Durango; San Luis Valley; Florissant; Leavenworth Valley; Georgetown.

B. INTERMEDIUM Kirby. South Park, 8,000 to 10,000 feet, Bowditch; Garland; Veta Pass; Colorado Springs; La Junta, Hayward; Grand Junction, Wickham.

B. TIMIDUM Lec. Mountains southwest of Montrose; Durango; Upper San Juan; Colorado Springs; Spring Cañon, March; Warren's Lake, October.

B. VERSICOLOR Lec. Warren's Lake, October; La Veta; Alamosa; Garland; Breckenridge; Colorado Springs; Grand Junction.

B. DEJECTUM Casey. Colorado Springs, June, Wickham.

B. OBTUSANGULUM Lec. South Park, 8,000 to 10,000 feet, Bowditch; San Luis Valley; Salida, Wickham.

B. RUBIGINOSUM Lec. Garland; Veta Pass, 9,400 feet.

B. CONSTRICTICOLLE Hayward. Colorado Springs, July, Wickham.

B. DYSCHIRINUM Lec. Leavenworth Valley; Breckenridge; Leadville.

B. PRÆCINCTUM Lec. Alamosa; Florissant; Gunnison; Horsefly Peak; Leadville; Buena Vista; Leavenworth Valley; Ouray.

B. DUBITANS Lec. Garland; Buena Vista; Ouray; Leavenworth Valley.

B. MUTATUM G. & H. Durango; Mountains southwest of Montrose; Veta Pass, 9,350 feet; Leadville; Williams River Valley, 9,000 feet.

B. QUADRIMACULATUM Linn. Reported from the state by Ulke; vicinity of Fort Collins, March; Colorado Springs.

B. AFFINE Say. Colorado, Hayward, *in litt.*

B. ACUTIFRONS Lec. Alamosa; La Veta; Veta Pass; Ouray; Williams River Valley.

B. CAUTUM Lec. La Veta.

B. CONNIVENS Lec. La Veta.

B. ASSIMILE Gyll. Ouray; Colorado Springs, Wickham.

TACHYS NANUS Gyll. Veta Pass; Ouray; Rist Cañon, April, under pine bark; Colorado Springs in same situations.

T. INCURVUS Say. West Cliff; Salida; La Veta.

T. DOLOSUS Lec. Colorado, Hayward.

T. AUDAX Lec. Western Colorado, Hayward.

T. NEBULOSUS Chaud. Cañon City; Colorado Springs.

T. FERRUGINEUS Dej. Recorded from Colorado by Leng and Beutenmueller.

T. VITTIGER Lec. Colorado Springs, Wickham; the name is from Dr. Horn.

T. CORAX Lec. Colorado, 10,000 feet, Hayward.

PATROBUS LONGICORNIS Say. Garland; La Veta; Boulder, Packard; Colorado Springs; Buena Vista.

P. SEPTENTRIONIS Dej. Aspen; Leadville; Gunnison; Ouray; Silver Plume; Leavenworth Valley.

P. ATERRIMUS Dej. Idaho Springs, Packard; Nathrop, Cockerell; Gunnison; South Fork of San Miguel; Ouray; Red Mountain Road; Georgetown; Silver Plume; Leavenworth Valley.

TRECHUS CHALYBEUS Mann. Garland; Plateau Creek, near Eagalite, September, Cockerell; Mountains southwest of Montrose; Rico; Durango; Red Cliff; Breckenridge; Leadville; Peak Eight, above timber; Mineral Point Trail, 9,000 to 10,000 feet; Leavenworth Valley.

PTEROSTICHUS HERCULEANUS Mann. Wales Cañon, Pueblo County, Cockerell.

P. VALIDUS Dej. Colorado, Bowditch.

P. PROTRACTUS Lec. Dome Rock, Snow; Roaring Fork and Fort Garland, Ulke; Marshall Pass; Fort Collins, September; Estes Park, July; Ironton, Gillette; near Long's Peak; Red Mountain Road, 8,000 to 9,000 feet; Leavenworth Valley; Durango; Horsefly Peak; Pagosa Springs; Red Cliff; Colorado Springs; Buena Vista; Breckenridge; Leadville; often found under logs in wooded districts.

P. LONGULUS Lec. Omitting several more or less indefinite localities, we have the following records for this widely distributed species; Cimarron, Cockerell; West Cliff; San Luis Valley; Roaring Fork; Red Cliff; Garland; Veta Pass, 9,000 feet; Durango; Rico; Summitville; Upper San Juan; Georgetown; Silver Plume; Leavenworth Valley, 10,000 to 11,000 feet; Red Mountain Road; Breckenridge; Leadville.

P. SUBSTRIATUS Lec. Pueblo, Bowditch; Colorado Springs, common under stones and about Yucca roots, August, Uhler.

P. CONSTRICTUS Say. Southern Colorado, Leconte; Colorado Springs, Wickham.

P. INCISUS Lec. Colorado Springs, Snow; La Junta, Hayward; La Veta; Greeley.

P. LACHRYMOSUS Newm. Colorado, Bowditch.

P. SCITULUS Lec. Pueblo; Berkeley, July; Colorado Springs, June and July; Fort Collins, May and October.

P. LUCUBLANDUS Say. Berkeley, May; Colorado Springs.

P. CONVEXICOLLIS Say. Alamosa; vicinity of Fort Collins, March to May.

P. CAUDICALIS Say. Fort Collins, April; Greeley, May.

P. LUCTUOSUS Dej. Fort Collins.

P. MUTUS Say. Red Cliff, determined by Dr. Horn; Nathrop, Cockerell.

P. ORINOMUM Leach. South Park, Bowditch; Leavenworth Valley, 9,000 to 10,000 feet; Ironton, Gillette; Salida; Red Cliff; Garland.

P. LUCZOTII Dej. Vicinity of Fort Collins, March and June; Idaho Springs, Packard; Berkeley, June; South Park, 8,000 to 10,000 feet, Bowditch; West Cliff; San Luis Valley, Ulke; Pleasant Valley, Fremont County, Cockerell; Gunnison; Little Willow Creek; Cañon of Big Blue; Rico; Mountains southwest of Montrose; Durango; Silver Plume; Georgetown; Leavenworth Valley; Buena Vista; Colorado Springs, June and July; Breckenridge; Leadville; common under logs in woods and near streams.

P. ERYTHROPUS Dej. Greeley; Fort Collins, April.

P. FEMORALIS Kirby. Colorado Springs.

P. HUDSONICUS Lec. Red Cliff. The name is from Dr. Horn.

P. SURGENS Lec. Moose Mountain, about 12,000 feet, near snow bank; Alma; Durango; Leavenworth Valley and Argentine Pass, 10,000 to 13,000 feet; Red Mountain Road.

P. RIPARIUS Dej. Slope of Gray's Peak, 12,000 feet, Packard. This and the two preceding species are closely allied and it is possible that one or more of the records are in error.

EVARTHRUS TORVUS Lec. Colorado, probably taken in the vicinity of Fort Collins.

AMARA AVIDA Say. North Fork of South Platte, 7,000 to 8,000 feet; Idaho Springs; La Junta, Bowditch.

A. RUFIMANA Kirby. Grand Junction, Bowditch; Little Willow Creek; Cañon of Big Blue.

A. CYLINDRICA Lec. South Park, 8,000 to 10,000 feet; Cochetopa Pass; doubtful records are at hand for western Custer County, and Durango.

A. JACOBINÆ Lec. Mr. Hayward gives me the record Colorado, with a mark of doubt.

A. LATICOLLIS Lec. West Cliff; La Junta; Mountains southwest of Montrose; Cañon of Big Blue; Durango; Cochetopa Pass; Little Willow Creek; Mr. Hayward does not feel certain of the correctness of identification in the case of the last five localities, this being a very difficult section of the genus and the original descriptions insufficient.

A. CARINATA Lec. Colorado Springs.

A. ESCHSCHOLTZII Chaud. Roaring Fork, Ulke; Cochetopa Pass, Bowditch.

A. HYPERBOREA Dej. Pike's Peak, a short distance below summit, Snow; summit of Mt Abrams, above Ouray, about 13,000 feet, Wickham; Peak

Eight, above timber; mountains above 12,000 feet, Carpenter; Colorado, 14,000 feet, Bowditch.

A. BRUNNIPENNIS Dej. Above timber line and up to 15,000 feet. Recorded from Moose Mountain, Peak Eight, Arapahoe Peak, Pike's Peak, Mt. Lincoln and the Argentine Pass. Seems scarcely distinct from *hyperborea*.

A. TRISTIS Putz. Williams River Valley, Bowditch.

A. LATIOR Kirby. West Cliff; Colorado Springs; Ouray; Salida; Mountains southwest of Montrose; Durango.

A. SEPTENTRIONALIS Lec. La Junta; Durango.

A. ANGUSTATA Say. Mountains southwest of Montrose.

A. PALLIPES Kirby. Colorado, Horn; Aspen, Gillette.

A. SCITULA Zimm. Rico.

A. IMPUNCTICOLLIS Say. Red Cliff; Colorado, Snow.

A. FALLAX Lec. South Pueblo County, Cockerell; Florissant; La Junta; Dome Rock; Buena Vista; Breckenridge; Ouray.

A. SUBPUNCTATA Lec. Florissant; South Park; Leavenworth Valley; Rico; Gunnison; Little Willow Creek; Mountains southwest of Montrose; San Luis Valley.

A. CONFUSA Lec. Little Willow Creek; Durango; San Luis Valley; Cochetopa Pass; La Junta, Bowditch; Garland; Rio Grande, Ulke; West Cliff; Fremont County, Cockerell; Colorado Springs; Breckenridge; Leadville.

A. PROTENSA Lec. Monument Gulch.

A. POLITA Lec. West Cliff; Salida; Little Willow Creek; Georgetown; Leavenworth Valley; Colorado Springs; Buena Vista; Ouray; Garland; Rico; San Luis Valley; Mt. Lincoln.

A. ERRATICA Sturm. Alma; South Park; Cañon of Big Blue; Rico; Little Willow Creek; Veta Pass; Williams River Valley; Leavenworth Valley; Breckenridge; it is also doubtfully recorded from West Cliff.

A. INTERSTITIALIS Dej. West Cliff; Wales Cañon, Pueblo County, Cockerell; Veta Pass; South Park, 8,000 to 10,000 feet, Bowditch; Montrose; San Luis Valley; Cochetopa Pass; Idaho Springs, Packard; Colorado Springs, July; Buena Vista; Georgetown, June; Ouray, July; Salida, May.

A. FARCTA Lec. Colorado Springs; Leadville; Cañon of the Big Blue; Little Willow Creek.

A. OBESA Say. In the Bowditch list this species is said to occur everywhere between 8,000 and 10,000 feet; Alma; Florissant; San Luis Valley; South Park; Cañon of the Big Blue; Dome Rock; West Cliff; Idaho Springs, Manitou and Golden, Packard.

A. REMOTESTRIATA Dej. West Cliff; Clearwater Creek, Mesa County, 9,800 feet, Cockerell; Cimarron, Cockerell; Cañon City, Wickham; Veta Pass, 9,400 feet; Idaho Springs, Packard; Colorado Springs; Buena Vista; Breckenridge; Leadville; Georgetown; Silver Plume; Argentine Pass; Mt. Lincoln; Gunnison; Monument Gulch; Little Willow Creek; Cañon of Big Blue; Montrose; Rico; Durango; Cochetopa Pass; South Park, Bowditch.

A. CHALCEA Dej. "8,000 to 10,000 feet, everywhere," Bowditch; West Cliff, in doubt; Silver Plume; Georgetown, Wickham.

A. BRUNNEA Gyll. Colorado, Horn.

A. GIBBA Lec. "8,000 to 10,000 feet, everywhere," Bowditch; Salida. Professor Cockerell gives a record, with doubt, from western Custer County.

A. RUBRICA Hald. Colorado, Horn; La Junta, Bowditch.

A. SUBÆNEA Lec. Rico; Upper San Juan; Montrose.

A. MUSCULUS Say. West Cliff; Ouray.

A. FEMORALIS Horn. Mt. Lincoln; Argentine Pass; Gunnison; Cañon of Big Blue; Rico.

A. NUPERA Horn. Fremont County, Cockerell; West Cliff; Little Willow Creek.

DIPLOCHILA MAJOR Lec. Fort Collins, August.

DICÆLUS LÆVIPENNIS Lec. Northern Colorado, May; Fort Collins.

D. SCULPTILIS Say. Manitou, Packard; Colorado Springs, near mouth of Cheyenne Cañon, Wickham.

BADISTER PULCHELLUS Lec. Ouray, on bank of small lake.

B. OBTUSUS Lec. Southern Pueblo County, Cockerell.

CALATHUS INGRATUS Dej. 8,000 to 13,000 feet, Bowditch; Buzzard Creek, Mesa County, Cockerell; Marshall Pass, Gillette; Veta Pass, 9,400 to 10,000 feet; Dome Rock; Red Cliff; Leadville; Leavenworth Valley, 10,000 to 11,000 feet; Argentine Pass; Ouray; Alma; Rico; Mountains southwest of Montrose; Durango.

C. ADVENA Lec. Rico; Upper San Juan.

C. IMPUNCTATUS Say. Ouray.

C. DUBIUS Lec. Buena Vista; Ouray; Idaho Springs; La Junta; Florissant; Horsefly Peak; Cañon of Big Blue; Mountains southwest of Montrose; Cochetopa Pass; Durango.

PLATYNUS LARVALIS Lec. Fort Collins, May.

P. CAUDATUS Lec. Durango.

P. DISSECTUS Lec. Ouray; some specimens from Denver are also provisionally included here, but they are smaller than usual. Taken by Hayward and Bowditch at Durango, Cochetopa Pass, Upper San Juan and Gunnison.

P. JEJUNUS Lec. Squaw Creek, Eagle and Chaffee Counties, Cockerell; the identification is credited to the United States National Museum.

P. OVIPENNIS Mann. Straight Creek, Summit County, Cockerell, determined by Hamilton.

P. DECENS Say. Ouray.

P. EXTENSICOLLIS Say. Fort Collins, August; Mr. Hayward reports the form *viridis* from Durango.

P. CALIFORNICUS Dej. Professor Cockerell took specimens along Cottonwood Creek, Fremont County, which Dr. Hamilton referred to the variety *texanus*.

P. BICOLOR Dej. Red Cliff; Cañon of Big Blue; South Fork of San Miguel; Durango.

P. PICEOLUS Lec. Aspen; Ouray; Upper San Juan; South Fork of San Miguel; Durango.

P. ERRANS Say. South Park, 8,000 to 10,000 feet; Salida; Buena Vista.

P. PROPINQUUS G. & H. Ouray.

P. AFFINIS Kirby. This is recorded, with doubt, from West Cliff, by Cockerell.

P. CARBO Lec. Gunnison, Bowditch.

P. CUPRIPENNIS Say. Ouray; Gunnison; Alamosa; Nathrop; South Park, 8,000 to 10,000 feet; Buena Vista; Leadville; Colorado Springs. Mr. Hayward writes that he has a specimen of the variety *subsericeus* from Little Willow Creek.

P. BASALIS Lec. "Nebraska, near the Rocky Mountains," Leconte.

P. NUTANS Say. Dixon Cañon.

P. PLACIDUS Say. Vicinity of Fort Collins, March and August; Dome Rock; Florissant; Idaho Springs; Salida; Denver; Ouray; Red Mountain Road; San Luis Valley; Roaring Fork; South Fork of San Miguel; Pagosa Springs; Colorado Springs; Buena Vista.

P. PLANIPENNIS Mots. Colorado, Hamilton. According to Dr. Horn, this is probably a variety of *P. fossiger* Dej.

P. CUPREUS Lec. South Park; San Luis Valley, Bowditch.

P. CRASSICOLLIS Lec. Little Willow Creek.

P. OBSOLETUS Say. Colorado, Snow; South Park, Ulke.

P. BEMBIDIOIDES Kirby. Little Beaver Creek, July, Gillette; Silver Plume.

P. SORDENS Kirby. West Cliff; Durango; Garland.

P. RUFICORNIS Lec. Ouray.

LEBIA DIVISA Lec. Vicinity of Fort Collins, March to May.

L. GRANDIS Hentz. Colorado, Snow.

L. ATRICEPS Lec. Vicinity of Fort Collins, February to July; Pueblo, Bowditch; Colorado Springs.

L. PULCHELLA Dej. Horsefly Peak.

L. VIVIDA Bates. West Cliff.

L. CYANIPENNIS Dej. This species and the variety *ruficollis* Lec., are both reported from Durango by Mr. Bowditch.

L. VIRIDIS Say. West Cliff; Pueblo, Cockerell; Durango; South Fork of San Miguel; Berkeley, June; Colorado Springs; Rustic; Dolores; Marshall Pass, August; vicinity of Fort Collins, March to June, September and October. Mr. Bowditch has the variety *moesta* from the valley of the Upper San Juan.

L. SCAPULARIS Dej. San Luis Valley, Bowditch.

L. FURCATA Lec. West Cliff; Berkeley, June 15.

L. DEPICTA Horn. Rist Cañon, August; Livermore.

L. GUTTULA Lec. Durango, Bowditch.

L. BIVITTATA Fabr. Colorado Springs, on the open prairie.

APRISTUS SUBSULCATUS Dej. Gunnison; La Veta.

BLECHRUS NIGRINUS Mann. West Cliff; Garland; Colorado Springs; Fort Collins, March to June and also in September.

B. LUCIDUS Lec. Colorado, Horn.

METABLETUS AMERICANUS Dej. Garland; Veta Pass; Horsefly Peak; Little Willow Creek; Leavenworth Valley, 9,000 to 11,000 feet; Leadville; Breckenridge; Buena Vista.

AXINOPALPUS BIPLAGIATUS Dej. Garland; vicinity of Fort Collins, April and May.

TECNOPHILUS CROCEICOLLIS Men. La Junta, Hayward; a specimen from Colorado, without definite locality, is in my cabinet. Mr. Hayward's specimen belongs to the variety *pilatei*.

CALLIDA FULGIDA Dej. Dixon Cañon, March and May; Bellevue, May.

C. PURPUREA Say. Colorado, Snow.

PHILOPHUGA AMŒNA Lec. Fort Collins, April; Horsetooth Gulch, May; Florissant; Durango; Pagosa Springs; Colorado Springs; Buena Vista, chiefly about the roots or lower leaves of Yuccas.

CYMINDIS LATICOLLIS Say. South Park, Snow; Veta Pass.

C. CRIBRICOLLIS Dej. South Park, Snow; Black Lake Creek, Summit County, Cockerell; Roaring Fork; Breckenridge; Leadville; Moose Mountain, above timber; near Long's Peak; Plains south of Denver; Fort Garland; Horsefly Peak; Argentine Pass; Leavenworth Valley and Argentine Road, 9,000 to 11,000 feet; Mt. Lincoln; Pike's Peak, Bowditch; Cañon of Big Blue; Little Willow Creek; Mountains southwest of Montrose; Rico.

C. PLANIPENNIS Lec. Pikeview, El Paso County, and Lakeview, Fremont County, Cockerell; West Cliff; Denver, May; Colorado Springs; Buena Vista; Fort Collins; Ouray; Gunnison; Monument Gulch; Cochetopa Pass; San Luis Valley; Durango; Pagosa Springs; La Junta; South Park, Snow.

C. UNICOLOR Kirby. Red Mountain Road, 9,000 to 10,000 feet; summit of Mt. Abrams, over 11,000 feet; Argentine Pass, 12,000 feet; Mt. Lincoln; Summitville; Rico; Breckenridge; Leadville.

HELLUOMORPHA TEXANA Lec. Fort Collins and Bellevue, May and June.

BRACHYNUS MINUTUS Harr. Denver, Packard; specimens from Fort Collins are referred here with doubt.

B. CONFORMIS Dej. Recorded from the state by Putnam and Ulke; Montrose, Bowditch.

B. BALLISTARIUS Lec. Durango; Fort Collins.

CHLÆNIUS SERICEUS Forst. Denver, June and August; Colorado Springs, July; Ouray; Alamosa; Gunnison; Durango; La Junta; vicinity of Fort Collins; Delta.

C. LATICOLLIS Say. Southern Colorado, Leconte.

C. PRASINUS Dej. Colorado, Leng and Beutenmueller.

C. LEUCOSCELIS Chev. Delta, April; Durango.

C. SOLITARIUS Say. Fort Collins. Reported from the state without definite locality, by Dr. Horn.

C. NEBRASKENSIS Lec. Bellevue, May; Cañon City.

C. TRICOLOR Dej. Dolores, June.

C. BREVILABRIS Say. Colorado, Horn; Durango, Bowditch.

C. PENNSYLVANICUS Say. Fort Collins, May; Alamosa; Ouray.

C. INTERRUPTUS Horn. A pair from Buena Vista, taken in a salt marsh. The identification is due to Dr. Horn.

BRACHYLOBUS LITHOPHILUS Say. Ouray; Garland.

GEOPINUS INCRASSATUS Dej. Fort Collins, June; Denver; Pueblo; Poncha Springs, July; Greeley, September.

NOTHOPUS ZABROIDES Lec. Fort Collins; Denver; Pueblo; Colorado Springs; Salida; Durango; Lamar; La Junta; occurs from May to September.

CRATACANTHUS DUBIUS Beauv. Fort Collins, April and May; Colorado Springs, June to August; Denver; Pueblo; Garland; Durango; La Veta; La Junta; Clear Creek Cañon; Buena Vista.

PIOSOMA SETOSUM Lec. Durango, May and July; Fort Collins, July and August; Alpine, Snow; Colorado Springs, June to August; Pagosa Springs; La Junta.

AGONODERUS LINEOLA Fab. Fort Collins, May and June; Greeley; La Junta.

A. PALLIPES Fab. Denver; Livermore; Fort Collins; Ouray; Colorado Springs; Buena Vista; West Cliff; Idaho Springs. Prof. Cockerell records a variety *nigricollis* from Cottonwood Creek, Fremont County. The species may be found from March to August.

A. INDISTINCTUS Dej. Dixon Cañon, April.

DISCODERUS IMPOTENS Lec. La Junta, Bowditch.

HARPALUS AUTUMNALIS Say. A few specimens taken at Colorado Springs were referred here by Dr. Horn.

H. ERRATICUS Say. Montclair and Clear Creek Cañon, August.

H. RETRACTUS Lec. San Luis Valley; South Park, August, Oslar; Durango; Pagosa Springs; Garland; West Cliff; Colorado Springs, June and July.

H. AMPUTATUS Say. An abundant species in open spots. La Junta; Cañon of Big Blue; Mountains southwest of Montrose; Durango; Upper San Juan; San Luis Valley; Cochetopa Pass; Summitville; South Park; Alamosa; Garland; West Cliff; Denver; Cimarron; Colorado Springs; Buena Vista; Cañon City, May; Fort Collins, March to August; Golden.

H. CALIGINOSUS Fab. Fort Collins; Denver; Golden; Berkeley; Clear Creek; La Junta; Durango.

H. FAUNUS Say. Montrose; Durango.

H. VAGANS Lec. Nathrop, Cockerell. The name is from the U. S. National Museum.

H. PENNSYLVANICUS De Geer. Denver; Golden; Fort Collins; La Junta; Durango. The variety *compar* is known from Salida and Colorado Springs, while *erythropus* is from the latter locality only.

H. SPADICEUS Dej. Colorado, Snow.

H. FALLAX Lec. Georgetown; Ouray; La Junta; Gunnison; Cañon of Big Blue; Mountains southwest of Montrose; Rico; Durango; Idaho Springs; Kelso's Cabin, Gray's Peak, July; Cañon City, August; Colorado Springs, June to August; Buena Vista; Breckenridge.

H. PLEURITICUS Kirby. Cochetopa Pass; Alamosa.

H. HERBIVAGUS Say. Alma; South Park; Little Willow Creek.

H. VENTRALIS Lec. Garland, Bowditch.

H. OPACIPENNIS Hald. Colorado, Ulke.

H. NITIDULUS Chaud. Recorded in doubt from West Cliff.

H. ELLIPSIS Lec. Garland; Veta Pass; San Luis Valley; Cañon of Big Blue; South Park; La Junta; Gunnison; Georgetown; Leavenworth Valley, 10,000 to 11,000 feet; Colorado Springs.

H. INNOCUUS Lec. Breckenridge and Leadville, abundant.

H. CARBONATUS Lec. Veta Pass; Little Willow Creek.

H. MONTANUS Lec. Cañon of Big Blue; San Luis Valley; Leadville; Argentine Pass; Mt. Lincoln; Silver Plume.

H. LATICEPS Lec. San Luis Valley.

H. FRATERNUS Lec. Denver; South Park; Gunnison; Pagosa Springs; Leavenworth Valley, 9,000 to 10,000 feet.

H. FUNESTUS Lec. Fort Collins; Nathrop; Garland; La Junta; Cochetopa Pass; San Luis Valley; Ouray; Georgetown; Leavenworth Valley; Argentine Road.

H. OBLITUS Lec. Fort Collins; Denver; Beaver Brook; Manitou; Colorado Springs; Salida; Cañon City; Pagosa; Idaho Springs; Georgetown; Silver Plume; Garland; Veta Pass; La Junta; Greeley; Gunnison; Monument Gulch; Little Willow Creek; Cañon of Big Blue; Durango; Cochetopa Pass; South Park; North Fork of South Platte; Buena Vista; Breckenridge.

H. CLANDESTINUS Lec. Garland; Buena Vista.

H. FURTIVUS Lec. Golden; Idaho Springs; Manitou; Garland; Little Willow Creek; San Luis Valley.

H. OCHROPUS Kirby. South Park; San Luis Valley; Cochetopa Pass; Montrose; Colorado Springs; Buena Vista.

H. LUSTRANS Casey. South Park; Cañon City; Chimney Gulch; Fort Collins; Gunnison.

H. BASILARIS Kirby. South Park; Alamosa; Gunnison; Cochetopa Pass; West Cliff; Cañon City; Fort Collins; Greeley; Georgetown; Ouray; Buena Vista; Breckenridge; Leadville.

H. VARICORNIS Lec. Colorado, Putnam.

H. ALIENUS Lec. Veta Pass.

SELENOPHORUS PEDICULARIUS Dej. San Luis Valley; Clear Creek; Fort Collins; Golden; Colorado Springs, common about the roots of plants on dry hillsides.

S. FOSSULATUS Dej. La Junta, Hayward.

STENOLOPHUS PLEBEIUS Dej. Denver, H. G. Smith, Jr., determined by Dr. Horn.

S. CONJUNCTUS Say. Vicinity of Fort Collins, February to May; West Cliff; Florissant; Colorado Springs; Buena Vista.

S. UNICOLOR Dej. Colorado Springs, June; I found a small colony under a board on an alkali flat. The name is from Dr. Horn.

S. OCHROPEZUS Say. Fort Collins, March and April; Colorado Springs, June; Buena Vista.

BRADYCELLUS COGNATUS Gyll. Cattle Creek, Garfield County, Cockerell; Fort Collins; Greeley; Cochetopa Pass; Garland; Georgetown; Ouray; Buena Vista; Breckenridge; Leadville.

B. RUPESTRIS Say. Fort Collins; Colorado Springs; Buena Vista; Alamosa.

TACHYCELLUS NIGRINUS Dej. West Cliff.

T. BADIIPENNIS Hald. West Cliff.

ANISODACTYLUS DILATATUS Dej. Colorado, Bowditch.

A. RUSTICUS Dej. Colorado, Ulke; Bellevue, May.
A. CARBONARIUS Say. Colorado, Horn.
A. HARRISII Lec. Fort Collins, April.
A. NIGRITA Dej. Cottonwood Gulch, Saguache County, Cockerell.
A. BALTIMORENSIS Say. Fort Collins, April; Alamosa.
A. PITYCHROUS Lec. Colorado, Horn.
A. TERMINATUS Say. Colorado, Ulke.
A. LUGUBRIS Dej. Colorado, Snow.

AMPHIZOIDÆ.

AMPHIZOA LECONTEI Matth. Glenwood Springs, at the junction of the Roaring Fork with Grand River, Hubbard; Georgetown, one specimen, Wickham; Mr. Hayward reports that he and Mr. Bowditch found a specimen floating down stream in the cañon of the Big Blue, and about a dozen others under stones at the edge of the river along the Upper San Juan, at an altitude of about 8,000 feet.

HALIPLIDÆ.

HALIPLUS CRIBRARIUS Lec. Garland; Ouray.
H. RUFICOLLIS De Geer. Gunnison, Bowditch; West Cliff; Alamosa; Garland.
CNEMIDOTUS EDENTULUS Lec. "Kansas, near the Rocky Mountains," Leconte.

DYTISCIDÆ.

LACCOPHILUS MACULOSUS Germ. In the Putnam list; vicinity of Fort Collins, March, April and August.
L. DECIPIENS Lec. Gunnison, Bowditch; Alamosa; West Cliff; Fort Collins, August; Denver; Buena Vista.
L. QUADRILINEATUS Horn. Colorado, Crotch.
BIDESSUS AFFINIS Say. Durango and Gunnison, Bowditch; San Luis Valley; West Cliff; Garland; Alamosa; Mr. Schwarz reports the variety *obscurellus* from Garland and I have the form *macularis* from Colorado Springs. A species of *Bidessus* closely allied to *affinis*, if not identical with it, was taken at Ouray.
B. LACUSTRIS Say. Fort Collins, August, in stagnant water.
CŒLAMBUS INÆQUALIS Fab. Garland.
C. PATRUELIS Lec. Mr. Hayward records this species, with a mark of doubt, from Horsefly Peak Divide.
C. SUTURALIS Lec. Fort Collins, August; Placerville, Bowditch.
C. SELLATUS Lec. Gunnison, Bowditch; Denver, Packard; Alamosa.
C. MEDIALIS Lec. Colorado Springs, June; Buena Vista.
C. NUBILUS Lec. Buena Vista; Colorado Springs, June; Fort Collins, August; Florissant, Bowditch.
C. IMPRESSOPUNCTATUS Sch. Placerville, Bowditch. A species of this genus was taken by Mr. Bowditch at Rico and Alamosa, which he thinks may be new.

DERONECTES CATASCOPIUM Say. In the Putnam list; West Cliff; Ouray.

D. GRISEOSTRIATUS De Geer. Alamosa; Gunnison; Durango; the last two records come from Mr. Bowditch.

D. STRIATELLUS Lec. Florissant; Colorado Springs; Durango, Bowditch; Dolores; Howe's Gulch and Rist Cañon, April; Garland; Alamosa.

HYDROPORUS 12-LINEATUS Lec. A specimen from Georgetown is presumed to belong here.

H. SEPTENTRIONALIS Gyll. Durango and San Juan River, Bowditch.

H. RIVALIS Gyll. Georgetown; Florissant; the latter record is for the form *congruus* Lec.

H. CALIGINOSUS Lec. Reported under the name *puberulus*, from the Leavenworth Valley.

H. TENEBROSUS Lec. Montrose, Bowditch.

H. TARTARICUS Lec. Upper San Juan and Leavenworth Valley, Bowditch; Horsefly Peak Divide, Hayward. A species closely allied to this and to *morio* Sharp, was taken at Leadville and Breckenridge.

H. TRISTIS Payk. Abundant in Ute Pass, below the Bridal Veil falls, Snow.

H. CONTRACTULUS Mann. Veta Pass, Bowditch.

H. OBLITUS Aube. Colorado Springs.

H. VILIS Lec. Durango, Bowditch; Montrose; Georgetown, Wickham; Red Mountain Road.

H. BELFRAGEI Sharp. Colorado, Snow, (record from Bowditch).

ILYBIUS SUBÆNEUS Er. Placerville, Bowditch.

I. VIRIDIÆNEUS Cr. A specimen from Denver is doubtfully referred here.

I. QUADRIMACULATUS Aube. Colorado, Ulke.

I. ANGUSTIOR Gyll. Gunnison, Bowditch.

I. BIGUTTALUS Germ. Abundant below Bridal Veil falls, Snow.

I. CONFUSUS Aube. Denver, Packard.

COPTOTOMUS LONGULUS Lec. Colorado, Crotch.

AGABUS CORDATUS Lec. Abundant in a small stream in Williams Cañon, near Manitou; Gunnison; Montrose; Horsefly Peak; Georgetown.

A. INTERSECTUS Cr. West Cliff; Georgetown; Ouray; Manitou, Bowditch; Placerville.

A. SERIATUS Say. Durango; Upper San Juan; Gunnison; Manitou, Bowditch; Garland; La Veta; West Cliff.

A. LUGENS Lec. Vicinity of Fort Collins, March and April; Colorado Springs.

A. TEXANUS Sharp. Cañon City, Bowditch.

A. PUNCTULATUS Aube. Placerville, Bowditch.

A. TÆNIOLATUS Harr. Colorado, Putnam.

A. DISINTEGRATUS Cr. Denver, Packard.

A. AUSTINII Sharp. Florissant; Georgetown; Gunnison; Leavenworth Valley, 10,000 to 11,000 feet.

A. STRIGULOSUS Lec. Florissant. The record is under the name *nanus*.

A. MOROSUS Lec. West Cliff; also in the Putnam list.

A. INFUSCATUS Aube. Leavenworth Valley; Durango; Williams River.

A. OBSOLETUS Lec. San Luis Valley and Gunnison, Bowditch.

A. LECONTEI Cr. South Fork of San Miguel; Williams River; West Cliff.

A. GRISEIPENNIS Lec. Colorado Springs; Georgetown; Silver Plume; Leavenworth Valley; Ouray; Red Mountain Road, 10,000 to 11,000 feet.

A. OBLITERATUS Lec. Southern Colorado and northern New Mexico, Leconte; West Cliff; Placerville; Rico; Leavenworth Valley, 10,000 to 11,000 feet.

A. TRISTIS Aube. Garland; Rico.

RHANTUS DIVISUS Aube. Florissant; Rico; Gunnison; Dillon, September, Cockerell.

R. BINOTATUS Harr. South Park, August, Oslar; Rio Grande, Ulke; Florissant; Gunnison; South Fork of San Miguel; Rico; Cochetopa Pass; Denver, August; Berkeley, May; West Cliff; Colorado Springs; Fort Collins and vicinity, April, May and August.

R. BISTRIATUS Berg. Gunnison, Bowditch.

COLYMBETES LONGULUS Lec. Gunnison, Bowditch.

C. SCULPTILIS Harr. In both Ulke's and Putnam's lists; Fort Garland.

DYTISCUS MARGINICOLLIS Lec. Colorado, Putnam and Ulke; Durango, July, Oslar; Upper San Juan, Hayward.

D. DAURICUS Gebl. Pagosa, Ulke.

ACILIUS SEMISULCATUS Aube. Mountains southwest of Montrose.

A. FRATERNUS Harr. Alamosa.

GRAPHODERES CINEREUS Linn. Fort Collins, July and August.

GYRINIDÆ.

GYRINUS ÆNEOLUS Lec. Gunnison, Bowditch.

G. AQUIRIS Lec. San Luis Valley; Durango, Bowditch.

G. MACULIVENTRIS Lec. San Juan Valley, Bowditch; Saguache Creek, Saguache County, October, Cockerell, determined by Horn.

G. CANADENSIS Reg. Durango; Montrose; San Juan Valley; Gunnison; all of these records are from Mr. Bowditch.

G. AFFINIS Aube. Colorado, Ulke.

G. ANALIS Say. Dolores, June.

G. MARINUS Gyll. Gunnison and Durango, Bowditch.

G. BOREALIS Aube. Alamosa.

DINEUTES ASSIMILIS Aube. Colorado, Roberts, Trans. Am. Ent. Soc., XX, 285.

HYDROPHILIDÆ.

HELOPHORUS OBLONGUS Lec. Placerville; Garland; Alamosa; Veta Pass, 9,500 feet.

H. LACUSTRIS Lec. Garland; Alamosa; San Luis Valley; Little Willow Creek.

H. NITIDULUS Lec. Leadville; Leavenworth Valley, 10,000 to 11,000 feet; Montrose; Little Willow Creek.

H. LINEARIS Lec. Colorado Springs.

H. LINEATUS Lec. Arapahoe Peak, 11,000 to 12,000 feet, Packard; Garland; Mountains southwest of Montrose; South Fork of San Miguel.

OCHTHEBIUS DISCRETUS Lec. A variety of this species is reported by Mr. Schwarz from Veta Pass, 9,200 feet.

O. CRIBRICOLLIS Lec. Garland.

O. HOLMBERGI Mækl. Alamosa; Garland.

O. LINEATUS Lec. Colorado, Horn.

O. INTERRUPTUS Lec. Colorado, Horn; Cañon City, Wickham.

HYDRÆNA PENNSYLVANICA De Geer. Buena Vista; Colorado Springs. A new species of this genus was found by Mr. Schwarz, "everywhere."

HYDROPHILUS TRIANGULARIS Say. Poncha Springs, July; Denver, August; Buena Vista.

TROPISTERNUS DORSALIS Brulle. Fort Collins; Denver; Sloan's Lake; Colorado Springs; Buena Vista.

T. GLABER Hbst. Berkeley; Denver; Colorado Springs.

T. CALIFORNICUS Lec. Colorado, Horn; Fort Collins.

T. SUBLÆVIS Lec. Colorado, Ulke.

T. ELLIPTICUS Lec. Pagosa Springs, Bowditch.

T. STRIOLATUS Lec. Ouray.

HYDROCHARIS OBTUSATUS Say. Berkeley, one specimen, May.

BEROSUS STYLIFERUS Horn. Denver, Packard.

B. INFUSCATUS Lec. Colorado, Horn.

B. STRIATUS Say. Garland; Colorado Springs; Buena Vista; Gunnison, Bowditch.

LIMNOCHARIS PICEUS Horn. Cañon City, determined by Dr. Horn.

LACCOBIUS AGILIS Rand. West Cliff; Garland; Florissant; Colorado Springs.

PHILYDRUS DIFFUSUS Lec. Gunnison; Alamosa; Garland; Berkeley; West Cliff.

P. PERPLEXUS Lec. Garland, Bowditch.

HYDROCOMBUS n. sp. Pagosa Springs, Bowditch.

CYMBIODYTA MORATA Horn. Cañon City; Colorado Springs, June, not uncommon.

HYDROBIUS SCABROSUS Horn. Veta Pass, 9,350 feet; San Luis Valley; Upper San Juan; Mountains southwest of Montrose.

H. FUSCIPES Linn. Colorado Springs; Leadville; Garland; Veta Pass; Georgetown; Leavenworth Valley; Silver Plume; Ouray.

CRENIPHILUS SUBCUPREUS Say. Garland; West Cliff.

CERCYON PYGMÆUS Ill. Buena Vista.

C. TRISTIS Ill. Ouray. Mr. Schwarz reports finding an unnamed species at Garland, La Veta and Veta Pass.

SILPHIDÆ.

NECROPHORUS MARGINATUS Fab. Fort Collins; Golden; West Cliff; Colorado Springs; it is known to occur from July to October.

N. GUTTULA Mots. Recorded from West Cliff; Little Willow Creek; Georgetown; between Fort Garland and Costilla; Fort Collins; all except the first and third of these records are for the variety *hecate* Bland.

N. PUSTULATUS Hersch. The variety *melsheimeri* Kirby, is known from Montrose and Little Willow Creek, Bowditch. There are several state records without definite locality.

N. VESPILLOIDES Hbst. Summit and Delta Counties, Cockerell; Fort Collins, October.

N. TOMENTOSUS Web. Boulder, Oslar; Fort Collins, September.

SILPHA TRUNCATA Say. Southern Colorado, Leconte; West Las Animas and Grenada, Hayward; Colorado Springs, Wickham.

S. LAPPONICA Hbst. Denver; Georgetown; Idaho Springs; Florissant; West Cliff; Ouray; Little Willow Creek; Fort Collins; near Long's Peak; Livermore; South Park; Colorado Springs; Buena Vista; Breckenridge; Leadville. An abundant species occurring from March to October.

S. TRITUBERCULATA Kirby, variety *coloradensis* Wickham. Argentine Road above Georgetown, 12,000 to 13,000 feet. Mr. Bowditch has a specimen of *trituberculata* from Gunnison which may belong to this variety.

S. RAMOSA Say. Over 12,000 feet, Carpenter; Gunnison and South Park, Bowditch; plains south of Denver, Ulke; West Cliff; Clear Creek Cañon, Oslar; vicinity of Fort Collins, March to August; Buena Vista.

S. OPACA Linn. Mr. Bowditch has a specimen from the Argentine Pass which he refers here with doubt.

PTEROLOMA TENUICORNIS Lec. Cañon City, Wickham.

CHOLEVA SIMPLEX Say. Fort Collins, October.

C. BASILLARIS Say. Rico; South Fork of San Miguel; the form *brunnipennis* is recorded from La Veta in the Schwarz list.

C. CLAVICORNIS Lec. Colorado, Horn; Rico, Bowditch.

PTOMOPHAGUS CONSOBRINUS Lec. Colorado, Bowditch; Georgetown, Wickham.

COLON PUSILLUM Horn. Colorado, Horn.

C. CLAVATUM Mann. Veta Pass, 11,000 feet.

C. INERME Mann. Colorado, Horn.

C. MAGNICOLLE Mann. Leavenworth Valley, 10,000 to 11,000 feet.

C. LIEBECKI Wickham. Breckenridge.

HYDNOBIUS LONGIDENS Lec. Garland.

H. SUBSTRIATUS Lec. Colorado, Horn.

H. CURVIDENS Lec. La Veta; Garland.

H. PUMILUS Lec. Veta Pass, 9,200 feet.

H. LATIDENS Lec. Colorado, Horn; Durango, Bowditch.

H. OBTUSUS Lec. Garland; Veta Pass, 9,200 feet.

ANISOTOMA VALIDA Horn. Silver Plume; Breckenridge.

A. ASSIMILIS Lec. Colorado, Horn.

A. PUNCTATOSTRIATA Kirby. Colorado, Hamilton.

A. COLLARIS Lec. Colorado, Horn. A species "allied to *collaris*" is reported from Garland and Veta Pass by Dr. Leconte, in the Schwarz list.

A. STRIGATA Lec. Leavenworth Valley, 10,000 feet; Red Mountain Road, 8,000 to 9,000 feet.

A. OBSOLETA Melsh. Colorado, Horn.

LIODES GLOBOSA Lec. Veta Pass; Ouray.

? CYRTUSA sp. Veta Pass, 9,200 feet.

AGATHIDIUM EXIGUUM Melsh. Colorado, Horn.

A. ESTRIATUM Horn. Ouray; Garland.

A. CONCINNUM Mann. Ouray; Breckenridge; Garland.

A. ANGULARE Mann. Colorado, Horn; Veta Pass, Bowditch. Two unidentified species are reported from Veta Pass.

CALYPTOMERUS OBLONGULUS Mann. Veta Pass, 9,000 to 11,000 feet; Ouray, in mycelia of fungi, under logs.

CLAMBUS VULNERATUS Lec. Garland.

C. GIBBULUS Lec. Garland.

SCYDMÆNIDÆ.

SCYDMÆNUS TRISTIS Casey. Colorado, Casey. An unidentified species of this genus is reported from Garland, and another from Garland and Veta Pass.

CONNOPHRON FOSSIGER Lec. Colorado, Casey.

EUTHIA LONGULA Lec. Garland.

PSELAPHIDÆ.

TYCHUS MICROPHTHALMUS Brend. Cañon City, Wickham.

BATRISUS FRONTALIS Lec. Colorado Springs, June, two specimens with *Lasius claviger* Rog.; Buena Vista.

B. GLOBOSUS Lec. Colorado Springs, June, one specimen with *Camponotus herculaneus*. This and the preceding species are of my own collecting.

REICHENBACHIA ALBIONICA Mots. Garland; Veta Pass, 9,200 feet.

R. PROPINQUA Lec. A specimen from Buena Vista is referred with some doubt to this species.

R. ARTICULARIS Casey. Southern Colorado, Casey.

R. WICKHAMI Brend. Cañon City, Wickham.

EUPLECTUS near *californicus* Casey. Buena Vista, one specimen in rotten log.

STAPHYLINIDÆ.

A great number of our native Staphylinidæ are still nondescript, while many of the described species are so imperfectly characterized as to render their proper determination a matter of difficulty and uncertainty. The succeeding list is therefore necessarily incomplete. It might be very materially lengthened by the inclusion of a number of generic records, but it seems scarcely worth while to incorporate these at present.

FALAGRIA DISSECTA Er. West Cliff.

F. VENUSTULA Er. Fort Collins, April, under boards.

ECHIDNOGLOSSA MONTICOLA Casey. Colorado, Casey. Possibly this is the species recorded from Veta Pass by Mr. Schwarz.

HOMALOTA PLANA Gyll. Garland; Veta Pass, 9,400 feet.

COLPODOTA SORDIDA Marsh. La Veta; Colorado Springs, June; Fort Collins, March.

C. FUNGI Grav. Veta Pass, 9,200 feet.

XENODUSA CAVA Lec. West Cliff; Pueblo; I took a species of this genus from ants' nests at Cañon City.

X. CASEYI Wasmann. Sent to Dr. Wasmann by a correspondent in Pueblo. Lives with *Formica subpolita* Mayr. It is possible that all of the Colorado specimens are referable to this form.

DINARDILLA LIOMETOPI Wasm. Collected by Rev. P. J. Schmitt at Cotopaxi, in the nests of *Liometopon microcephalum* Pz., variety *occidentale* Em., during the month of March.

APTERONINA SCHMITTI Wasm. Cotopaxi, with the preceding.

TRICHOPHYA LATIVENTRIS Casey. Colorado Springs, June.

TACHYUSA NIGRELLA Lec. Colorado, Bowditch.

ALEOCHARA BIMACULATA Grav. Colorado Springs; Buena Vista; Williams River; Fort Collins; Garland; Willow Creek, on Cusack's ranch.

A. NITIDA Grav. Leadville; Williams River.

DASYGLOSSA PROSPERA Er. Garland; Veta Pass, 9,200 to 9,400 feet.

OXYPODA SAXATILIS Casey. Cañon City, Casey.

MYRMECOCHARA CRINITA Casey. Cañon City; I found several specimens in the nest of a small yellow ant.

NOTATAPHRA LUGUBRIS Casey. Colorado, Casey.

HETEROTHOPS FUMIGATUS Lec. West Cliff; Garland; Fort Collins, March and April.

QUEDIUS SPELÆUS Horn. Garland; Veta Pass, 9,200 feet.

Q. FULGIDUS Fab. Colorado, Putnam.

Q. SP. near SUBLIMBATUS Lec. Breckenridge, from about 10,000 feet to timber line, under wood in wet spots.

Q. LÆVIGATUS Gyll. Veta Pass, 9,400 feet.

Q. MOLOCHINUS Grav. Veta Pass, 9,200 feet; a small variety is reported from the snow fields at an altitude of 11,000 feet.

Q. FULVICOLLIS Steph. This species is reported, under the name *hyperboreus*, from Garland and Veta Pass.

Q. BRUNNIPENNIS Mann. Williams River, Bowditch.

Q. DEBILIS Horn. Garland, Bowditch.

Q. PROSTANS Horn. Colorado Springs; Garland; Veta Pass; West Cliff.

LISTOTROPHUS CINGULATUS Grav. Ouray; Georgetown.

CREOPHILUS VILLOSUS Grav. Georgetown; Little Willow Creek; La Junta; Fort Collins; Clear Creek; Ouray; Pagosa Springs; Durango; San Luis Valley; Fort Garland to Costilla; West Cliff; Colorado Springs; Buena Vista.

STAPHYLINUS FOSSATOR Grav. Upper San Juan, Hayward.

PHILONTHUS POLITUS Linn. West Cliff; Straight Creek, Summit County, Cockerell; Buena Vista.

P. FURVUS Nord. West Cliff; Salida; Red Cliff; Fort Collins; Colorado Springs; Williams River Valley; Georgetown; Ouray; Leavenworth Valley, 9,000 to 10,000 feet.

P. SERICINUS Horn. Little Willow Creek, Hayward. Name in some doubt, as is the next.

P. IRINUS Horn. Gunnison, Hayward.

P. SEMIRUBER Horn. Salida; Cañon City.

P. BASALIS Horn. Williams River Valley; Alma; Red Cliff.

P. HEPATICUS Er. Colorado Springs, Bowditch; Rico (in doubt), Hayward.

P. PALLIATUS Grav. Colorado, Horn.

P. QUISQUILIARIUS Gyll. Durango; La Junta. Both of these records are from Mr. Hayward who expresses some doubt as to the determinations of his Philonthi. Allowance must be made for this doubt in the case of the other species of this genus credited to him.

P. THEVENETI Horn. Williams River Valley.

P. DEBILIS Grav. Garland; Veta Pass, 9,400 feet.

P. VARIANS Payk. Buena Vista; Pike's Peak, 10,000 to 11,000 feet; Moose Mountain, above timber; Georgetown; Fort Collins.

P. LONGICORNIS Steph. Summit County, Cockerell.

P. DISCOIDEUS Grav. Gunnison; Montrose. Both records are from Mr. Hayward.

P. FUSIFORMIS Melsh. Colorado, Horn; Buena Vista.

P. OCCIDENTALIS Horn. Saguache Creek, above Rock Cliff, Saguache County, Cockerell; Colorado Springs; Durango and mountains southwest of Montrose, Hayward.

P. FERREIPENNIS Horn. West Cliff, name in doubt.

P. BRUNNEUS Grav. Dixon Cañon, March.

P. SORDIDUS Grav. Colorado, Horn.

P. CEPHALOTES Grav. Colorado Springs, Wickham.

P. INVERSUS Horn. Garland, Horn.

P. VIRILIS Horn. Cañon City. A species closely allied or identical was taken by me at Ouray, Georgetown, and in the Leavenworth Valley, up to about 11,000 feet.

P. NIGRITULUS Grav. Garland; Veta Pass, 9,200 feet.

P. MICROPHTHALMUS Horn. Cañon City; Ouray, with *Formica obscuripes*. A species, probably the same, was taken at Georgetown, Leadville, Buena Vista and in the Leavenworth Valley.

P. INSTABILIS Horn. Colorado Springs; Buena Vista; Leadville.

P. LECONTEI Horn. Colorado, Horn; Cochetopa Pass, Hayward.

P. AURULENTUS Horn. Salida; Buena Vista, on marsh land; Fort Collins.

ACTOBIUS SENILIS Horn. Colorado, Horn.

A. PUSIO Horn. Garland, Horn.

A. PÆDEROIDES Lec. Colorado Springs; Spring Cañon.

BISNIUS PROCERULUS Grav. Colorado, Horn.

XANTHOLINUS CEPHALUS Say. Veta Pass, 9,400 feet.

X. OBSIDIANUS Melsh. Fort Collins.

X. EMMESUS Grav. West Cliff.

X. OBSCURUS Er. Vicinity of Fort Collins, April and May; Colorado Springs; Buena Vista; Alamosa; West Cliff.

X. HAMATUS Say. Fort Collins; Trinidad.

DIANOUS NITIDULUS Lec. Garland.

STENUS PUNCTIGER Casey. Garland, Casey.

S. COLON Say. West Cliff (in doubt), Cockerell.

S. RENIFER Lec. Colorado Springs, June; Pleasant Valley, March, Gillette.

S. PERPLEXUS Casey. Williams River Valley, Bowditch.

S. SECTATOR Casey. Alamosa, Bowditch.

S. RUGIFER Casey. Alamosa, Casey.

S. SCABIOSUS Casey. Buena Vista; Leadville; both records come from Mr. Bowditch.

S. INCULTUS Casey. Cañon City.

S. ALPICOLA Fauv. Garland; Veta Pass.

S. HUMILIS Er. Fort Garland, Casey; Buena Vista, Bowditch.

S. STYGICUS Say. Greeley.

S. DOLOSUS Casey. Fort Garland, Casey.

S. MORIO Grav. Alamosa; Veta Pass.

S. ENODIS Casey. Veta Pass, Casey.

S. DIVES Casey. Cañon City, Wickham.

S. MONTICOLA Casey. Williams River Valley, Bowditch.

S. ALACER Casey. Colorado, Casey.

S. TAHOENSIS Casey. Colorado Springs.

S. NIMBOSUS Casey. Fort Garland, Casey; Dixon Cañon, March; Salida.

S. AMICUS Casey. Colorado, Casey.

S. ANNULARIS Er. Greeley.

S. POLLENS Casey. Alamosa, Casey, (under name *patens*).

S. TARSALIS Ljungh. Greeley; Alamosa; Garland; Veta Pass, 9,400 feet.

S. PINGUIS Casey. Colorado, Casey.

S. UTENSIS Casey. Alamosa, Bowditch; Fort Garland, Casey.

S. TRAJECTUS Casey. Veta Pass, Casey.

LATHROBIUM TERMINATUM Grav. Alamosa.

L. TENUE Lec. Alamosa.

L. LONGIUSCULUM Grav. Colorado Springs.

L. COLLARE Er. Alamosa.

L. PALLIDULUM Lec. Colorado, Leconte.

PÆDERUS GRANDIS Aust. This is reported in the original description as coming from "Col." and Arizona. I think, however, that it was from the neighborhood of the Colorado river, at Fort Yuma.

P. COMPOTENS Lec. Cañon City; Buena Vista, Bowditch.

P. LITTORARIUS Grav. West Cliff; Routt County, Cockerell; Fort Collins, March and April.

SUNIUS BINOTATUS Say. Fort Collins, March and April.

HYPOCYPTUS NIGRITULUS Lec. Garland; Veta Pass, 9,200 feet.

TACHINUS AGILIS Horn. Veta Pass, 9,400 feet.

T. ANGUSTATUS Horn. Leadville; Mountains southwest of Montrose, Hayward, in doubt.

T. PARALLELUS Horn. Veta Pass, 11,200 feet.

T. NIGRICORNIS Mann. Buena Vista, Bowditch.

T. REPANDUS Horn. Garland; La Veta.

T. FUMIPENNIS Say. Little Willow Creek, Hayward, in doubt.

TACHYPORUS MACULIPENNIS Lec. Fort Collins.

T. JOCOSUS Say. Buzzard Creek District; Mesa County; southern Pueblo County; Custer County, subalpine. All the records are from Cockerell.

T. CHRYSOMELINUS Linn. Fort Collins; West Cliff; Red Cliff; Buena

Vista; Williams River Valley; Alamosa; Garland; La Veta; Little Willow Creek.

T. NANUS Er. Alamosa.

T. NITIDULUS Fab. Fort Collins; Leadville; Veta Pass.

BOLETOBIUS DIMIDIATUS Er. Dome Rock.

B. INTRUSUS Horn. Veta Pass, 9,400 feet; Williams River Valley.

B. PYGMÆUS Fab. Garland; Veta Pass, 9,200 feet; North Park, Gillette; Gunnison, Hayward.

BRYOPORUS RUFESCENS Lec., variety *rubidus* Lec. Veta Pass, 9,400 feet.

MYCETOPORUS HUMIDUS Say. Mr. Schwarz reports a very large form from Garland.

M. TENUIS Horn. A variety of this species is reported by Mr. Schwarz, from Garland and Veta Pass.

M. CONSORS Horn. Garland.

M. SPLENDIDUS Grav. Garland; Veta Pass.

PSEUDOPSIS SULCATA Newm. Garland; Veta Pass; Ouray.

P. OBLITERATA Lec. La Veta.

BLEDIUS ARMATUS Er. Fort Collins; Denver.

B. ADUSTUS Casey. Garland, Casey.

B. TENUIS Casey. Grand Junction, Bowditch.

B. FUMATUS Lec. Buena Vista.

B. RUFICORNIS Lec. Dome Rock; Buena Vista.

B. TURGIDUS Casey. Veta Pass, Bowditch; Fort Garland, Casey.

PLATYSTETHUS AMERICANUS Er. West Cliff; Garland; La Veta; Leadville; Buena Vista; Breckenridge; Ouray; Micawber Mine.

OXYTELUS PENNSYLVANICUS Er. West Cliff.

O. FUSCIPENNIS Mann. Veta Pass; a species closely allied to *fuscipennis*, or identical with it, is found at Ouray, Buena Vista and in the North Park.

O. ALPICOLA Casey. Colorado, Casey.

O. NITIDULUS Grav. Fort Collins; West Cliff; Garland; La Veta; Veta Pass, 9,400 feet.

TROGOPHLŒUS MEMNONIUS Er. Alamosa.

T. CORTICINUS Grav. Garland; Veta Pass.

T. SCRUPULUS Casey. Greeley.

APOCELLUS CRASSICORNIS Casey. Fort Garland, Casey.

A. SPHÆRICOLLIS Say. Fort Collins; Garland.

DELEASTER CONCOLOR Lec. Cañon City; Colorado Springs.

PORRHODITES FENESTRALIS Zett. Roaring Fork.

GEODROMICUS OVIPENNIS Lec. San Juan Valley; Leavenworth Valley, 9,000 to 11,000 feet; Silver Plume; Georgetown; Ouray; Leadville; Veta Pass.

G. DEBILIS Casey. Colorado, Casey.

TILEA CASTANEA Casey. Colorado, Casey.

LESTEVA FUSCONIGRA Mots. Veta Pass, 9,400 to 11,000 feet; Williams River Valley.

ACIDOTA QUADRATA Zett. Colorado, Hamilton.

ARPEDIUM SP. Leadville; Leavenworth Valley, 10,000 to 11,000 feet.
DELIPHRUM EXPANSUM Lec. Summitville, Bowditch; Veta Pass.
OLOPHRUM MARGINATUM Kirby. Veta Pass, 9,200 feet.
O. ROTUNDICOLLE Sahlb. Leadville.
OMALIUM PUSILLUM Grav. Veta Pass, 9,400 feet.
O. PLANUM Payk. Garland, Bowditch.
O. FORAMINOSUM Mækl. Veta Pass, 9,200 feet.
ANTHOBIUM SPP. Veta Pass, 9,000 to 11,000 feet; Pike's Peak, 8,000 to 9,000 feet; Leadville; Breckenridge.
OROBANUS SIMULATOR Lec. Leavenworth Valley, 10,000 to 11,000 feet; Veta Pass, 9,400 feet.
MICRÆDUS AUSTINIANUS Lec. Veta Pass, 9,400 feet; Leavenworth Valley, 9,000 to 10,000 feet.
MEGARTHRUS SINUATOCOLLIS Lec. Ouray; Veta Pass, 9,200 to 11,000 feet.
SIAGONIUM PUNCTATUM Lec. Veta Pass, 9,400 feet.
MICROPEPLUS LATICOLLIS Mækl. Veta Pass, 9,200 to 11,000 feet.

TRICHOPTERYGIDÆ.

PTILIUM N. SP. Garland.
PTENIDIUM EVANESCENS Marsh. Garland.
TRICHOPTERYX near *californica* Matth. Garland; Veta Pass, 11,200 feet.
T. near *haldemanni* Lec. Garland; Veta Pass, 9,200 feet. I have an undetermined species from Buena Vista.

SCAPHIDIIDÆ.

SCAPHIDIUM ORNATUM Casey. Supposed by the describer to have come from Colorado.
SCAPHISOMA CONVEXUM Say. Dolores; Pleasant Valley.
S. CASTANEUM Mots. Durango, Bowditch.

PHALACRIDÆ.

PHALACRUS PENICILLATUS Say. Pueblo; Garland; Fort Collins; North Park; Dolores; Marshall Pass; Little South; Livermore; Colorado Springs.
P. SIMPLEX Lec. Alamosa; Garland.
P. POLITUS Melsh. Pueblo.
P. SERIATUS Lec. Garland.
PHALACROPSIS DISPAR Lec. Veta Pass, 9,400 feet.
OLIBRUS VITTATUS Lec. Holly; Fort Collins; Livermore; Durango.
O. SEMISTRIATUS Lec. Durango and La Junta, Bowditch.
STILBUS APICALIS Melsh. Fort Collins; La Veta; Garland.

CORYLOPHIDÆ.

SACIUM LUGUBRE Lec. Garland; Veta Pass; West Cliff.
S. MONTANUM Casey. Colorado, Casey.

S. BIGUTTATUM Lec. Ouray; Garland; Veta Pass, 9,200 to 11,000 feet. I have an undetermined species from Colorado Springs.

SERICODERUS FLAVIDUS Lec. Northern Colorado; Fort Collins.

ORTHOPERUS SCUTELLARIS Lec. Fort Collins; Garland.

O. PRINCEPS Casey. Colorado, Casey.

COCCINELLIDÆ.

The arrangement of this family follows Casey's recent revision as far as possible, though of course it is out of the question to correlate the old records with his arrangement in every case. It seems too, that Major Casey had very little material from Colorado before him, so that we are left without a clue as to the disposition he would have made of doubtful or osculant forms. For the present it seems unnecessary to make comments on the status of some of the new names proposed, as more than one opinion may easily exist regarding the separation of certain races and varieties. The trinomial system seems destined to prevail in Entomology, as it has already done in some of the kindred sciences, and most of the names will probably be perpetuated in some form, even if a succeeding monographer degrades them from specific rank.

MACRONÆMIA EPISCOPALIS Kirby. West Cliff; Garland; Greeley; Fort Collins. May be taken from April to June, in sweepings.

PARANÆMIA SIMILIS Casey. Durango, Oslar; Fort Collins and vicinity; Greeley; Colorado Springs, in swampy spots, on flowers of Umbelliferæ; West Cliff. This is recorded in most lists as *Megilla vittigera* Mann.

MEGILLA FUSCILABRIS Muls. La Junta, Bowditch. The insect is equivalent to what has been called *Megilla maculata* De Geer, in this country.

HIPPODAMIA TREDECIMPUNCTATA Linn. West Cliff; Garland; Gunnison; Delta; Grand Junction.

H. QUINQUESIGNATA Kirby. Clear Creek Cañon; Beaver Brook Gulch; Leavenworth Valley, 10,000 to 11,000 feet; Ouray; Red Mountain Road; Aspen; Durango; Montrose; Surface Creek, Delta County; Fort Collins; Livermore; Denver; Colorado Springs; Palmer Lake; Golden; Pike's Peak, 9,000 to 10,000 feet; Buena Vista; Breckenridge; Leadville; Marshall Pass.

H. LECONTEI Muls. Denver; Greeley; Colorado Springs; Buena Vista; Pike's Peak, 9,000 to 10,000 feet; Garland; La Veta; West Cliff; La Junta; Durango.

H. DISPAR Casey. Colorado, Casey.

H. GLACIALIS Fab. Fort Collins and Livermore.

H. CONVERGENS Guer. Denver; Colorado Springs; Fort Collins; Greeley; Manitou; Buena Vista; Berkeley; Chimney Gulch; Florence; Salida; Palmer Lake; Livermore; Dolores; Wales Cañon; Pueblo; La Junta; Trinidad; Delta; Montrose; Durango; Cañon of Big Blue; Upper San Juan; Cochetopa Pass; Red Mountain Road; West Cliff; Micawber Mine; Garland; Veta Pass. The commonest species of *Hippodamia* in the state.

H. QUINDECIMMACULATA Muls. Colorado Springs, one specimen.

H. SPURIA Lec. Buena Vista; Hesterburgs Lane, Custer County, Cockerell. Mr. Baker bred *Euphorus sculptus* from this species and *convergens*, at Fort Collins.

H. SINUATA Muls. Denver; Berkeley; Fort Collins; Colorado Springs, common on *Helianthus*; Glenwood Springs; Durango.

H. PARENTHESIS Say. Durango; Gunnison; Monument Gulch; Rico; Cochetopa Pass; Williams River Valley; Alamosa; Garland; Veta Pass; Ula; Pueblo; Roaring Fork; Riverside, Chaffee County and Cottonwood Gulch, Saguache County, Cockerell; Denver; Stove Prairie; Little South; Cerro Summit; Marshall Pass; Cañon City; Greeley; Clear Creek Cañon; Colorado Springs; Pike's Peak, 8.000 to 9,000 feet; Buena Vista; Leadville; also included by Carpenter in his list of species taken at altitudes over 12,000 feet.

ADALIA BIPUNCTATA Linn. Fort Collins, June.

A. HUMERALIS Say. Fort Collins; Little Willow Creek; Cañon of Big Blue; Placerville; Ouray.

A. ANNECTANS Crotch. Colorado Springs; Manitou; Rocky Ford; Fort Collins; Little Willow Creek; Gunnison.

A. FRIGIDA Schn. Little Willow Creek; Cañon of Big Blue; Placerville; Upper San Juan; Veta Pass; Garland. I do not know which of Casey's names fit these specimens.

A. ORNATELLA Casey. Colorado, Casey.

COCCINELLA NOVEMNOTATA Hbst. Denver; Berkeley; Clear Creek Cañon; Cañon City; Colorado Springs; Pike's Peak; Buena Vista; Leadville; Fort Collins; Greeley; La Junta; Pueblo; West Cliff; Little South; Dolores; Cimarron; Little Beaver; Monument Gulch; Durango; Pagosa Springs; Williams River Valley; Ouray.

C. DEGENER Casey. Colorado, Casey.

C. DIFFICILIS Crotch. Greeley.

C. PROLONGATA Crotch. Southern Colorado, Leconte; Cañon City, Bowditch.

C. SUTURALIS Casey. Colorado, Casey.

C. MONTICOLA Muls. Clear Creek, Oslar; Garland; Leadville; Buena Vista; Colorado Springs; Fort Collins.

C. QUINQUENOTATA Kirby. This is what we have been calling *transversoguttata* Fald. It is known from Ouray and the pass above; Georgetown; Gunnison; Cañon of Big Blue; Mountains southwest of Montrose; Rico; Pagosa Springs; Upper San Juan; Cochetopa Pass; Delta; San Luis Valley; South Park; Eagle River; Roaring Fork; Buena Vista; Leadville; Moose Mountain; Breckenridge; Micawber Mine; Marshall Pass; Salida; Palmer Lake; Livermore; Fort Collins; Estes Park; Golden; Nathrop; Cañon City; Idaho Springs; West Cliff; in the Carpenter list of species occurring over 12,000 feet. The form which we have heretofore designated *transversalis* is now called by Casey, *nugatoria* Muls., and this comes from the following points; Denver; Colorado Springs; Cañon City; near Steamboat Springs; Glenwood Springs; Delta; Fort Collins; Silver Plume; above Ouray; Clear Creek Cañon; Breckenridge; West

Cliff, in doubt; Lake and Chaffee Counties, Cockerell; Gunnison; Leavenworth Valley.

C. PERPLEXA Muls. Known to us as *trifasciata* Linn. North Park; Rist Cañon; Steamboat Springs; Rocky Ford; Ula; Micawber Mine; La Veta; Veta Pass, 9,400 feet; Cañon of Big Blue; Mountains southwest of Montrose; Little Willow Creek.

C. TRICUSPIS Kirby. Upper San Juan, Bowditch.

CYCLONEDA SANGUINEA Linn. I retain the Linnæan designation, as it is impossible to assign the names of Casey without access to the original specimens. Trinidad; Dolores; Cimarron; Chimney Gulch; Dome Rock; Colorado Springs; Pike's Peak, 9,000 to 10,000 feet; West Cliff.

OLLA ABDOMINALIS Say. Denver; Salida; Fort Collins; Lamar; Manitou; La Junta; Pueblo.

CLEIS PICTA Rand. Dome Rock; Garland; Veta Pass; Cusack Ranch, Custer County, Cockerell; Colorado Springs; Buena Vista; Peak Eight, 11,500 to 12,000 feet; Fort Collins; Horsefly Peak Divide; Mountains southwest of Montrose.

ANATIS RATHVONI Lec. Placerville; West Cliff; Red Mountain Road, 9,000 to 10,000 feet; Fort Collins, June; not a common species.

NEOMYSIA HORNII Crotch. West Cliff; Garland; Mountains southwest of Montrose; Fort Collins; Durango.

N. SUBVITTATA Muls. South Fork of San Miguel; Garland; Veta Pass, 9,400 feet.

N. MONTANA Casey. Colorado, Casey.

PSYLLOBORA VIGINTIMACULATA Say. La Veta; Garland; Ouray; West Cliff; Fort Collins; Colorado Springs; Pike's Peak, 7,000 to 8,000 feet.

EPILACHNA CORRUPTA Muls. Boulder; Colorado Springs; Denver; Golden; Fort Collins; Trinidad; Buena Vista; Durango.

CHILOCORUS BIVULNERUS Muls. Golden; Colorado Springs; Manitou; Salida; Greeley; Fort Collins; Durango.

EXOCHOMUS HOGEI Gorh. West Cliff; Delta; Durango; Buena Vista; Breckenridge; Leadville. This is what we have been calling *marginipennis*.

E. ÆTHIOPS Bland. Ouray; Durango; Garland; Veta Pass; Montrose; vicinity of Fort Collins; Stove Prairie; Rustic; Horsetooth Mountain; Colorado Springs; Buena Vista; Leadville, not common.

BRACHYACANTHA URSINA Fab. Southern Colorado, Leconte; Garland; La Veta; vicinity of Fort Collins, June to August. Specimens intermediate between this and *albifrons* were taken by Gillette and Baker at various points in the neighborhood of Fort Collins.

B. DECEMPUSTULATA Melsh. Colorado Springs, July; a specimen, not very typical, was taken near Palmer Lake by Prof. Gillette.

B. ILLUSTRIS Casey. Beaver Brook.

B. ALBIFRONS Say. Colorado Springs; Fort Collins; Gunnison; Durango; Little Willow Creek; Beaver Brook.

B. DENTIPES Fab. Colorado, my cabinet; Dolores, Gillette.

B. INDUBITABILIS Crotch. Montrose; Gunnison, Bowditch.

HYPERASPIS LATERALIS Muls. Garland; Leadville; Montrose; Clear Creek

Cañon; Rocky Ford; Cerro Summit; vicinity of Fort Collins; except the first two, all of the records are due to Prof. Gillette's collecting.

H. BINOTATA Say. Cimarron, August; Durango, Bowditch. This is *signata* Lec., not Olivier, according to Casey.

H. FIMBRIOLATA Mels. West Cliff; Pueblo; Boulder; vicinity of Fort Collins; Golden; Colorado Springs; Dome Rock; La Junta.

H. TRISTIS Lec. Colorado, Leconte.

H. CINCTA Lec. Mr. Bowditch thinks this occurs near Durango, as he has it from just across the line in New Mexico.

H. LUGUBRIS Rand. Colorado, Leconte.

H. UNDULATA Say. Colorado Springs; Cañon City; La Junta.

H. SEXVERRUCATA Fab. Colorado Springs, Bowditch.

H. QUADRIVITTATA Lec. Colorado Springs and Buena Vista, chiefly about roots of herbs on dry ground; Leadville; Denver; Bellevue; Williams River Valley.

HELESIUS NIGRIPENNIS Lec. Florissant; Garland, in doubt, Bowditch.

HYPERASPIDIUS TRIMACULATUS Linn. Alamosa; Garland; La Veta; Gunnison; Fort Collins and vicinity; Colorado Springs; Buena Vista; Leadville; occurs from May to August. Frequently found in rubbish about the roots of plants.

H. INSIGNIS Casey. Colorado Springs.

H. MILITARIS Lec. Foothills near Fort Collins, May.

STETHORUS PUNCTUM Lec. Cañon City, Gillette, on plum. Buena Vista, on dwarf pines which were badly infested with Aphides.

S. UTILIS Horn. Leadville, one specimen, concerning which Dr. Horn wrote that it was a little less distinctly punctured than the types.

SCYMNUS FLAVESCENS Casey. Colorado Springs.

S. PALLENS Lec. Palmer Lake, October; Horsetooth Gulch, June.

S. NUGATOR Casey. Colorado, Casey.

S. FRATERNUS Lec. Clear Creek Cañon; Palmer Lake, August.

S. BRULLEI Muls. Spring Cañon, May.

S. CERVICALIS Muls. Garland, in doubt.

S. COLLARIS Melsh. Colorado Springs; Fort Collins; Montrose; Rocky Ford; Lamar. Mr. Bowditch writes that he calls these *cervicalis*.

S. PUNCTICOLLIS Lec. Ouray; Fort Collins; Colorado Springs.

S. MONTICOLA Casey. Colorado, Casey.

S. GARLANDICUS Casey. Garland, Casey.

S. TENEBROSUS Muls. Horsetooth Mountain, August.

S. LACUSTRIS Lec. Garland; Veta Pass; West Cliff; Dome Rock; Dolores; Colorado Springs.

S. ARDELIO Horn. Horsetooth Gulch; vicinity of Fort Collins; Rocky Ford. Possibly these should go to *lacustris*.

S. CINCTUS Lec. Buena Vista; name from Dr. Horn.

S. CONIFERARUM Crotch. Garland; Veta Pass, 10,500 feet; Mountains southwest of Montrose; Rist Cañon, May.

S. OPACULUS Horn. Colorado, Horn.

S. AMERICANUS Muls. Fort Collins, March, April and June.

S. PHELPSII Crotch. Garland; Mountains southwest of Montrose.

S. NAVICULATUS Casey. Colorado, (Rocky Mountains), Casey.

S. COLORADENSIS Horn. Garland, Horn.

S. INTRUSUS Horn. Salida, Wickham.

COCCIDULA OCCIDENTALIS Horn. Fort Collins.

ENDOMYCHIDÆ.

LYCOPERDINA FERRUGINEA Lec. West Cliff.

APHORISTA MOROSA Lec. Pagosa Springs, Hayward; Durango, Bowditch; Horsetooth Gulch; Estes Park; Veta Pass; Ouray; West Cliff; not a common insect.

A. PALLIDA Horn. Colorado, Horn.

EPIPOCUS UNICOLOR Horn. Colorado, Horn.

EROTYLIDÆ.

LANGURIA MOZARDI Lat. Fort Collins, April.

L. LÆTA Lec. Vicinity of Fort Collins, April and June.

L. LECONTEI Crotch. Colorado Springs.

L. DIVISA Horn. Colorado, Horn.

TRITOMA THORACICA Say. Colorado, Snow.

T. CALIFORNICA Lec. Smith's Park, Cockerell; La Veta; Gunnison.

T. FLAVICOLLIS Lec. Colorado Springs, common; Trinidad; Fort Collins; Gunnison; Pagosa Springs; Mountains southwest of Montrose.

EROTYLUS BOISDUVALI Chev. "Usually taken on *Pinus ponderosa* and not taken at an altitude of above 9,000 feet. Abundant in the foothills of the Front Range, not found by Carpenter on the Pacific slope" (Ulke); Custer County, Cockerell; Durango; Pagosa Springs; Chimney Gulch; Dome Rock; Boulder; Fort Collins and vicinity; Stove Prairie; Denver to Georgetown; Clear Creek Cañon and adjacent mountains; Colorado Springs; Pike's Peak, 7,000 to 8,000 feet. Generally found on logs or flying.

COLYDIIDÆ.

DITOMA ORNATA Lec. Trinidad, May, collected from beneath bark of cottonwood log by Professor Gillette.

AULONIUM LONGUM Lec. Colorado, Horn.

BOTHRIDERES MONTANUS Horn. Mountains near San Juan, Horn.

CUCUJIDÆ.

SILVANUS SURINAMENSIS Linn. Fort Collins.

S. PLANATUS Germ. Colorado Springs, one specimen; Trinidad, under bark of cottonwood log, Gillette; Northern Colorado, Gillette.

PEDIACUS FUSCUS Er. Alamosa; Breckenridge; Pike's Peak, 7,000 to 8,000 feet.

P. DEPRESSUS Hbst. Veta Pass, 9,200 feet.

CUCUJUS CLAVIPES Fab. Trinidad, under bark of cottonwood in May, Gillette; Monument Gulch; Mountains southwest of Montrose; Horsefly Peak.

LÆMOPHLÆUS BIGUTTATUS Say. West Cliff.

L. ANGUSTULUS Lec. Colorado, Casey.

DENDROPHAGUS GLABER Lec. Veta Pass, 9,400 feet.

CRYPTOPHAGIDÆ.

TELMATOPHILUS AMERICANUS Lec. Greeley.

ANTHEROPHAGUS OCHRACEUS Melsh. In the Putnam list; I have a specimen from the slope of Pike's Peak, above Manitou, (7,000 to 8,000 feet), which I refer here with very little doubt.

A. CONVEXULUS Lec. Buena Vista; Garland; West Cliff.

EMPHYLUS AMERICANUS Lec. Veta Pass, 11,500 feet.

HENOTICUS SERRATUS Gyll. Garland; Veta Pass, 10,000 feet.

CRYPTOPHAGUS CELLARIS Scop. In the Putnam list with a mark of doubt. Mr. Schwarz took four species at Garland and Veta Pass.

C. CONFERTUS Casey. This and all of the following species belonging to the family are described by Major Casey as coming from Colorado, without citation of definite locality.

C. PORRECTUS Casey.

CÆNOSCELIS OCHREOSA Casey.

C. PARALLELA Casey.

AGATHENGIS CRASSULA Casey.

A. CAPITATA Casey.

A. QUADRICOLLIS Casey.

A. CONSTRICTA Casey.

A. TENEBROSA Casey.

A. COLORADENSIS Casey.

A. LUCIDA Casey.

A. FORTICORNIS Casey.

ATOMARIA EPHIPPIATA Zimm. Colorado. Mr. Schwarz took seven species of this genus at Garland and Veta Pass.

A. INCERTA Casey.

A. BREVICOLLIS Casey.

A. OBLONGULA Casey.

MYCETOPHAGIDÆ.

MYCETOPHAGUS CONFUSUS Horn. This and the following species are recorded by the describer from Colorado, without definite locality.

M. TENUIFASCIATUS Horn.

LITARGUS BALTEATUS Lec. Colorado, Horn.

L. NEBULOSUS Lec. Vicinity of Fort Collins.

HYPOCOPRUS FORMICETORUM Mots. Garland, in doubt.

DERMESTIDÆ.

DERMESTES MARMORATUS Say. Denver; Pueblo; Colorado Springs; Lamar; Fort Collins; West Cliff; Buena Vista; Leadville; Durango; common.

D. MANNERHEIMII Lec. Colorado, Putnam.

D. FASCIATUS Lec. Fort Collins; Trinidad; Mountains southwest of Montrose; La Veta; West Cliff; Buena Vista; Denver.

D. CANINUS Germ. Denver, Ulke; Pueblo, Bowditch. So much confusion exists in the application of names here, that I give the rest of the records that should belong with this species as understood in Henshaw's list, in the original form; *murinus*, Cañon City; *nubilus*, Colorado, (Putnam, Ulke, Leconte,); Pikeview, Cockerell.

D. TALPINUS Mann. Colorado, Putnam; Dome Rock; near Long's Peak; Fort Collins.

D. LARDARIUS Linn. Berkeley; Fort Collins; the variety *signatus* Lec., is known from Durango, (Bowditch), and West Cliff.

PERIMEGATOMA CYLINDRICUM Kirby. Garland; Alamosa; West Cliff.

ATTAGENUS PICEUS Oliv. Colorado Springs; Denver; West Cliff; Pueblo.

TROGODERMA ORNATUM Say. Fort Collins.

T. TARSALE Melsh. Fort Collins.

ANTHRENUS SCROPHULARIÆ Linn. The form known as *lepidus* Lec., is from Garland, Beaver Brook and Colorado Springs; at the last-named place it is often common on flowers. I have taken *flavipes* Melsh., at Ouray. Records for *scrophulariæ* are West Cliff; Fort Collins; Dolores.

A. VERBASCI Linn. Colorado Springs, Hayward.

CRYPTORHOPALUM BALTEATUM Lec. Manitou, Montrose and Dolores, Gillette; Colorado Springs and the adjacent lower slopes of Pike's Peak, common on flowers.

C. HÆMORRHOIDALE Lec. Montrose and Dolores, Gillette; Colorado, Horn.

C. APICALE Mann. This or a closely allied species comes from Fort Collins and vicinity; Mr. Hayward reports it from Colorado Springs.

C. RUFICORNE Lec. Garden of the Gods, Packard.

C. TRISTE Jayne. Vicinity of Fort Collins.

ORPHILUS SUBNITIDUS Lec. Dome Rock; Beaver Creek; Little South; Fort Collins; Colorado Springs; Pike's Peak, lower slopes; South Fork of San Miguel; Ouray; Durango; Georgetown. Common on flowers.

HISTERIDÆ.

HISTER SUBOPACUS Lec. West Cliff.

H. GUTTIFER Horn. Rist Cañon, Titus, April.

H. SELLATUS Lec. Near Ula, Cockerell.

H. INSTRATUS Lec. Lamar; Horsetooth Gulch; vicinity of Fort Collins; Greeley; Berkeley.

H. TUNICATUS Lewis. Cañon City, Lewis, Ann. & Mag. Nat. Hist. 1898, p. 170.

H. ULKEI Horn. Denver; Berkeley; Colorado Springs.

H. HARRISII Kirby. West Cliff; Denver, July, Oslar.

H. MERDARIUS Hoffm. Ouray.

H. FŒDATUS Lec. La Junta, Bowditch.

H. ABBREVIATUS Fab. West Cliff; Greeley; Colorado Springs; La Junta, Hayward; a common species.

H. DEPURATOR Say. Durango and Rico, Bowditch; Cusack Ranch; Buena Vista; not common.

H. FURTIVUS Lec. Durango, Bowditch.

H. PERPLEXUS Lec. Alamosa.

H. LECONTEI Mars. Durango, Bowditch; Fort Collins; Colorado Springs.

H. PUNCTIGER Lec. Durango, Bowditch; Veta Pass, 9,400 feet.

EPIERUS ELLIPTICUS Lec. Pagosa Springs; Upper San Juan. The records come from Mr. Hayward, who marks them with doubt.

HETÆRIUS MORSUS Lec. West Cliff.

H. TRISTRIATUS Horn. Rist Cañon, April; Georgetown, June; Ouray, July. Lives in nests of ants.

ONTHOPHILUS SOLTAUI Casey. Denver, Casey.

PAROMALUS ESTRIATUS Lec. Trinidad, May, under cottonwood bark, Gillette.

P. 14-STRIATUS Steph. Fort Collins, June.

P. DEBILIS Lec. Veta Pass, 9,400 feet.

SAPRINUS LUGENS Er. Denver; Fort Collins; Colorado Springs; Buena Vista; Salida; Beaver Brook Gulch; West Cliff; Trinidad; Pagosa Springs; Durango; Ouray; Montrose; Gunnison; Little Willow Creek; La Junta. A very abundant insect on carrion.

S. PENNSYLVANICUS Payk. Denver; Lamar; Pueblo; Colorado Springs; Greeley; La Junta; Durango.

S. OREGONENSIS Lec. Near Long's Peak; various points in Custer County; Colorado Springs; La Junta; Alamosa; Garland; Buena Vista; Leadville; Horsefly Peak; Monument Gulch; Little Willow Creek; Mountains southwest of Montrose; Durango; Gunnison.

S. CILIATUS Lec. Cañon City; name from Dr. Horn.

S. LARIDUS Lec. La Junta, Bowditch.

S. INSERTUS Lec. Little Willow Creek, Bowditch.

S. LUBRICUS Lec. Montrose and adjacent mountains, Bowditch; Ouray, Gillette; Dolores; Fort Collins; Grand Junction, Wickham.

S. PLENUS Lec. Grand Junction, Wickham; Livermore; Bellevue; La Junta; San Luis Valley; Durango; Mountains southwest of Montrose; Horsefly Peak.

S. FIMBRIATUS Lec. Cusack Ranch, Custer County, Cockerell; Cañon City; Colorado Springs; Buena Vista; Alamosa; Garland; La Junta; Durango; San Luis Valley.

S. SPHÆROIDES Lec. Eastern Custer County, Cockerell.

S. FRATERNUS Say. Garland; several specimens which seem to belong here were taken at Buena Vista and Leadville, in carrion.

S. MANCUS Say. Little Willow Creek, Bowditch.

S. PROFUSUS Casey. Colorado, Casey.

S. DETRACTUS Casey. Greeley, Wickham.

PLEGADERUS TRANSVERSUS Say. Rist Cañon, under pine bark.

P. SAYI Mars. Veta Pass, 9,400 feet.

P. CONSORS Horn. Colorado, Horn.

P. CRIBRATUS Casey. Colorado, Casey.

TERETRIUS AMERICANUS Lec. La Veta; Veta Pass.

T. MONTANUS Horn. Veta Pass.

NITIDULIDÆ

BRACHYPTERUS URTICÆ Fab. La Veta; Garland.

B. GLOBULARIUS Murr. Rico; Gunnison; Placerville; Cañon of Big Blue; Montrose.

CARPOPHILUS PALLIPENNIS Say. La Junta; Gunnison; Montrose; Pueblo; Big Narrows of Poudre; Dolores; Larimer County, foothills; Clear Creek Cañon; Evans Peak region; Durango; Cañon City; Denver; West Cliff; Ula; Buena Vista; Colorado Springs, common in cactus blossoms.

C. DIMIDIATUS Fab. Colorado, Hamilton.

C. NIGER Say. Colorado Springs, Wickham.

C. DISCOIDEUS Lec. Colorado, Putnam.

EPURÆA INTEGRA Horn. Colorado, Horn.

E. ERICHSONII Reitt. Veta Pass. The identification is in doubt, specimens are said to be larger than usual.

E. PAPAGONA Casey. Eastern Custer County, sub-alpine, Cockerell.

E. AVARA Rand. Fort Collins; the name is credited to Mr. Schwarz.

E. LINEARIS Mækl. Veta Pass. 9,400 feet.

E. TRUNCATELLA Mann. Veta Pass; Colorado Springs; Leadville; Dome Rock.

E. PLANULATA Er. Ouray.

E. OVATA Horn. Montrose, June, Gillette, name credited to Dr. Riley; Garland.

E. ÆSTIVA Linn. Colorado, Hamilton.

E. LABILIS Er. West Cliff, on flowers of *Sambucus*.

E. SCAPHOIDES Horn. Colorado, Horn.

NITIDULA BIPUNCTATA Linn. Colorado, Hamilton.

N. RUFIPES Linn. Fort Collins.

N. ZICZAC Say. Fort Collins; Dome Rock; West Cliff; Colorado Springs; Buena Vista; Leadville; Gunnison; Mountains southwest of Montrose; Durango.

PHENOLIA GROSSA Fab. Cañon City, Uhler. A few specimens are said to have been found on plants.

OMOSITA COLON Linn. Fort Collins, common.

O. DISCOIDEA Fab. Veta Pass, 9,200 feet; lower slopes of Pike's Peak.

ORTHOPEPLUS QUADRICOLLIS Horn. Colorado, Horn.

MELIGETHES BRASSICÆ Scop. West Cliff.

M. MUTATUS Har. Vicinity of Fort Collins; Rustic; West Cliff; Colorado Springs; Buena Vista; Garland; La Veta; Dome Rock; Ouray; Leavenworth Valley; not uncommon.

M. SEMINULUM Lec. La Veta; Garland; Veta Pass, 9,000 to 10,000 feet; West Cliff.

PALLODES PALLIDUS Beauv. Cañon of the Arkansas, on plants at entrance, Uhler. If this record is correct it shows a habit unusual to this species.

CRYPTARCHA STRIGATA Fab. Colorado, Hamilton.

IPS QUADRIGUTTATUS Fab. Clear Creek, August, Oslar.

I. VITTATUS Say. Veta Pass, 9,400 feet; also in the Ulke and Putnam lists without definite locality.

PITYOPHAGUS VERTICALIS Horn. Colorado, Horn; eastern Custer County, Cockerell.

RHIZOPHAGUS SCALPTURATUS Mann. Veta Pass, 9,400 feet.

R. DIMIDIATUS Mann. Colorado, Hamilton.

R. BIPUNCTATUS Say. Ouray. This name is probably correct, but there is a chance of error, the specimens not being typical.

LATHRIDIIDÆ.

LATHRIDIUS MONTANUS Fall. Leavenworth Valley, 10,000 feet.

L. COSTICOLLIS Lec. Veta Pass.

ENICMUS MINUTUS Linn. Colorado, Fall.

E. STRENUUS Fall. Ouray.

E. FICTUS Fall. Garland; Veta Pass.

E. MIMUS Fall. Denver.

E. VANUS Fall. Ouray.

E. TENUICORNIS Lec. Ouray.

CARTODERE FILUM Aube. Greeley.

CORTICARIA PUBESCENS Gyll. Fort Collins.

C. VARICOLOR Fall. Garland.

C. PARALLELA Fall. Garland.

C. VALIDA Fall. Garland.

C. PLANULA Fall. Leadville.

C. SERRICOLLIS Lec. Garland; Veta Pass.

C. OCCIDUA Fall. Veta Pass.

C. DENTIGERA Lec. Garland; Breckenridge; Leadville.

C. FERRUGINEA Marsh. Garland; Veta Pass, 9,200 feet.

MELANOPHTHALMA PICTA Lec. Greeley.

M. PUMILA Lec. Garland.

M. AMERICANA Mann. Garland; Veta Pass, 9,200 to 11,000 feet. The records appeared under the names *scissa* and *expansa*, which are reduced by Mr. Fall to synonyms of *americana*.

M. CAVICOLLIS Mann. Colorado, Fall; Garland, Schwarz list, under name *angularis*.

TROGOSITIDÆ.

NEMOSOMA CYLINDRICUM Lec. Dome Rock; Veta Pass, 9,400 feet.

TROGOSITA VIRESCENS Fab. Fort Collins; Dome Rock; Durango.

TENEBRIOIDES MAURITANICA Linn. Durango, Bowditch.

T. CORTICALIS Melsh. Southwestern Colorado, Strecker; Buena Vista; Leadville.

T. SINUATA Lec. Durango, Bowditch.

T AMERICANA Kirby. Cochetopa Pass, Bowditch.

PELTIS PIPINGSKŒLDI Mann. West Cliff; Red Cliff.

P. FERRUGINEA Linn. Engelmann's Cañon; Cochetopa Pass; Cañon of Big Blue; Silver Plume; Leadville; Breckenridge.

CALITYS SCABRA Thunb. Cheyenne Cañon; West Cliff; Cusack's Ranch; Georgetown; Breckenridge; Leadville; above Ouray; Montrose, Gillette; Rico; Durango. Occurs under bark and on woody fungi.

MONOTOMA PICIPES Hbst. Ouray.
M. FULVIPES Melsh. Garland.

BYRRHIDÆ.

CYTILUS SERICEUS Forst. Colorado, Ulke.
C. TRIVITTATUS Melsh. Leadville; Red Cliff; Moose Mountain, 12,000 feet.
BYRRHUS AMERICANUS Lec. Veta Pass, Schwarz.
B. CYCLOPHORUS Kirby. Colorado, Putnam.
B. GEMINATUS Lec. Veta Pass, 9,400 feet.
B. KIRBYI Lec. Mount Lincoln; Leadville.
SYNCALYPTA GRISEA Lec. Garland.
LIMNICHUS MONTANUS Lec. La Veta; an undetermined species is in my cabinet from Buena Vista.

GEORYSSIDÆ.

GEORYSSUS PUSILLUS Lec. Garland.

PARNIDÆ.

DRYOPS STRIATUS Lec. West Cliff and other points in Custer County; Garfield County, Cockerell; below Bridal Veil Falls; Colorado Springs; Manitou; Spring Cañon; Garland; La Veta; Veta Pass; Pagosa Springs; Upper San Juan; Durango. Often exceedingly abundant under stones in running water.
ELMIS CONCOLOR Lec. Colorado Springs, one pair, Wickham. Taken in June.
E. CORPULENTUS Lec. Veta Pass, 9,400 feet; Buena Vista. Mr. Bowditch has a new species from the Upper San Juan.

HETEROCERIDÆ.

HETEROCERUS PALLIDUS Say. La Junta, Bowditch.
H. UNDATUS Melsh. Buena Vista; the form *mollinus* Kies., comes from Ouray. The form *substriatus* is known from Alamosa; Garland; Mountains southwest of Montrose; South Fork of San Miguel.
H. COLLARIS Kies. San Luis Valley; Durango.
H GEMMATUS Horn. Gunnison, Hayward.

DASCYLLIDÆ.

EUCINETUS TERMINALIS Lec. West Cliff.
CYPHON CONCINNUS Lec. Rist Cañon; Horsetooth Gulch.
C. VARIABILIS Thunb. Fort Collins; West Cliff.

ELATERIDÆ.

DELTOMETOPUS AMŒNICORNIS Say. Colorado Springs, June, Wickham.
ANELASTES DRURII Kirby. Pagosa Springs, Oslar; Mountains southwest of Montrose; Upper San Juan; West Cliff; Dome Rock; Wales' Cañon, Pueblo County, Cockerell.
EPIPHANIS CORNUTUS Esch. South Fork of San Miguel, Hayward.

ADELOCERA RORULENTA Lec. Durango, Bowditch.

A. PROFUSA Cand. Garland.

LACON RECTANGULARIS Say. La Junta, common; Fort Collins, March and May; Colorado Springs; Pueblo, Snow.

ALAUS OCULATUS Linn. Poudre Cañon, July; Fort Collins, June.

A. LUSCIOSUS Hope. Southern Colorado, Leconte; La Junta, Hayward.

A. MELANOPS Lec. Cheyenne Cañon, Snow; Durango, Bowditch.

CARDIOPHORUS CONVEXUS Say. Garland, Bowditch; Montrose, Gillette.

C. EDWARDSII Horn. Colorado Springs; Buena Vista, in the evergreen scrub.

C. FENESTRATUS Lec. Greeley; Berkeley; Spring and Dixon Cañons; Little Willow Creek; road from Monument Gulch to Montrose.

C. LONGIOR Lec. Garland, Blanchard, Tr. Am. Ent. Soc., XVI, p. 16.

C. PULLUS Blanch. Garland, Blanchard, t. c. p. 11.

C. LURIDIPES Cand. Garland.

C. TENEBROSUS Lec. Ouray; Rist Cañon; Horsetooth Gulch; Smith's Park Gulch, 10,000 to 12,000 feet, Cockerell; Colorado Springs. Specimens which seem to belong to a small variety of this species have been taken in the neighborhood of Fort Collins.

C. PUBESCENS Blanch. Colorado, Blanchard.

CRYPTOHYPNUS IMPRESSICOLLIS Mann. Colorado, rare, Horn; Horsefly Peak, Bowditch.

C. ABBREVIATUS Say. Garland, Bowditch; Dolores, Gillette; Red Cliff; Ouray; Georgetown; South Fork of San Miguel; Rico.

C. NOCTURNUS Esch. Under this name we have the following records;—Leadville; Durango; Red Cliff; Little Willow Creek; Mountains south-west of Montrose. For *bicolor* the localities are, Breckenridge; Leadville; Buena Vista; Colorado Springs; Pike's Peak, 10,000 to 11,000 feet; Veta Pass; Garland; South Fork of San Miguel; Roaring Fork; Leavenworth Valley; Georgetown; Alma; Aspen; Marshall Pass.

C. MUSCULUS Esch. Argentine Pass, Bowditch.

C. TUMESCENS Lec. Leavenworth Valley; Silver Plume; Leadville; Breckenridge.

C. STRIATULUS Lec. La Junta; Gunnison. Both records are from Mr. Hayward.

C. EXIGUUS Rand. Trinidad, Gillette.

C. GENTILIS Lec. Alamosa; Garland.

ŒDOSTETHUS FEMORALIS Lec. Colorado, Horn.

MONOCREPIDIUS VESPERTINUS Fab. Near the Grand Cañon of the Arkansas, Uhler.

M. SORDIDUS Lec. Cañon City, Wickham.

M. AURITUS Hbst. Colorado, Horn; Trinidad and northern Colorado, Gillette.

ELATER RUBRIVENTRIS Lec. Rist Cañon, Gillette.

E. ATER Lec. Little Willow Creek, Hayward; Manitou.

E. MIXTUS Hbst. Colorado, Snow.

E. MŒRENS Lec. Colorado, Hayward; a specimen from the state is in my own cabinet.

E. luctuosus Lec. Rist Cañon, May, Gillette.

E. apicatus Say. Breckenridge; Leadville; Durango; Rist Cañon; Leavenworth Valley; Veta Pass; Little Willow Creek; Ouray.

E. affinis Lec. South Fork of San Miguel, Bowditch.

Drasterius elegans Fab. Durango; La Junta; Little Willow Creek; Colorado Springs; Berkeley; vicinity of Fort Collins; Montrose.

Megapenthes stigmosus Lec. West Cliff.

Agriotes fucosus Lec. Fort Collins.

A. montanus Lec. Vicinity of Fort Collins.

Dolopius lateralis Esch. Horsefly Peak; Little Willow Creek; Chimney Gulch; Berkeley; Horsetooth Gulch; Ouray; Pagosa Springs; Garland; Rico; Cañon City. It was also taken by Cockerell on the eastern slope of the Sangre de Cristo range along Brush Creek, at an elevation of 10,000 to 11,000 feet.

Melanotus decumanus Er. Southern Colorado, Leconte.

M. fissilis Say. Berkeley, June.

M. scrobicollis Lec. Rist Cañon, May.

M. paradoxus Melsh. Colorado, Cockerell.

Limonius californicus Mann. Colorado, determined by Mr. Liebeck. A species allied to this was taken at Bellevue.

L. canus Lec. Vicinity of Fort Collins, April to June.

Athous ferruginosus Esch. West Cliff; Micawber Mine, Cockerell; Leavenworth Valley.

A. simplex Lec. Colorado, Leconte; Leadville and Breckenridge, beaten from foliage of conifers.

A. cribratus Lec. Southern Colorado, Leconte.

Corymbites maurus Lec. Cañon City; Pagosa Springs; Little Beaver to Cipango, Gillette.

C. monticola Horn. Horsetooth Gulch; Rist Cañon, May.

C. mœrens Lec. Garland; Veta Pass.

C. morulus Lec. Colorado.

C. fallax Say. Rist Cañon, May; Fort Collins, June.

C. planulus Lec. Beaver Brook, Leconte; Buena Vista; Colorado Springs.

C. triundulatus Rand. Garland; Mountains southwest of Montrose.

C. nigricollis Bland. Rocky Mountains, Colorado, Bland.

C. hieroglyphicus Say. Cañon of Big Blue; Horsefly Peak Divide; Placerville; South Fork of San Miguel; Ouray; Mineral Point Trail, 9,000 to 10,000 feet; Golden.

C. semivittatus Say. Fort Collins and Poudre Cañon, May.

C. æripennis Kirby. Mountains southwest of Montrose; Veta Pass; Silver Plume; Golden.

C. carbo Lec. West Cliff; Horsefly Peak; Rist Cañon, June.

C. conjungens Lec. West Cliff.

C. leucaspis Germ. Veta Pass, Bowditch.

C. metallicus Payk. Garland; Veta Pass, 9,200 to 9,400 feet.

C. inflatus Say. Vicinity of Fort Collins, May, June and August; Mr. Schwarz records the form *glaucus* from Veta Pass, 9,400 feet.

ANTHRACOPTERYX HIEMALIS Horn. West Cliff, common, crawling on the ground early in the year; Northern Colorado, February, Gillette.

ASAPHES CARBONATUS Lec. West Cliff; Durango; Rico road; South Fork of San Miguel; Dome Rock; Golden.

A. DILATICOLLIS Mots. Colorado, Hayward. Also in my own collection.

A. DECOLORATUS Say. Professor Snow records two specimens of a variety of this species from Colorado.

A. MEMNONIUS Hbst. La Junta, Bowditch; Wales' Cañon, Pueblo County, Cockerell.

MELANACTES PICEUS DeGeer. La Junta, Hayward.

M. PUNCTICOLLIS Lec. La Junta, Bowditch.

BUPRESTIDÆ.

GYASCUTUS OBLITERATUS Lec. Delta, on *Sarcobates vermiculatus*, Gillette.

CHALCOPHORA ANGULICOLLIS Lec. Fort Collins; Estes Park; Rio Grande, Ulke; Durango, Bowditch.

C. VIRGINIENSIS Drury. Cusack Ranch, Cockerell.

PSILOPTERA DRUMMONDI Lap. & Gory. West Las Animas, Hayward.

DICERCA PROLONGATA Lec. Denver; Idaho Springs, on *Populus*, Packard; Horsefly Peak; Short Creek, Custer County; Prof. Cockerell took a larva which presumably belongs here in logs of *Populus tremuloides*.

D. DIVARICATA Say. Vicinity of Fort Collins, April to August.

D. TENEBROSA Kirby. Colorado, Snow; Leadville.

D. CALIFORNICA Crotch. A specimen from Colorado, in the collection of the Agricultural College, is labelled thus with a mark of doubt. The determination is credited to Mr. Schwarz.

TRACHYKELE LECONTEI Gory. Garland.

PŒCILONOTA CYANIPES Say. Denver; La Junta; Horsefly Peak Divide; Durango, Bowditch; Fort Collins and vicinity; Ouray; Leadville; Colorado Springs. I have taken this species on poplars.

BUPRESTIS CONFLUENS Say. Gunnison; Fort Collins; Ouray; Pueblo, Snow; Fort Garland, Ulke.

B. CONSULARIS Gory. Dome Rock; Colorado Springs; Buena Vista; Leadville; Little Beaver.

B. NUTTALLI Kirby. Florissant; Durango; Cusack Ranch, Cockerell; Dome Rock.

B. MACULIVENTRIS Say. Pass between Wheeler and Red Cliff, Cockerell; Dome Rock; Engelmann's Cañon; Cusack Ranch; Beaver Brook Gulch; Upper San Juan; Florissant; a rather common species, often found out of its natural range on account of shipments of lumber in which it breeds. The form *subornata* is known from Greenhorn; Durango; Buena Vista; Colorado Springs and Leadville. For the name *rusticorum* we have Packard's record, Manitou, and several which refer simply to its being found in the state.

B. FASCIATA Fab. Little Willow Creek. The form known as *langii* comes from Denver; Arkins; Steamboat Springs; and Bear Creek Cañon.

B. AURULENTA Linn. Ouray; Leadville; Fort Collins.

B. ADJECTA Lec. Colorado Springs; Leadville.

MELANOPHILA MIRANDA Lec. Southern Colorado, Leconte.

M. ACUMINATA De Geer. Leadville; Breckenridge; Rico; Montclair; West Cliff; Chaffee and Summit Counties, Cockerell; Garland; South Park, Ulke.

M. ATROPURPUREA Say. Clearwater Creek on the Grand Mesa, 9,800 feet, Cockerell; Rico; Upper San Juan; Durango; Garland; Gunnison; South Park Region, Oslar; Fort Collins; Denver; Colorado Springs.

M. DRUMMONDI Kirby. Leavenworth Valley, 10,000 to 11,000 feet; Ouray; Durango; Monument Gulch to Montrose, 7,900 feet; Rico; Upper San Juan; Dome Rock; Garland; Buena Vista; Leadville.

M. GENTILIS Lec. Durango; Horsefly Peak; Mountains southwest of Montrose, 9,000 to 10,000 feet; Dome Rock.

ANTHAXIA ÆNEOGASTER Lap. Dome Rock; Dolores; Horsetooth Gulch and other points in the vicinity of Fort Collins; near Boulder; Upper San Juan; South Fork of San Miguel; Durango, Oslar; Ouray; Colorado Springs; Pike's Peak, 7,000 to 8,000 feet. A common species on various wild flowers.

A. DELETA Lec. Durango, Bowditch.

A. VIRIDIFRONS Lap. Cañon of Big Blue.

CHRYSOBOTHRIS FEMORATA Fab. Colorado Springs; Horsefly Peak.

C. CUPRASCENS Lec. Colorado, Horn.

C. IGNICOLLIS Horn. Buena Vista; Placerville.

C. SPECULIFER Horn. Colorado, Horn; Montrose, Bowditch.

C. DENTIPES Germ. Horsefly Peak; Durango, Oslar; Ouray; Pagosa Springs; Florissant; Colorado Springs; Buena Vista; Dome Rock; a common species.

C. LUDIFICATA Horn. Colorado, Horn; Rico; Durango; Horsefly Peak; Little Willow Creek; Mountains southwest of Montrose; Pagosa Springs; all of the above localities were furnished by Hayward and Bowditch.

C. TRINERVIA Kirby. Cañon of Big Blue; Florissant; Salida, Oslar; Micawber Mine, Cockerell; The Divide, (on the railroad), Packard; Leavenworth Valley, 8,000 to 10,000 feet, Bowditch; Colorado Springs; Buena Vista.

C. CAURINA Horn. Little Willow Creek; Rico; Florissant; Leavenworth Valley; Leadville.

C. CARINIPENNIS Lec. Colorado Springs; Durango; Rico; Florissant.

C. SCABRIPENNIS Lap. Rico; Leavenworth Valley, Bowditch.

C. TEXANA Lec. Colorado, Horn.

C. MALI Horn. Colorado, Horn.

C. ÆNEOLA Lec. Cañon of Big Blue, Hayward.

C. ATROFASCIATA Lec. La Junta, Bowditch.

ACMÆODERA MILIARIS Horn. Colorado, Snow.

A. SPARSA Horn. Durango, Oslar; Manitou, Horn; near Colorado Springs, Wickham.

A. ORNATA Fab. Colorado, Hayward; common near base of mountains, Snow.

A. VARIEGATA Lec. Colorado, Leconte; also recorded from the state by Fall.

A. PULCHELLA Hbst. Spring Cañon; The Rustic; La Porte; Clear Creek Cañon, Gillette; Poncha Springs, Oslar; La Junta and Montrose, Hayward; Durango, Bowditch; Dome Rock; Colorado Springs, abundant on Compositæ and *Geranium*, June and July. The form *mixta* is recorded from Manitou and Garden of the Gods, Packard; Pueblo, Snow; Morrison, Oslar.

A. QUADRIVITTATA Horn. Colorado, Bowditch.

CHRYSOPHANA PLACIDA Lec. Dome Rock, Snow.

AGRILUS LATERALIS Say. Colorado Springs, one specimen, answering the description except in size, which reaches .36 inch. It is probably of the same form as the New Mexican specimen mentioned by Horn as occurring in the Ulke cabinet.

A. NIVEIVENTRIS Horn. Colorado Springs, one female. The specimen is in perfect condition and agrees exactly with the description; the recorded range is western Nevada and southern California.

A. ANXIUS Gory. West Cliff; Horsefly Peak; Colorado Springs.

A. PULCHELLUS Bland. Colorado, Horn.

A. POLITUS Say. North Park; Little Beaver; Montrose, Gillette; Berkeley; Alamosa; Garland; Veta Pass; Red Mountain Road; Pueblo, Ulke; Gunnison; Little Willow Creek; San Juan Valley; South Fork of San Miguel; Colorado Springs; Leadville; a common species, infesting willows and poplars.

A. OBSOLETEGUTTATUS Gory. Colorado, Snow.

A. LACUSTRIS Lec. Bellevue; Colorado Springs.

A. PUSILLUS Say. Colorado, Horn.

TAPHROCERUS GRACILIS Say. Greeley; Fort Collins; Colorado Springs; near Denver, Uhler.

BRACHYS ÆROSA Melsh. Colorado, Snow; Durango, Oslar.

LAMPYRIDÆ.

RHYNCHEROS SANGUINIPENNIS Say. Stove Prairie Gulch; Little South, July; Ouray; Red Mountain Road; Pagosa Springs, June, Oslar; La Veta; Manitou, Snow; Colorado Springs, Wickham.

LYCOSTOMUS LATERALIS Melsh. Colorado, Bowditch.

L. FULVELLUS Lec. Colorado Springs, one specimen, Wickham.

CALOPTERON TERMINALE Say. Colorado, Ulke; Fort Collins, August.

C. RECTICULATUM Fab. Colorado, Bowditch.

CÆNIA AMPLICORNIS Lec. Colorado, Snow; the record is by Dr. Leconte, Tr. Am. Ent. Soc., 1881, p. 22.

EROS AURORA Hbst. Rist Cañon; Ironton, Gillette; West Cliff.

PLATEROS TIMIDUS Lec. Vicinity of Durango, Hayward.

P. FLORALIS Melsh. Dolores, June.

LYGISTOPTERUS RUBRIPENNIS Lec. Pagosa Springs, Hayward and Oslar; Dome Rock; occurs from June to August.

CALOCHROMUS FERVENS Lec. Colorado, Leconte.

C. RUFICOLLIS Lec. Upper San Juan; Pagosa Springs; Cochetopa Pass.

ELLYCHNIA FLAVICOLLIS Lec. Colorado, Leconte.

E. CALIFORNICA Mots. Vicinity of Pagosa Springs, Hayward.

E. CORRUSCA Linn. Northern Colorado, Gillette; West Cliff; Dome Rock; Garland; Veta Pass; I have a specimen from Colorado Springs, which is nearly intermediate between this and *californica*.

PYROPYGA FENESTRALIS Melsh. Ula, Cockerell; Nathrop; Denver; Fort Collins; Chimney Gulch; Colorado Springs; Buena Vista; Horsefly Peak Divide; San Luis Valley; Montrose; Durango.

P. NIGRICANS Say. Reported from Colorado by Leconte, Horn and Snow.

PYRACTOMENA BOREALIS Rand. West Cliff; Cusack Ranch, May and June.

P. LUCIFERA Melsh. Colorado, Ulke.

PHOTINUS PYRALIS Linn. Near Denver, August, not abundant, Uhler.

MICROPHOTUS ANGUSTUS Lec. Colorado, Putnam.

PHOTURIS PENNSYLVANICA De Geer. Fort Collins, July; not uncommon at Ouray, flying after dusk.

CHAULIOGNATHUS LIMBICOLLIS Lec. Colorado, Leconte.

C. BASALIS Lec. Golden and Denver, Oslar; Pleasant Valley, Fremont County, Cockerell; near West Cliff; Livermore; vicinity of Fort Collins; Garland, Bowditch; Upper San Juan; West Las Animas; Bijou; Colorado Springs; Cañon City. A common species in August and September.

C. PENNSYLVANICUS De Geer. La Junta, Wickham; Boulder and Durango, Oslar; Palmer Lake.

PODABRUS sp. near *quadratus* Lec. Ouray.

P. sp. near *modestus* Say. Rico.

P. TOMENTOSUS Say. Mountains southwest of Montrose.

P. BREVIPENNIS Lec. Argentine Pass, 13,000 feet, Bowditch.

P. PINIPHILUS Esch. Cañon of Big Blue; Summitville; Little Beaver; Stove Prairie; Little South.

P. LATERALIS Lec. Little Willow Creek; Rico; Durango; South Fork of San Miguel; Mountains southwest of Montrose; Pike's Peak, 10,000 to 11,000 feet; South Park region, Oslar; Ouray; Red Mountain Road; Silver Plume; Leavenworth Valley; Georgetown; Brush Creek, Custer County, Cockerell, 10,000 to 12,000 feet; Peak Eight, above timber; Breckenridge; Leadville; Fort Collins; Stove Prairie; Little South; West Cliff; Dolores; Little Beaver; Argentine Pass; Garland; Veta Pass. A common species, chiefly confined to the higher altitudes.

P. LÆVICOLLIS Kirby. Over 12,000 feet, Carpenter; Roaring Fork.

SILIS MUNITA Lec. Boulder, Gillette; Fort Collins and vicinity; Chimney Gulch; West Cliff; Garland.

S. DIFFICILIS Lec. West Cliff; Mountains southwest of Montrose.

S. PERCOMIS Say. Lamar; Dixon Cañon.

TELEPHORUS FRAXINI Say. Fort Collins; Berkeley; Colorado Springs; Bear Creek Cañon, Evans' Peak region, Oslar; Garland; La Veta.

T. LINEOLA Fab. Denver; Fort Collins; June and July.

T. RECTUS Melsh. Buena Vista; the identity is in some doubt.

T. FLAVIPES Lec. Fort Collins and vicinity.

T. ruficollis Lec. Cañon of Big Blue; Little Willow Creek; Rico; Montrose; La Veta.

T. fidelis Lec. Dolores; Colorado, Snow.

T. alticola Lec. Garland.

T. bilineatus Say. On grass and weeds near mouth of the Cañon of the Arkansas, Uhler.

Polemius platyderus G. & H. Cañon of Big Blue.

Malthodes concavus Lec. Colorado, Bowditch.

M. furcifer Lec. Veta Pass. Specimens from La Veta, (Bowditch) and Leadville, (Wickham) are referred to this species with some doubt.

MALACHIDÆ.

Collops tricolor Say. Colorado, Horn.

C. punctatus Lec. Vicinity of Fort Collins, May to July; Dolores.

C. eximius Er. Dome Rock; Upper San Juan; Durango; with doubt, Garland; Alamosa; La Veta.

C. nigriceps Say. Colorado Springs. Closely allied or identical forms come from the South Park, (Oslar) and from Dolores.

C. cribrosus Lec. South Park, Ulke; over 12,000 feet, Carpenter; state records are in the Putnam list and Ulke's Hayden report.

C. hirtellus Lec. Durango, Oslar; Mount Lincoln; Pike's Peak; Red Mountain Road, 8,000 to 9,000 feet; Montrose, Gillette. A new species allied to *hirtellus* is reported from Alamosa, and another (or the same?) from Little Willow Creek and Cimarron, (Bowditch).

C. bipunctatus Say. Nathrop; Montclair; Fort Collins; Trinidad, Gillette; Cañon City; Colorado Springs; Buena Vista. A common species, often seen in great numbers on Compositæ during the late summer.

C. quadrimaculatus Fab. Dolores; La Junta; near Cañon City, common on sunflowers, August 10, Ulke.

C. limbellus G. & H. Colorado, Horn.

C. vittatus Say. Fort Collins; Bellevue; West Cliff; Alamosa; Garland; Mr. Schwarz took a form which was thought to be either new or a variety of this at Alamosa.

Trophimus æneipennis Horn. Colorado, Horn.

Malachius montanus Lec. Alamosa; Garland; La Veta; South Fork of San Miguel; West Cliff; Dolores; Fort Collins. Occurs in June and July.

Microlipus lævicollis Horn. South Fork of San Miguel; Mountains southwest of Montrose.

Anthocomus erichsonii Lec. Fort Collins; Manitou; Dolores; May and June.

A. flavilabris Say. Mountains southwest of Montrose.

Pseudebæus apicalis Say. La Junta, Bowditch. An undetermined species of this genus was taken at Colorado Springs.

P. obscurus Lec. Garland.

Attalus basalis Lec. Upper San Juan; Garland.

A. MORULUS Lec. Cañon City, Wickham; Colorado Springs; Alamosa; Garland; Buena Vista; Pike's Peak, 7,000 to 8,000 feet; Dome Rock; Red Mountain Road, 9,000 to 10,000 feet.

A. NIGRIPES Horn. Colorado, Horn.

A. CINCTUS Lec. Colorado, Horn. A specimen in the Agricultural College collection marked "*cinctus* det. Riley" differs from the description in not having a yellow abdomen and in the elytra being broadly margined with yellow.

TRICHOCHROUS SPARSUS Casey. Colorado, Casey.

T. ANTENNATUS Mots. This name occurs in the Packard list as from Golden. I have also seen a number from Montrose with this label but it is doubtful where they would go by Major Casey's revision. His understanding of Motschulsky's species is different from that of Dr. Leconte.

T. INÆQUALIS Casey. Colorado, Casey.

T. FUNEBRIS Casey. Colorado, Casey.

T. TEXANUS Lec. Southern Colorado, Leconte.

T. ÆNESCENS Lec. Upper San Juan, Bowditch.

CRADYTES SERRICOLLIS Lec. Trinidad and Rocky Ford, Gillette; taken in September.

C. SERRULATUS Lec. San Luis Valley, Bowditch.

LISTRUS INTERRUPTUS Lec. Fort Collins; Steamboat Springs.

L. SENILIS Lec. Southern Colorado, Leconte; Durango; Cochetopa Pass; Florissant; Cañon City; Colorado Springs; West Cliff; Eastern Custer County, Cockerell; Buena Vista; Estes Park Toll Road; Fort Collins; Steamboat Springs. Common and widely distributed over the state.

L. LUTEIPES Lec. Vicinity of Fort Collins; Dolores.

L. RUBRIPES Casey. Colorado, Casey.

DASYTELLUS NIGRICORNIS Bland. Southern Colorado, Leconte; this or an allied species occurs at Dolores and Ouray.

DASYTES HUDSONICUS Lec. North Park; Timber line above Smith's Park Gulch, Custer County, Cockerell; Garland; Veta Pass; Leadville, not uncommon on the foliage of dwarf pines; Breckenridge; Mountains southwest of Montrose; Upper San Juan; Little Willow Creek.

D. OBTUSUS Casey. Colorado, Casey.

D. BREVIUSCULUS Mots. The name occurs in the Putnam list. This is not the species to which Casey applies Motschulsky's name, as he does not follow Leconte in his identification.

DASYTASTES RUFICOLLIS Ulke. Colorado, Bowditch.

ESCHATOCREPIS CONSTRICTUS Lec. Montrose, Bowditch.

PSEUDALLONYX PLUMBEUS Lec. Beaver Brook; South Fork of San Miguel.

DOLICHOSOMA FOVEICOLLE Kirby. North Park; Steamboat Springs.

EURELYMIS ATRA Lec. Beaver Brook.

MECOMYCTER OMALINUS Horn. Colorado Springs, June.

CLERIDÆ.

CYMATODERA MOROSA Lec. Between Aztec, New Mexico and Durango, Colorado, Bowditch; possibly not taken in this state.

TRICHODES ORNATUS Say. West Cliff and vicinity, common on various flowers; Dillon; South Park; Poncha Springs; Durango; Ouray; Red Mountain Road; Upper San Juan; Little Willow Creek; Cañon of Big Blue; Mountains southwest of Montrose; South Fork of San Miguel; Colorado Springs; Buena Vista; Leadville; Breckenridge; Denver; Fort Collins; Boulder; Stove Prairie; Georgetown; Leavenworth Valley; Silver Plume; Micawber Mine; Beaver Brook; Dome Rock; Garland; La Veta; more abundant at high altitudes.

T. NUTTALLI Kirby. Golden, Packard; Boulder, Gillette; Dome Rock.

CLERUS SPINOLÆ Lec. Durango, Hayward.

C. ANALIS Lec. Colorado, in flowers of prickly pear, Putnam; La Junta, Bowditch.

C. QUADRIGUTTATUS Oliv. Garland; Veta Pass, 9,400 feet; Lamar.

C. ABRUPTUS Lec. Fort Collins, June to August; Chimney Gulch; Poncha Springs; La Junta; Colorado Springs; Durango.

C. CORDIFER Lec. Fort Collins, July and August; Morrison, Oslar; Colorado Springs; southern Colorado, Leconte.

C. NIGRIVENTRIS Lec. Buena Vista and Leadville, running on lumber piles in July; Little Willow Creek; Mountains southwest of Montrose; Florissant.

C. SPHEGEUS Fab. Leadville; West Cliff; Beaver Brook, not common.

C. MŒSTUS Klug. Ouray; Durango; Little Willow Creek; Buena Vista, on lumber piles; Montrose, Gillette; Florissant.

THANASIMUS UNDULATUS Say. Little Beaver; Dome Rock; Veta Pass, 9,200 to 11,500 feet; Breckenridge; Leadville; Rico; often found running in the sunshine on piles of lumber.

HYDNOCERA UNIFASCIATA Say. Rocky Ford, Gillette.

H. SUBFASCIATA Lec. Vicinity of Fort Collins; The Rustic; Big Narrows of Poudre; Bellevue; Colorado Springs; Buena Vista; Mount Lincoln, 10,000 to 13,000 feet; Garland; La Veta; Alamosa; Durango; Rico. Occurs from June to August.

H. SUBÆNEA Spin. Colorado, Horn.

H. HUMERALIS Say. Vicinity of Fort Collins; Colorado Springs; Cañon City; Durango; Mountains southwest of Montrose. Not usually common, occurs from June to August.

H. CYANESCENS Lec. Upper San Juan.

H. DIFFICILIS Lec. Mount Lincoln, Bowditch.

H. PUBESCENS Lec. Colorado, Putnam.

H. SCABRA Lec. Upper San Juan; Durango; Alma.

H. PEDALIS Lec. Spring Cañon; Rist Cañon; March and July.

H. LONGICOLLIS Ziegl. Fort Collins, July, Baker.

NECROBIA RUFIPES Fab. Pikeview, El Paso County, Cockerell.

N. VIOLACEA Linn. West Cliff; Florissant; La Junta; Colorado Springs; Buena Vista; Breckenridge; Leadville; Durango; Montrose; Ouray; Fort Collins; Dolores; Manitou; Garland; La Veta; a very common species on drying carrion.

PTINIDÆ.

Ernobius tristis Lec. Veta Pass, 9,200 feet.

E. gracilis Lec. Garland.

Xestobium squalidum Lec. North Park, July, Gillette.

Oligomerus sericans Melsh. Dome Rock.

Gastrallus marginipennis Lec. Garland.

Trypopitys punctatus Lec. Buena Vista.

Xyletinus fucatus Lec. Veta Pass, 9,400 feet; Pike's Peak, 8,000 to 9,000 feet, one specimen by beating.

X. lugubris Lec. Colorado.

Cænocara oculata Say. North Park, July, Gillette.

Amphicerus bicaudatus Say. Catlin; Denver; Fort Collins; Rocky Ford. Depredates on apple twigs. The dates run from February to June.

Dinoderus substriatus Payk. Garland; Veta Pass, 9,400 feet; Colorado Springs; Durango; Leavenworth Valley.

D. pacificus Casey. Colorado, Casey.

D. cribratus Lec. Boulder, Packard.

D. pusillus Fab. Fort Collins, from rice purchased in Chicago.

Lyctus planicollis Lec. Colorado, Horn; and with doubt, Veta Pass, 9,400 feet.

CIOIDÆ.

Cis striolata Casey. Salida.

Ennearthron thoracicornis Ziegl. Fort Collins, bred in cage. February.

SPHINDIDÆ.

Sphindus crassulus Casey. Buena Vista.

LUCANIDÆ.

Lucanus mazama Lec. Southern Colorado, Leconte; Durango, Oslar.

Platycerus depressus Lec. Delta County, Cockerell; Rist Cañon; Horsefly Peak; Ouray; not uncommon in July.

Ceruchus punctatus Lec. Colorado, Leng and Beutenmueller.

SCARABÆIDÆ.

Canthon ebenus Say. Denver, Packard; La Junta, Hayward.

C. praticola Lec. La Junta, Bowditch; Colorado Springs; Fort Collins and vicinity, April to June; West Cliff; Garland.

C. simplex Lec. Specimens of the form *corvinus* are reported from Colorado by Mr. Blanchard; I took this variety at Ouray.

C. vigilans Lec. Colorado, Ulke and Blanchard.

C. lævis Drury. Hilly region west of Denver, Uhler; Berkeley; Fort Collins, April and June; Pueblo.

Phanæus carnifex Linn. State records are given in several lists but the only definite localities that can be cited are Greenhorn and Fort Collins.

Onthophagus hecate Panz. Lamar; Fort Collins and vicinity; La Junta; Colorado Springs; Pueblo; Cañon City.

O. JANUS Panz. Cañon City, Wickham.

ÆGIALIA RUFESCENS Horn. Ouray; Veta Pass, 9,400 feet.

Æ. LACUSTRIS Lec. Argentine Pass; Rico; Garland; La Veta; Veta Pass, 9,200 feet; Buena Vista. What seems to be a smaller form of the same species was taken on Peak Eight, in the Ten Mile Range, at an altitude of about 12,000 feet.

RHYSSEMUS SCABER Hald. Greeley; vicinity of Fort Collins, March, April and June.

R. SONATUS Lec. Cañon City, Wickham.

ATÆNIUS ABDITUS Hald. Cañon City, Wickham.

A. WENZELII Hald. Colorado? Horn. The locality is cited as open to doubt.

APHODIUS VALIDUS Horn. Durango, Bowditch, in doubt.

A. HAMATUS Say. Buena Vista; Garland, (as *omissus*); Alamosa, (as *torpidus*).

A. DENTICULATUS Hald. Fort Collins; Bellevue; Placerville; Buena Vista; Cañon City; Greeley.

A. BIDENS Lec. Veta Pass, over 9,000 feet; Garland.

A. FIMETARIUS Linn. Durango, July, Oslar; Berkeley.

A. CONGREGATUS Mann. Leavenworth Valley, 10,000 to 11,000 feet; Rist Cañon.

A. ALEUTUS Esch. Leavenworth Valley, 10,000 to 11,000 feet; Alma; Argentine Pass; Moose Mountain, 11,500 to 12,000 feet; Summitville; Upper San Juan.

A. FŒTIDUS Fab. Leavenworth Valley, 10,000 to 11,000 feet.

A. DUPLEX Lec. Colorado, Horn.

A. RURICOLA Melsh. Colorado Springs.

A. ANTHRACINUS Lec. Red Mountain Road, 9,000 to 10,000 feet; Ouray.

A. GRANARIUS Linn. La Junta; Rico; West Cliff; Fort Collins and vicinity; Trinidad; Greeley; Cañon City; Berkeley.

A. VITTATUS Say. Hayden's, Lake County, Cockerell; West Cliff; Cimarron; Rico; Montrose; Durango; Garland; Colorado Springs; Buena Vista; Leadville; Peak Eight; Moose Mountain; Greeley; Fort Collins and vicinity; Berkeley; Georgetown; Leavenworth Valley; Argentine Pass; Ouray. This is the commonest species of the genus in Colorado, and ranges from the lower altitudes of the eastern part of the state to the peaks above timber line.

A. LIVIDUS Oliv. Hardscrabble district, Custer County, Cockerell.

A. OBTUSUS Lec. Colorado, Horn.

A. ALTERNATUS Horn. Durango; Gunnison; Little Willow Creek; Alamosa; Garland; West Cliff.

A. EXPLANATUS Lec. Rico Road; Garland; West Cliff.

A. RUDIS Lec. Dome Rock.

A. PHÆOPTERUS Lec. Moose Mountain, 11,500 to 12,000 feet.

A. BREVICOLLIS Lec. West Cliff.

A. MARGINATUS Lec. West Cliff.

A. RUBEOLUS Beauv. La Junta, Bowditch.

A. CONCAVUS Say. Colorado, Horn; Fort Collins.

A. COLORADENSIS Horn. Durango; Garland; Monument Gulch to Montrose; Colorado Springs, June and July.

A. INQUINATUS Hbst. Argentine Pass, Bowditch.

A. PUMILUS Horn. South of Durango, Bowditch. Mr. Hayward reports it from Aztec, New Mexico, twenty miles south of the Colorado line.

A. TERMINALIS Say. Argentine Pass; Mount Lincoln.

A. CRUENTATUS Lec. Upper San Juan; Rico Road; Durango; La Junta; Veta Pass; West Cliff.

A. SCABRICEPS Lec. Dixon Cañon, April; Durango, July, Oslar.

A. SUBTRUNCATUS Lec. Colorado, Horn.

A. FEMORALIS Say. Summitville, Hayward.

A. OBLONGUS Say. Colorado, Horn.

OCHODÆUS SIMPLEX Lec. Fort Collins, May and June; Little South, July; Manitou, April, Gillette.

O. BIARMATUS Lec. Greeley, Wickham.

O. MUSCULUS Say. Denver, May; Fort Collins, June.

O. SPARSUS Lec. Colorado, Horn.

BOLBOCERAS LAZARUS Fab. Southern Colorado, Leconte; Fort Collins, June and July; Greeley.

ODONTÆUS OBESUS Lec. Veta Pass; Buena Vista, one male. The occurrence of this species in the Rocky Mountains is interesting as it is otherwise Pacific in distribution.

TROX SCUTELLARIS Say. Pueblo, Bowditch; La Junta, Hayward.

T. SCABROSUS Beauv. Lamar.

T. SUBEROSUS Fab. Pueblo; Fort Collins and vicinity.

T. PUNCTATUS Germ. Lamar; vicinity of Colorado Springs; Fort Collins; La Junta; Denver; a common form in the Southwest.

T. TUBERCULATUS De Geer. Vicinity of Fort Collins.

T. GEMMULATUS Horn. Durango, Hayward.

T. SONORÆ Lec. South Park region, Oslar; Florissant; Buena Vista; West Cliff; Durango.

T. UNISTRIATUS Beauv. Colorado Springs.

T. ATROX Lec. Near Long's Peak, Leconte; Fort Collins; Greeley.

HOPLIA LATICOLLIS Lec. Southern Colorado, Leconte.

DICHELONYCHA BACKII Kirby. Vicinity of Fort Collins; near Brush Creek, 10,000 to 12,000 feet, Cockerell; Southern Colorado, Leconte; Garland; Veta Pass; common at times.

D. TRUNCATA Lec. Durango, Oslar; Placerville; South Fork of San Miguel; Mountains southwest of Montrose.

D. SULCATA Lec. Chimney Gulch, June; Fort Collins, May; Garland; Veta Pass, 9,100 feet.

SERICA VESPERTINA Gyll. Horsetooth Gulch, May; Greeley; Colorado, without definite record, Horn and Snow. Specimens which may belong here were taken at Buena Vista and Colorado Springs.

S. SERICEA Ill. Southern Colorado, Leconte.

S. CURVATA Lec. Southern Pueblo County, Cockerell.

S. FRONTALIS Lec. Fort Garland, Ulke; specimens with this label are in the Agricultural College collection, the determination being credited to Schwarz.

S. very near *trociformis* Burm. Buena Vista; differs from eastern specimens of *trociformis* in the weaker sculpture.

MACRODACTYLUS SUBSPINOSUS Fab. Colorado, Riley, Insect Life, II, p. 297.

DIPLOTAXIS near *liberta* Germ. Rist Cañon, April.

D. BREVICOLLIS Lec. Road from Monument Gulch to Montrose; Montrose; Mountains southwest of Montrose; Garland; Veta Pass; Rio Grande, Ulke; West Cliff; Leadville; this or a closely allied form comes from Rist Cañon with the date June 14.

D. OBSCURA Lec. Rico; Veta Pass, Bowditch.

D. CARBONATA Lec. Colorado Springs, a few about Yucca bunches, Uhler.

D. ATRATULA Lec. Colorado, Snow; Pueblo, Ulke.

D SUBANGULATA Lec. West Cliff, Cockerell.

D. PACATA Lec. West Cliff, in doubt, Cockerell.

D. HAYDENII Lec. Southern Pueblo County, Cockerell; West Cliff, common at light; Durango; Florissant; Horsefly Peak; Pueblo, Gillette; Fort Collins; Colorado Springs; Greeley.

LACHNOSTERNA LANCEOLATA Say. Found creeping out of holes in patches of buffalo grass on hills near the Garden of the Gods, August 13 and 16, Uhler; Boulder, Packard; La Junta, Bowditch; Colorado Springs, Ulke; Fort Collins, July.

L. GRACILIS Burm. La Junta, Hayward.

L. A FINIS Lec. Colorado, Horn.

L. GRANDIS Smith. Colorado, Smith.

L. DUBIA Smith. Colorado, Smith; Greeley, Wickham.

L. FUSCA Frœh. Southern Colorado, Leconte; Denver; both of these records were made before the separation of the various forms of this group, and they may not refer to *fusca* as now understood. Indeterminates of this section of the genus are known from Colorado Springs and the Upper San Juan.

L. FRATERNA Harr. South of Denver, Ulke

L. RUGOSA Melsh. Colorado, Horn.

L. LIMULA Horn. Colorado, Horn.

L. RUBIGINOSA Lec. Buena Vista, one female.

L. GLABRICULA Lec. Colorado, Hayward.

L. CRINITA Burm. Near Swift Creek, Custer County, Cockerell.

LISTROCHELUS DISPARILIS Horn. Colorado, Horn; Durango, Hayward.

L. FIMBRIPES Lec. Colorado, Horn.

L. FALSUS Lec. Pagosa Springs, June, Oslar; Dome Rock, Snow.

POLYPHYLLA DECEMLINEATA Say. Southwestern Colorado, Strecker; San Luis Valley; Greenhorn; Pueblo County; Salida; Colorado Springs; not common.

P. SPECIOSA Casey. Colorado, Casey.

ANOMALA BINOTATA Gyll. Cañon City, Wickham.

CYCLOCEPHALA IMMACULATA Oliv. Fort Collins, July; Pueblo, Snow.

LIGYRUS GIBBOSUS De Geer. Denver, Packard; Fort Collins; Pueblo; occurs in June and July.

L. RELICTUS Say. Chimney Gulch; Denver; Fort Collins; June to August.

APHONUS PYRIFORMIS Lec. Southwest Colorado, Strecker; South Park region, Oslar; Durango; Fort Collins; Greenhorn; Colorado Springs; found from June to August.

A. TRIDENTATUS Say. Durango; Upper San Juan; vicinity of Long's Peak, Leconte.

XYLORYCTES SATYRUS Fab. Fort Collins, July.

EUPHORIA KERNII Hald. La Junta; West Las Animas; Colorado Springs; southern Colorado; Chimney Gulch; Montrose; Fort Collins and vicinity; often abundant in flowers of *Argemone* and thistles.

E. FULGIDA Fab. Colorado Springs, one specimen, less green than the eastern form.

E. INDA Linn. Colorado Springs; Fort Collins, one in nest of *Lasius*, March, another flying in April; Bellevue; Denver; Mace's Hole, Pueblo County, Cockerell; Pueblo; Bijou, flying in August, Uhler.

CREMASTOCHILUS SAUCIUS Lec. Berkeley and vicinity, April, May and June; Salida, Oslar.

C. WHEELERI Lec. Rist Cañon; Bellevue, May.

C. CASTANEÆ Knoch. Salida, Wickham; Fort Collins and vicinity, April.

C. CRINITUS Lec. Salida, Wickham.

C. KNOCHII Lec. Berkeley; Chimney Gulch; Fort Collins and vicinity; West Cliff; Greeley; Colorado Springs; Buena Vista; La Junta; found from April to August.

TRICHIUS PIGER Fab. West Cliff, on *Rosa*; Manitou, Packard.

T. TEXANUS Horn. West Cliff; Beddoes' old ranch, Custer County, Cockerell.

T. AFFINIS Gory. Beaver Brook; Horsefly Peak; Mountains southwest of Montrose; South Fork of San Miguel; La Junta; Little South; Stove Prairie; Fort Collins; Steamboat Springs; near Long's Peak; La Veta; Colorado Springs. A common insect in June and July, especially in cañons among the foothills.

SPONDYLIDÆ.

PARANDRA BRUNNEA Fab. Colorado, Horn; Durango, Oslar.

SPONDYLIS UPIFORMIS Mann. Colorado, Ulke; West Cliff.

CERAMBYCIDÆ.

ERGATES SPICULATUS Lec. Vicinity of Fort Collins, July and August; Colorado Springs; Engelmann's Cañon; West Cliff; Durango. Many of the Colorado specimens show lighter areas on the wing covers, constituting Cockerell's variety *marmoratus*.

PRIONUS CALIFORNICUS Mots. Greenhorn; Estes Park; Fort Collins; Salida; Dome Rock; Engelmann's Cañon; Durango, Hayward; West Cliff; a specimen from the last-named place is but 25 mm. in length, or only about half the usual size. Mr. Oslar sent me a specimen from Durango, which is referable to the variety *curvatus* Lec.

P. FISSICORNIS Hald. Vicinity of Fort Collins, June and July.

P. PALPALIS Say. A specimen from the Agricultural College collection, without label, is supposed by Prof. Gillette to have been taken in Colorado.

HOMÆSTHESIS INTEGER Lec. Fort Collins, July; Denver; West Las Animas, Hayward.

H. EMARGINATUS Say. Estes Park, July; Fort Collins, June; Willow Creek, Custer County, Cockerell; Colorado Springs, Snow; southwestern Colorado, Strecker.

TRAGOSOMA HARRISII Lec. Salida, Oslar; South Park region, July; Willow Creek, Custer County, Cockerell; Pagosa Springs; Cochetopa Pass; Durango. I have retained Leconte's name for the present, in view of the differences of opinion as to the identity of our form with the European *T. depsarium*.

ASEMUM ATRUM Esch. Leadville, Bowditch; Rio Grande, Ulke; West Cliff.

A. MŒSTUM Hald Near Long's Peak; Estes Park; Fort Collins; Mederland, Packard; Veta Pass, 9,400 feet; Leadville, common on lumber piles and sidewalks.

NOTHORHINA ASPERA Lec. Colorado, Snow; West Cliff.

CRIOCEPHALUS PRODUCTUS Lec. Pagosa Springs, June, Oslar; South Park, Snow; Garland; Veta Pass, 9,400 feet; Leadville.

C. AGRESTIS Kirby. Denver; Fort Collins; Cañon City; Pagosa Springs; Leadville; found from June to August.

C. ASPERATUS Lec. Mountains southwest of Montrose; San Luis Valley; specimens from Denver, Fort Collins and the Poudre Cañon are not very typical and may be well developed individuals of *agrestis*.

C. MONTANUS Lec. West Cliff; Leadville.

C. OBSOLETUS Rand. Colorado, Putnam.

TETROPIUM VELUTINUM Lec. Colorado, Bowditch.

T. CINNAMOPTERUM Kirby. Leavenworth Valley, 9,000 to 10,000 feet, Bowditch.

T. PARALLELUM Casey. Colorado, Casey.

GONOCALLUS COLLARIS Kirby. Colorado, Bowditch.

HYLOTRUPES LIGNEUS Fab. West Cliff; Fort Collins.

PHYMATODES VARIABILIS Fab. Colorado, Snow; Red Mountain Road, on willows.

P. MACULICOLLIS Lec. Garland; Red Mountain Road, 8,000 to 9,000 feet.

P. DIMIDIATUS Kirby. Ouray and above; West Cliff; Veta Pass; Leadville.

MERIUM PROTEUS Kirby. Colorado, Leng.

CALLIDIUM ANTENNATUM Newm. Salida; Berkeley; Bellevue.

C. JANTHINUM Lec. Little Willow Creek; West Cliff; Fort Collins and vicinity, April and May; Leavenworth Valley, 9,000 to 10,000 feet; Georgetown.

C. CICATRICOSUM Mann. West Cliff, June.

C. HIRTELLUM Lec. Dome Rock, Snow; Leadville, two specimens beaten from conifers. Mr. Bowditch has an unidentified species of *Callidium* from the Leavenworth Valley.

PŒCILOBRIUM CHALYBEUM Lec. Garland.

MOLORCHUS BIMACULATUS Say. Rist Cañon, May and June.

RHOPALOPHORA RUGICOLLIS Lec. Upper San Juan, Hayward.

R. LONGIPES Say. Colorado Springs, on flowers of *Helianthus;* Horsetooth Mountain; Rustic; Durango; Upper San Juan, Bowditch; Dome Rock; Denver.

STENASPIS SOLITARIA Say. Colorado, Leng.

TRAGIDION COQUUS Linn. South Park region, Oslar; Engelmann's Cañon; Prof. Snow also records the variety *fulvipenne* Say, from this last locality.

AMANNUS PECTORALIS Lec. Colorado, Leng.

BATYLE IGNICOLLIS Say. Boulder; Golden; Colorado Springs; Dome Rock; entrance to Beaver Brook Gulch, Uhler; Rocky Ford; Durango; La Veta; Garland. Occurs from June to August, on flowers.

B. SUTURALIS Say. Custer County, Cockerell; Denver; Colorado Springs; Ute Pass; Engelmann's Cañon; Dome Rock; Golden; Clear Creek Cañon; Fort Collins and vicinity; Estes Park Toll Road; Ouray; Durango. Often very abundant on flowers.

OXOPLUS CRUENTUS Lec. Bridgetôn, Bowditch.

O. JOCOSUS Horn. Garland, Bowditch; in the Agricultural College collection is a specimen which agrees in color with *O. corallinus* Lec., but the sutural angle is not prolonged.

CROSSIDIUS TESTACEUS Lec. Colorado, Leng.

C. PULCHELLUS Lec. Montclair; Dixon Cañon; Livermore; Boulder; Holly; Trinidad; San Luis Valley; Garland. Occurs in August and September.

C. DISCOIDEUS Say. Custer and Fremont Counties, Cockerell; Denver; Colorado Springs; Boulder; Glenwood Springs; Beaver Brook Gulch; Garland; not rare in August.

SPHÆNOTHECUS SUTURALIS Lec. Cañon City, August, Uhler.

CYLLENE DECORUS Oliv. Colorado, Leng; Boulder, September, Gillette.

XYLOTRECHUS UNDULATUS Say. Florissant; at Buena Vista I took specimens of the form with white pubescence and reduced markings. Mr. Putnam records the variety *lunulatus* Kirby, while Mr. Hayward has the form *interruptus* Lap., collected in the state by Prof. Snow.

X. ANNOSUS Say. Monument Gulch to Montrose; Horsefly Peak; Gunnison; Durango; Ouray; Garland.

X. PLANIFRONS Lec. Recorded (in variety) from Short Creek, Custer County, by Prof. Cockerell.

X. OBLITERATUS Lec. Colorado, Leng. I have a specimen from Ouray that seems to belong here though not agreeing exactly with the original description.

NEOCLYTUS MURICATULUS Kirby. Ouray, common on felled trees, logs and sawed lumber; Little Willow Creek; Rico; Rist Cañon; Fort Collins;

West Cliff; Boulder; Leavenworth Valley, 9,000 to 10,000 feet; Colorado Springs; lower slopes of Pike's Peak; Buena Vista; Leadville.

N. ASCENDENS Lec. Leavenworth Valley, 9,000 to 10,000 feet, Bowditch.

N. APPROXIMATUS Lec. Morrison, August, Oslar.

CLYTANTHUS ALBOFASCIATUS Lap. A variety is reported from Garland, in the Schwarz list.

ATIMIA CONFUSA Say. Garland; West Cliff.

RHAGIUM LINEATUM Oliv. Golden; Little Willow Creek; Veta Pass; Custer County, (Splann's Ranch), Cockerell; Rio Grande, Ulke.

TOXOTUS VIRGATUS Lec. Placerville, Bowditch.

T. OBTUSUS Lec. I have seen a specimen from Colorado.

PACHYTA LITURATA Kirby. Fort Collins; Aspen; near Steamboat Springs; South Park region; Georgetown; Twin Lakes, Ulke; Custer and Lake Counties, Cockerell; Engelmann's Cañon; South Fork of San Miguel; Breckenridge; Leadville. At the last place a nearly black variety occurs along with the ordinary form. Mr. Ulke says that it occurs on *Populus tremuloides* and *P. balsamifera*, but I found most of mine on piles of sawed pine lumber.

ANTHOPHILAX MIRIFICUS Bland. Colorado, Leng.

A. SUBVITTATA Casey. Supposed by the describer to have come from Colorado.

ACMÆOPS BIVITTATA Say. Colorado, Leng.

A. ATRA Lec. Mount Lincoln, 11,000 to 13,000 feet, Bowditch; Breckenridge; Durango, May, Oslar.

A. TUMIDA Lec. Dome Rock, Snow.

A. LONGICORNIS Kirby. Vicinity of Fort Collins; Little Beaver; Leavenworth Valley, 9,000 to 10,000 feet; Georgetown; lower slopes of Pike's Peak; Garland; Veta Pass; Red Mountain Road; Ouray; Montrose; Durango; Cañon of Big Blue; Mountains southwest of Montrose; South Fork of San Miguel; Little Willow Creek. Sometimes abundant on flowers of various Rosaceæ.

A. VINCTA Lec. Lower slopes of Pike's Peak; South Fork of San Miguel; Durango; Ouray and above; Georgetown; Colorado Springs; Little Beaver; vicinity of Fort Collins. Thought by Mr. Leng to be only a variety of the last, with which it is frequently found feeding.

A. LIGATA Lec. Georgetown, abundant; Clear Creek; Leavenworth Valley; Veta Pass; Colorado Springs; Monument Gulch to Montrose, and mountains to the southwest, Bowditch and Hayward; West Cliff. Also placed by Mr. Leng as a variety of *longicornis*, and found in the same situations.

A. PROTEUS Kirby. Salida; Fort Collins; Denver; Georgetown; Colorado Springs; Buena Vista; Breckenridge; Leadville; Peak Eight, above timber; Dome Rock; West Cliff; Brush Creek, Custer County; Little Willow Creek; Summitville; Rico; Valley of Upper San Juan; Cañon of Big Blue; Pagosa Springs. The variety *gibbula* is recorded from Garland, Veta Pass and the Leavenworth Valley.

A. PRATENSIS Laich. South Park; Little Willow Creek; Cañon of Big

Blue; South Fork of San Miguel; Rico; Cochetopa Pass; Horsefly Peak; Durango; Ouray and above; West Cliff; Micawber Mine; Veta Pass; Leavenworth Valley; Georgetown; Colorado Springs; Manitou; Pike's Peak, to summit; Arapahoe Peak, 11,000 to 12,000 feet; Breckenridge; Leadville; Peak Eight, above timber; North Park; Steamboat Springs; Little Beaver; Fort Collins and vicinity; Denver; Cameron Pass; Marshall Pass. Often found in numbers on flowers.

GAUROTES CRESSONI Bland. Denver; above Ouray, up to about 10,000 feet; Veta Pass; Little Willow Creek; Cañon of Big Blue.

TYPOCERUS BRUNNICORNIS Lec. West Las Animas, Hayward; South Park, Snow.

T. BALTEATUS Horn. Garland. I have a pair from Colorado Springs which I refer here with some doubt.

T. SINUATUS Newm. Vicinity of Fort Collins; Golden.

LEPTURA SOROR Lec. Colorado, my collection.

L. PROPINQUA Bland. Little Beaver; Bear Creek Cañon, Snow; Estes Park; Bailey; Custer County, up to about 10,000 feet, Cockerell; Leavenworth Valley; Ouray and road above, up to 10,000 feet; South Park; South Fork of San Miguel; lower slopes of Pike's Peak.

L. PLAGIFERA Lec. Colorado, Leng.

L. SUBARGENTATA Kirby. West Cliff; Micawber Mine; Fort Collins and vicinity; North Park; Chimney Gulch; Leavenworth Valley, 9,000 to 10,000 feet; Colorado Springs; Poncha Springs; Veta Pass; South Park; Mountains southwest of Montrose; Durango; Upper San Juan; Ouray and road above; Horsefly Peak; common at times, on wild roses.

L. INSTABILIS Hald. Prof. Snow reports a black variety from Colorado; the form called *convexa* Lec., comes from Dome Rock; Chimney Gulch; South Park; Durango; Cimarron; Cañon of Big Blue; while Prof. Snow took five specimens at an altitude of 10,000 feet, on *Astragalus flexuosus*.

L. SEXMACULATA Linn. Gore Pass; Denver; Bullion Peak; Leadville; Leavenworth Valley, 9,000 to 10,000 feet; Red Mountain Road, 8,000 to 10,000 feet, on flowers of wild parsnips and mountain ash; South Fork of San Miguel; Little Willow Creek; this is a species which is partial to high altitudes.

L. NIGRELLA Say. South Park, Snow. A form with testaceous elytra was taken at the same place.

L. CARBONATA Lec. Dome Rock; Durango; Ouray and road above, both large and small specimens.

L. CANADENSIS Fab. Rist Cañon; Beaver Creek and Little South; North Fork of South Platte Cañon; Little Willow Creek; Custer County, Cockerell. I have a specimen of *erythroptera* from the South Park region, collected by Mr. Oslar. The variety *cribripennis* Lec., is known from the following points: Engelmann's Cañon; South Park; North Fork of South Platte; Pagosa Springs; Upper San Juan.

L. RUBRICA Say. Beaver Brook and Cañon City, Uhler.

L. SANGUINEA Lec. Fort Collins; Estes Park; Stove Prairie; Little Beaver; Clear Creek; Dome Rock; Colorado Springs; Manitou; lower slopes of

Pike's Peak, up to about 10,000 feet; Veta Pass; South Park; South Fork of San Miguel; Leadville.

L. CHRYSOCOMA Kirby. South Fork of San Miguel; Rico; Summitville; Pike's Peak, 9,000 to 10,000 feet; Colorado Springs; Manitou; Cheyenne Cañon; Engelmann's Cañon; Dome Rock; Fort Collins; Little Beaver; Stove Prairie; Beaver Brook, Bowditch; Georgetown; Leavenworth Valley; Breckenridge; Peak Eight, nearly to timber line; South Park; Custer County, Cockerell; Ouray and road above; a common insect on flowers.

L. NIGROLINEATA Bland. South Park; Upper San Juan; Summitville; Ouray; Red Mountain Road; Denver; Leadville; Breckenridge.

L. ASPERA Lec. Colorado, Leng; I took it along the Red Mountain Road and the Mineral Point Trail, at an altitude of about 9,000 feet or more, on flowers of mountain ash.

L. CUBITALIS Lec. Veta Pass, Bowditch.

MONILEMA ANNULATUM Say. La Junta; Horsetooth Mountain; Colorado Springs, under leaves of *Opuntia;* found from June to August.

M. LÆVIGATUM Bland. Pueblo, Ulke.

M. ARMATUM Lec. Cañon City, under leaves of *Opuntia arborescens*, August, Gillette; Pueblo, Bowditch.

MONOHAMMUS MACULOSUS Hald. Dome Rock; Buena Vista; southern Colorado, Leconte.

M. SCUTELLATUS Say. Fort Collins and vicinity; near Long's Peak; Little Beaver; Colorado Springs; Engelmann's Cañon; Dome Rock; South Park; Buena Vista; Leadville; Red Mountain Road; Durango; Upper San Juan. The variety *oregonensis* is known from Fort Collins; Glenwood Springs; and West Cliff.

LIOPUS ALPHA Say. Dome Rock.

DECTES SPINOSUS Say. La Junta; Colorado Springs; Manitou; Engelmann's Cañon; Fort Collins; Denver; Golden; near Pueblo; Cañon City. Sometimes common on wild sunflowers.

HYPERPLATYS ASPERSUS Say. Ouray, on piled poplar logs; Fort Collins; Horsefly Peak; Upper San Juan.

ACANTHOCINUS OBLIQUUS Lec. Fort Collins; Engelmann's Cañon; West Cliff; Ouray.

A. SPECTABILIS Lec. West Cliff; Ute Pass.

POGONOCHERUS PENICELLATUS Lec. Colorado, Leng and Hamilton.

P. MIXTUS Hald. Ouray, on piled poplar logs; Placerville; Rico road; Gunnison; Garland; West Cliff; Estes Park; Little Beaver; Fort Collins; Dome Rock; Colorado Springs; Idaho Springs; Breckenridge; Leadville; the form *simplex* Lec., is known from West Cliff and Veta Pass.

P. OREGONUS Lec. Horsefly Peak; Upper San Juan.

SAPERDA CALCARATA Say. Southern Colorado, Cassidy, injurious to *Populus angulatus* and Lombardy poplar; Pueblo, Gillette.

S. MŒSTA Lec. Along the Mineral Point Trail, above Ouray, common on small trees of quaking asp; Pagosa Springs; Fort Collins.

S. concolor Lec. Gunnison, Bowditch.

Mecas inornata Say. Colorado, Leng and Hamilton.

M. pergrata Say. Fort Collins and vicinity; Denver; Colorado Springs. Occurs in June.

Oberea oculaticollis Say. Colorado, Horn.

O. tripunctata Swed. Colorado, Leng and Hamilton; on the slopes of Pike's Peak just above Manitou, I took specimens from raspberry bushes which closely approximate Horn's *O. texana*. The form *basalis* Lec., was taken by Mr. Oslar at Chimney Gulch.

O. quadricallosa Lec. Dome Rock.

O. ruficollis Fab. Fort Collins and Bellevue, June and July.

Tetrops canescens Lec. West Las Animas, Hayward.

Tetraopes collaris Horn. Colorado, Leng and Hamilton.

T. femoratus Lec. San Luis Valley; Colorado Springs; Denver; Clear Creek Cañon; Fort Collins; Rocky Ford; Delta. I have *basalis* from Montclair.

T. quinquemaculatus Hald. Mr. Bowditch has the variety *texanus* Horn, from Durango.

T. canescens Lec. Fort Collins; Colorado Springs; Denver; Pueblo; Delta; occurs on *Asclepias*, from June to August.

CHRYSOMELIDÆ.

Donacia cincticornis Newm. The variety *magnifica* Lec., is recorded from Alamosa.

D. subtilis Kunze. Colorado, Leng.

D. emarginata Kirby. Colorado Springs.

D. pusilla Say. The variety *cuprea* Kirby, is reported by Putnam, while *pyrilosa* Lec., is known from Garland.

Orsodachna atra Ahrens. This species occurs commonly in the highlands, mostly in the form *childreni* Kirby. Colorado Springs; Fort Collins; Stove Prairie; Little Beaver; Pike's Peak, 9,000 to 10,000 feet; Georgetown; Leavenworth Valley; Silver Plume; Argentine Pass road, up to 12,000 feet; above Ouray; Silverton; Brush Creek, Custer County; Chimney Gulch; Garland; Veta Pass; Little Willow Creek; Cañon of Big Blue; South Fork of San Miguel; Horsefly Peak.

Zeugophora scutellaris Suffr. Colorado Springs. Specimens of an intermediate nature, allied to *consanguinea* and *californica* were sent from Rocky Ford by Prof. Gillette.

Z. abnormis Lec. Micawber Mine; Veta Pass; Gunnison; Placerville; Little Willow Creek; Pike's Peak; Breckenridge; Leadville, common on poplars, eating irregular holes in the leaves.

Syneta carinata Mann. Cañon of Big Blue; Horsefly Peak, Bowditch.

S. ferruginea Germ. Veta Pass; I have specimens collected in Hall Valley by Mr. Oslar which I place here.

Lema trilineata Oliv. Colorado Springs; La Junta; La Veta; Fort Collins, larva on *Physalis virginiana*, Baker; Golden; Berkeley.

L. COLORADENSIS Linell. Fort Collins; Greeley.

L. LONGIPENNIS Linell. Cañon City.

EURYSCOPA LECONTEI Crotch. On oak bushes in the vicinity of Manitou, Uhler.

COSCINOPTERA AXILLARIS Lec. West Cliff; Ouray; Upper San Juan; Berkeley; Colorado Springs, very abundant; Fort Collins.

C. DOMINICANA Fab. Colorado Springs, on scrub oak; Buena Vista; Berkeley; Fort Collins; occurs in June and July.

C. VITTIGERA Lec. Rather common in South Park, Snow; Little Beaver; Happy Hollow; vicinity of Fort Collins; Ouray; West Cliff, on *Oxytropis lamberti;* Colorado Springs; Buena Vista; Leadville, common on various plants; Pike's Peak; Alamosa; Garland; La Veta; San Luis Valley; Cañon of Big Blue; Placerville.

MEGALOSTOMIS SUBFASCIATA Lec. Colorado, Putnam.

BABIA QUADRIGUTTATA Oliv. Colorado Springs; Buena Vista; West Cliff, on *Yucca angustifolia;* Holly; Clear Creek Cañon; Ouray; a common insect, found on many different plants.

SAXINIS OMOGERA Lac. Poncha Springs; Durango; Fort Collins; Cimarron; Buena Vista.

S. SAUCIA Lec. Gunnison; Durango.

CHLAMYS PLICATA Fab. Fort Collins; Colorado Springs; Evans' Peak region.

EXEMA CONSPERSA Mann. Colorado Springs; Denver; Boulder; Grand Junction; Bellevue.

BASSAREUS DETRITUS Oliv. Colorado Springs.

B. MAMMIFER Newm. Dome Rock.

CRYPTOCEPHALUS QUADRIMACULATUS Say. Georgetown; Ouray; Garland; La Veta; Boulder; Fort Collins; Berkeley; Colorado Springs. The variety *notatus* Fab., is recorded from Colorado by Dr. Leconte and by Prof. Snow, while Mr. Ulke reports finding it at Cañon City and Manitou.

C. QUADRUPLEX Newm. Fort Collins, June.

C. GUTTULATUS Oliv. Cañon City, Uhler, one specimen.

C. LEUCOMELAS Suffr. The variety *vitticollis* Lec., is recorded from Colorado by Dr. Horn; it has also been taken at Fort Collins in July and August.

C. CONFLUENS Say. Colorado Springs and Buena Vista, not uncommon on Artemisiæ; Fort Collins, May and June; Little Beaver; Big Narrows of the Poudre, July; Durango; The Rustic.

C. VENUSTUS Fab. Fort Collins, July, on *Artemisia dracunculoides*. The variety *cinctipennis* Rand., comes from Fort Collins with the label July.

PACHYBRACHYS MOROSUS Hald. Colorado Springs, along the creeks; Rist Cañon, June.

P. STRIATUS Lec. Colorado, "entirely black," Leconte; Garland, Bowditch.

P. VIRGATUS Lec. Colorado Springs, Wickham.

P. LITIGIOSUS Suffr. North Park, July; vicinity of Fort Collins, June and July; Colorado Springs, common and variable.

P. ABDOMINALIS Say. Colorado Springs; Buena Vista; not uncommon.

P. OTHONUS Say. Colorado, Horn; Horsetooth Gulch, June.

P. PUBESCENS Oliv. This is the species heretofore known by the name *viduatus* Fab. It is known to occur at Cañon City; Berkeley; Denver; Montrose; Dolores; Colorado Springs and Fort Collins, on willows.

P. TRIDENS Melsh. Colorado Springs, Uhler.

P. CONFORMIS Suffr. Colorado, Leconte.

P. LIVENS Lec. La Junta, Bowditch.

P. LUSTRANS Lec. Durango; South Fork of San Miguel; Rico; San Luis Valley; Colorado Springs and lower slopes of Pike's Peak.

P. RENIDENS Lec. Veta Pass, Leconte; and, in doubt, from Little Willow Creek and from the mountains near Montrose.

P. SUBVITTATUS Lec. Leadville, beaten from foliage of dwarf pines.

P. ATOMARIUS Melsh. Dome Rock; Alamosa; Garland; La Veta.

P. SPUMARIUS Suffr. Durango, Bowditch.

P. HEPATICUS Melsh. West Cliff; Rist Cañon; Little Beaver; Colorado Springs.

DIACHUS AURATUS Fab. La Veta; Dome Rock; Colorado Springs.

D. ÆRUGINOSUS Lec. Mountains southwest of Montrose; Montrose; Garland; Denver, eating strawberry fruit.

XANTHONIA DECEMNOTATA Say. Horsetooth Gulch, June; Dome Rock; Durango; South Fork of San Miguel.

ADOXUS OBSCURUS Linn. The dark form is recorded from West Cliff, and I have seen it from the Red Mountain Road and Montrose Pass; the variety *vitis* Fab., is known from Custer County; above timber line on Pike's Peak, Snow; Red Mountain Road; South Park; Rico Road; Cañon of Big Blue; Fort Collins; Denver; Montrose Pass; near Palmer Lake; Upper San Juan; Buena Vista; Breckenridge; Leadville.

MYOCHROUS SQUAMOSUS Lec. Colorado Springs; Fort Collins, May to July; Lamar.

CHRYSOCHUS AURATUS Fab. Colorado, Horn; Pueblo, Ulke; Berkeley, July, Oslar.

C. COBALTINUS Lec. Dome Rock; Delta; Spring Cañon; Denver, Packard.

TYPOPHORUS CANELLUS Fab. The variety *quadriguttatus* Lec., has been seen from Lamar; Montrose; Fort Collins; and Pagosa. The form *aterrimus* Oliv., comes from Colorado Springs, where I took it commonly in sweepings, and from Fort Collins, where it was found on willows and on *Aster multiflorus*.

GRAPHOPS OBSCURUS Lec. Colorado, Horn.

G. VARIANS Lec. Fort Collins; West Cliff; Leadville.

G. PUBESCENS Melsh. Fort Collins, in sweepings, May.

G. MARCASSITA Crotch. Dome Rock, Snow.

G. NEBULOSUS Lec. Fort Collins; Colorado Springs; Leavenworth Valley; Williams River; specimens were seen in the Agricultural College collection, from Northern Colorado, which had been taken in February, March and April, so that this species probably hibernates in the imago state, like some of our eastern forms.

METACHROMA LONGULUM Horn. La Junta, Bowditch.

CHRYSODINA GLOBOSA Oliv. Colorado, Horn; Lamar; Horsetooth Gulch; Boulder.

RHABDOPTERUS PICIPES Oliv. La Junta, Bowditch; Fort Collins.

NODONOTA TRISTIS Oliv. La Veta; Poncha Springs; Durango; Berkeley; Colorado Springs; Fort Collins; a common species.

N. PUNCTICOLLIS Say. Dome Rock.

METAPARIA CLYTROIDES Crotch. La Junta, Wickham.

ENTOMOSCELIS ADONIDIS Fab. Mt. Lincoln; Williams River Valley; Rico; summit of Mt. Abrams; Mineral Point trail, 9,000 to 10,000 feet; Georgetown; Hesterburg's Lane, Custer County; Rist Cañon; Breckenridge; Leadville; Moose Mountain, above timber line. Prof. Cockerell found a specimen on *Cnicus*, but I took the insect chiefly on Cruciferæ.

PRASOCURIS PHELLANDRII Linn. Veta Pass, 11,500 feet.

P. OBLIQUATA Lec. Georgetown, Wickham.

DORYPHORA CLIVICOLLIS Kirby. A specimen without locality label in the Agricultural College collection is supposed to be from Colorado.

D. DECEMLINEATA Say. Livermore; Pueblo; Golden; Denver; Colorado Springs.

CHRYSOMELA EXCLAMATIONIS Fab. La Junta; Durango; Boulder; Fort Collins, on *Helianthus annuus;* Colorado Springs, common on sunflowers; La Veta; Pueblo; Denver; Clear Creek Cañon.

C. CONTINUA Lec. Colorado, Linell; Horseshoe Bend Gulch, August 15, on *Gymnolomia multiflora*, Cockerell.

C. CONJUNCTA Rog. Beaver Creek and Little South, July.

C. SUTURALIS Fab. Fort Collins, August.

C. DISRUPTA Rog. Howe's Gulch, June; Dome Rock.

C. ELEGANS Oliv. Fort Collins, August; Colorado Springs, July.

C. HETEROTHECÆ Linell. Colorado Springs; vicinity of Fort Collins.

C. LUNATA Fab. Horsetooth Gulch and other points in vicinity of Fort Collins; Rocky Ford; Dolores.

C. SCALARIS Lec. Fort Collins.

C. MULTIPUNCTATA Say. Alamosa; La Veta; Fort Collins. The form *bigsbyana* Kirby, is recorded in the Putnam list, and *verrucosa* Suffr., is reported from the state by Dr. Horn.

C. SIGMOIDEA Lec. Horsefly Peak, Bowditch.

C. MULTIGUTTATA Stal. This name occurs in one of Dr. Leconte's lists.

C. FLAVOMARGINATA Say. Fort Collins, larvæ feed on *Artemisia dracunculoides*, Baker; West Cliff.

C. BASILARIS Say. Colorado, Linell.

C. MONTIVAGANS Lec. Pike's Peak; Argentine Pass; Leavenworth Valley; Mount Lincoln; all of the foregoing records are from Mr. Bowditch; Custer County, Cockerell.

C. AURIPENNIS Say. Leavenworth Valley, 10,000 to 11,000 feet.

PLAGIODERA PRASINELLA Lec. Florissant, Bowditch.

P. OVIFORMIS Lec. Buena Vista; Breckenridge; Florissant; Salida; Stove Prairie; Little South; West Cliff; Veta Pass, 9,400 feet; Georgetown; Leavenworth Valley. Mr. Bowditch has a new species of this genus from Little Willow Creek.

GASTROIDEA DISSIMILIS Say. Fort Collins, on *Rumex crispus;* Estes Park Hill; peaks above 12,000 feet, Carpenter.

G. CYANEA Melsh. Durango; Denver; Leavenworth Valley; Fort Collins; Colorado Springs, on *Rumex*.

G. FORMOSA Say. Fort Collins, June, on *Rumex*.

LINA LAPPONICA Linn. Denver; Fort Collins; Montrose; Cerro Summit to Cimarron; Placerville; Gunnison.

L. SCRIPTA Fab. Pueblo; La Junta; Berkeley; Fort Collins and vicinity; Estes Park; Little Willow Creek; Placerville; Colorado Springs, common on willows and poplars.

GONIOCTENA PALLIDA Linn. Estes Park, July, Gillette.

TRIRHABDA CANADENSIS Kirby. Golden; Livermore; Palmer Lake; Garland; La Veta; Colorado Springs, very abundant on Artemisiæ.

T. NITIDICOLLIS Lec. Colorado, Horn; Poncha Springs, July, Oslar.

T. DIDUCTA Horn. Specimens from Durango are doubtfully referred here by Mr. Bowditch.

T. LEWISII Crotch. Big Narrows of Poudre, on *Bigelovia;* Clear Creek Cañon, Gillette; Durango; South Park; San Luis Valley, Bowditch.

T. CONVERGENS Lec Dome Rock; Garland; La Veta; peaks over 12,000 feet, Carpenter; West Cliff; Little South; Dolores, on *Bigelovia;* Ouray; Durango; Cochetopa Pass; Upper San Juan; Little Willow Creek; Gunnison; Colorado Springs; Buena Vista. Prof. Cockerell describes a variety *virescens* from West Cliff and Silver Cliff, but in a note expresses a doubt whether it may not belong to *flavolimbata*.

T. ATTENUATA Say. Denver; Pinewood; Little Willow Creek; occurs in July and August.

T. FLAVOLIMBATA Mann. South Park; Poncha Springs; Nathrop; West Cliff; Buena Vista; the insect is said to occur on *Solidago*. Mr. Bowditch has *luteocincta* Lec., from Garland.

GALERUCELLA AMERICANA Fab. Fort Collins, June; Dixon Cañon, February; the variety *cribrata* Lec., is recorded from West Cliff and Ula, occurring in May and July respectively.

G. CAVICOLLIS Lec. Palmer Lake, August, destroying foliage of *Prunus pumila*.

G. NOTULATA Fab., variety *bilineata* Kirby. Colorado, Putnam.

G. NYMPHÆÆ Linn. Fort Collins, Baker.

G. TUBERCULATA Say. Gunnison; Pagosa Springs.

G. DECORA Say. La Veta; Garland; West Cliff; Upper San Juan; Horsefly Peak; Colorado Springs and Buena Vista, common on willows. The variety *carbo* Lec., is recorded from the state by Dr. Horn.

MONOXIA PUNCTICOLLIS Say. Colorado Springs, not uncommon on alkali flats; Cañon City; Fort Collins; Boulder; Delta; Clear Creek Cañon; Denver.

M. CONSPUTA Lec. Durango; Upper San Juan; Dolores; Montrose; Berkeley; Fort Collins; Hotchkiss; Colorado Springs; West Cliff; Pueblo.

M. DEBILIS Lec. Garland; La Veta; Veta Pass, 9,000 feet; Williams River Valley; Little Willow Creek; Leadville; Fort Collins; North Park; Pueblo.

M. SORDIDA Lec. Denver; Pueblo; Cerro Summit; Delta; Dolores; all of these records are from Prof. Gillette's collections.

DIABROTICA TRICINCTA Say. Durango, Bowditch; Fort Collins; Pueblo; Rocky Ford; Little Beaver; Golden; Colorado Springs. Sometimes taken in abundance by sweeping in meadows.

D. DUODECIMPUNCTATA Oliv. Denver; Palmer Lake; La Junta.

D. ATRIPENNIS Say. Colorado, Horn; southern Pueblo County, Cockerell.

D. VITTATA Fab. Denver; Clear Creek; Rocky Ford.

D. LEMNISCATA Lec. Prof. Cockerell writes me that a specimen supposed to represent a color variety of this species was taken at Denver by H. G. Smith, Jr. The name is credited to Dr. Horn.

PHYLLOBROTICA DECORATA Say. Near Boulder, Gillette; Dolores; Fort Collins; Pleasant Valley; Clear Creek, Oslar. Occurs in May, June and July.

SCELOLYPERUS LONGULUS Lec. Veta Pass; Durango; Little Willow Creek; Montrose; Cochetopa Pass; Horsefly Peak; Dolores.

LUPERODES VARICORNIS Lec. Fort Collins, August.

L. LUTEICOLLIS Lec. Colorado, Horn.

L. LECONTEI Crotch. North Park, July; Happy Hollow; Fort Collins, August; South Fork of San Miguel; Upper San Juan.

L. MERACA Say. La Veta; Georgetown, Wickham.

L. CYANELLUS Lec. North Park; Clear Creek; Colorado Springs, on flowers along Bear Creek; Rist Cañon.

L. SPRETUS Horn. I have specimens referred here with some doubt from Durango, (Oslar) and from the road above Ouray.

L. VARIPES Lec. Rico; Veta Pass, 9,250 feet; Colorado Springs, rather common; Palmer Lake.

GALERUCA EXTERNA Say. Breckenridge and Leadville, under wood and stones; Summitville; Durango; Summit of Mt. Abrams; Dolores; Red Creek, Custer County; Veta Pass; Mt. Lincoln; Argentine Road, over 12,000 feet.

BLEPHARIDA RHOIS Forst. La Veta; Chimney Gulch; vicinity of Fort Collins, April to June.

ŒDIONYCHIS LUGENS Lec. Williams River; Elk River, near Steamboat Springs; Marshall Pass; West Cliff; Breckenridge.

Œ. PETAURISTA Fab. Colorado Springs, one specimen.

Œ. MINIATA Fab. Colorado Springs, one specimen.

DISONYCHA QUINQUEVITTATA Say. Pagosa; Durango; La Veta; West Cliff; Fort Collins and vicinity; Stove Prairie; Little South; Chimney Gulch; Cañon City; Colorado Springs; Buena Vista. A common species on willows.

D. CRENICOLLIS Say. Clear Creek, Oslar; Little Willow Creek.

D. GLABRATA Fab. Southern Colorado, Leconte.

D. FUNEREA Rand. Colorado, Bowditch.

D. TRIANGULARIS Say. West Cliff and Red Creek, Cockerell; Cañon City; Colorado Springs; Fort Collins; Little Beaver; Denver; Clear Creek; Durango; Upper San Juan.

D. XANTHOMELÆNA Dalm. Colorado, Horn.

D. MELLICOLLIS Say. Colorado, Horn.

HALTICA BIMARGINATA Say. Durango; Dome Rock; Dolores; Fort Collins; Denver; Beaver Brook Gulch; Palmer Lake; Holly; Little Beaver; Colorado Springs; Manitou; lower slopes of Pike's Peak.

H IGNITA Ill. North Park; Dolores; a species near *incærata* Lec., was taken by Mr. Schwarz at Alamosa and Veta Pass

H. VICARIA Horn. Colorado, Horn; Delta, August.

H. CARINATA Germ. La Junta; Durango; Mountains southwest of Montrose; the variety *torquata* Lec., I have from Denver and Colorado Springs, while specimens from Dolores and Montrose are in the collection of the Agricultural College.

H. OBLITERATA Lec. Colorado, Snow; Colorado Springs.

H. EVICTA Lec. West Cliff, Cockerell.

H. ÆRUGINOSA Lec. Leadville, a few specimens only.

H. OBOLINA Lec. Williams River Valley; Gunnison; Alamosa; Upper San Juan.

H. PUNCTIPENNIS Lec. Custer County, on *Epilobium angustifolium*, Cockerell; Idaho Springs; Fort Collins; Little Beaver; Denver; Colorado Springs; Cañon City; Breckenridge; La Veta; La Junta; Durango; South Fork of San Miguel.

H. LAZULINA Lec. Colorado, Horn.

H. TINCTA Lec. Durango, Bowditch.

H. FOLIACEA Lec. West Cliff; Cottonwood Springs, Pueblo County, Cockerell, on *Cucurbita perennis;* Poncha Springs; Florissant; Dome Rock; Pueblo; Colorado Springs and lower slopes of Pike's Peak; Buena Vista; Fort Collins; Garland; La Veta; Veta Pass, 9,400 feet.

C. HELXINES Linn. Ouray; Garland; Cerro Summit to Cimarron; Trinidad; Dolores; Lamar; Fort Collins; Little Beaver; Pagosa Springs; West Cliff; Buena Vista; Colorado Springs. Common on willows.

EPITRIX CUCUMERIS Harr. La Veta; Cañon City; Fort Collins.

E. PARVULA Fab. La Veta; Fort Collins; Colorado Springs.

ORTHALTICA MELINA Horn. Montrose, June, Gillette.

MANTURA FLORIDANA Crotch. Alamosa.

CHÆTOCNEMA PERTURBATA Horn. Veta Pass; Williams River Valley.

C. CRIBRATA Lec. Garland, Bowditch.

C. IRREGULARIS Lec. Veta Pass, 9,400 feet; Garland; Buena Vista.

C. SUBCYLINDRICA Lec. Garland; Buena Vista.

C. PROTENSA Lec. Vicinity of Fort Collins; Leadville; Garland; Veta Pass, 9,200 feet.

C. DENTICULATA Ill. Vicinity of Fort Collins; Colorado Springs; Greeley.

C. CRIBRIFRONS Lec. Alamosa; Colorado Springs.

C. OPACULA Lec. Alamosa; Garland.
C. MINUTA Melsh. Garland, Horn.
C. SUBVIRIDIS Lec. Fort Collins; North Park; Cerro Summit; La Veta; Alamosa; Garland; Veta Pass, 9,200 feet; Ula and West Cliff; Colorado Springs, extremely abundant; Buena Vista.
C. OPULENTA Horn. Durango, Bowditch.
C. PULICARIA Crotch. Garland; Alamosa.
C. CONFINIS Crotch. Colorado, Horn; Fort Collins; Cerro Summit.
C. ELONGATULA Crotch. Colorado, Horn.
SYSTENA HUDSONIAS Forst. Fort Collins, July.
S. ELONGATA Fab. Recorded in the Putnam list.
S. TÆNIATA Say. Pagosa Springs; Cerro Summit; Trinidad; Upper San Juan; Durango; Dolores; Aspen; North Park; Fort Collins. Said by Prof. Gillette to feed on potato, beet, alfalfa, lettuce, parsnip, egg plant, summer savory, *Chenopodium*, *Iva axillaris*, *I. xanthiifolia*, *Salvia lanceolata*, *Verbena bracteosa*, *Solanum triflorum*, *S. rostratum*, *Helianthus annuus*, *H. petiolaris*, *Portulaca oleracea* and *Amarantus blitoides*. I find that some of the varietal forms are recorded from the state as follows: *S. mitis* Say, Colorado Springs and Alamosa; *S. ligata* Lec., Idaho Springs, Packard; and *S. blanda* Lec., Colorado Springs and La Junta.
GLYPTINA NIVALIS Horn. Fort Collins, June.
G. SPURIA Lec. Veta Pass, Bowditch.
G. CERINA Lec. Fort Collins; Garland; Alamosa; Veta Pass, 9,400 to 11,500 feet.
G. ATRIVENTRIS Horn. Garland, Bowditch; Colorado Springs and lower slopes of Pike's Peak; Greeley; Fort Collins; Livermore; Micawber Mine.
APHTHONA TEXANA Crotch. Colorado, Horn.
PHYLLOTRETA SINUATA Steph. Breckenridge.
P. VITTATA Fab. Alamosa; Garland; Montrose; Bellevue; Williams River Valley.
P. ROBUSTA Lec. Colorado Springs; Alamosa; Garland.
P. ALBIONICA Lec. La Veta; Alamosa; Garland; Mountains southwest of Montrose; Pueblo; Idaho Springs and summit of Pike's Peak, Packard; Leadville. Said by Prof. Gillette to feed on cabbage, radish, beet, mustard, cauliflower, horseradish and *Cleome integrifolia*.
P. ÆNEICOLLIS Crotch. Montrose, June, Gillette; La Junta, Wickham.
P. LEWISII Crotch. Colorado Springs; La Junta; Salida; Cañon City; Pueblo; Fort Collins and vicinity, February to June.
P. PUSILLA Horn. Denver, on turnips, Cockerell; West Cliff; Micawber Mine; Trinidad; Salida; Palmer Lake; Greeley; Stove Prairie; Fort Collins; Colorado Springs; Buena Vista; San Luis Valley and Durango, Bowditch; Cañon City; Lamar.
LONGITARSUS SUBRUFUS Lec. Spring Cañon and Bellevue, July and October.
L. VANUS Horn. Dolores, June; Dixon Cañon and Bellevue, March and October.

L. OCCIDENTALIS Horn. Colorado, Horn; La Junta, Bowditch.

L. BICOLOR Horn. Durango; Ouray.

L. ALTERNATA Ziegl. Denver, Horn.

L. NITIDELLUS Ckll. West Cliff; La Junta; Cañon of Big Blue; Fort Collins; Williams River Valley. I have a species of this genus from Breckenridge that is allied to *L. erro* Horn, but is probably different.

DIBOLIA BOREALIS Chev. Buena Vista; Leadville; Veta Pass, 9,000 feet; Rist Cañon; Little Beaver.

PSYLLIODES PUNCTULATA Melsh. Fort Collins, on alfalfa; Colorado Springs; Pleasant Valley; Cerro Summit; Trinidad; Montrose; Gunnison; Upper San Juan.

P. CONVEXIOR Lec. West Cliff; Little Willow Creek; Upper San Juan; Gunnison.

MICRORHOPALA VITTATA Fab. Berkeley; Fort Collins, larvæ mining in leaves of *Solidago*. The variety *lælula* comes from Fort Collins and Marshall Pass.

M. XERENE Newm. Colorado.

M. CYANEA Say. Little Beaver; Denver; Pueblo; Colorado Springs, both blue and green specimens.

M. PORCATA Melsh. Near Palmer Lake, August, Gillette.

ODONTOTA COLLARIS Say. La Veta; Montrose; Big Narrows of Poudre, on *Bigelovia;* vicinity of Fort Collins; I took several pairs in copula, on grass blades, in Williams Cañon, near Manitou.

O. NERVOSA Panz. Clear Creek Cañon, near Denver, Uhler; vicinity of Fort Collins.

STENOPODIUS FLAVIDUS Horn. Fort Collins, May.

PHYSONOTA UNIPUNCTATA Say. Rist Cañon and Fort Collins, May.

CASSIDA NIGRIPES Oliv. Fort Collins, on wild morning glory; Rocky Ford. I have the variety *ellipsis* Lec., from Berkeley and Colorado Springs.

COPTOCYCLA AURICHALCEA Fab. Fort Collins, on dock and morning glory; Colorado Springs; La Veta.

C. GUTTATA Oliv. Vicinity of Fort Collins; Colorado Springs, common in June and July.

CHELYMORPHA ARGUS Licht. Denver; Colorado Springs, abundant in June and July. Prof. Gillette found it on *Ipomœa leptophylla.* The Colorado specimens belong to the variety *lewisii* Crotch.

BRUCHIDÆ.

BRUCHUS PISI Linn. Fort Collins, June.

B. DISCOIDEUS Say. Fort Collins, June; La Veta; Prof. Snow found it in the seeds of *Ipomœa leptophylla.*

B. AUREOLUS Horn. Colorado Springs; Buena Vista; lower slopes of Pike's Peak.

B. PROSOPIS Lec. Southern Colorado, Leconte.

B. FRATERCULUS Horn. Fort Collins, in seeds of *Glycyrrhiza lepidola*; near Boulder; Denver; Cerro Summit; Cimarron; Marshall Pass; La Veta; Durango; Mountains southwest of Montrose; West Cliff.

B. AMICUS Horn. La Veta; Garland; Veta Pass, 9,400 feet.

B. OBSOLETUS Say. Specimens of the bean weevil, *B. fabæ* Riley, were taken at Denver, in the haricot bean, by H. G. Smith Jr.

B. EXIGUUS Horn. Bellevue.

B. SEMINULUM Horn. Montrose; Lamar; Fort Collins, on alfalfa; Laporte.

ZABROTES CRUCIGER Horn. Colorado, Horn.

TENEBRIONIDÆ.

EDROTES GLOBOSUS Casey. Greeley; found about the roots of weeds in May.

E. ROTUNDUS Say. Pueblo, Bowditch; La Junta; Denver; Fort Collins; Colorado Springs.

STIBIA OVIPENNIS Horn. La Junta, Bowditch.

TRIMYTIS PRUINOSA Lec. La Junta; Pueblo; Dixon Cañon; Denver; Clear Creek; Colorado Springs; Buena Vista; Cañon City; Greeley; Salida.

EMMENASTUS ACUTUS Horn. Placerville; San Luis Valley; Gunnison; South Park; Garland; West Cliff.

E. OBESUS Lec. La Junta and San Luis Valley, Hayward.

EPITRAGUS CANALICULATUS Say. Colorado Springs, not uncommon on herbage, usually resting in crotches of branches or in axils of leaves; La Junta; Denver; Pueblo; Dixon Cañon; Poudre Cañon; Salida; Lamar; Cañon City; Fort Collins.

BATULIUS SETOSUS Lec. Greeley; La Junta.

ZOPHERUS ELEGANS Horn. Durango, May, Oslar.

ANEPSIUS MONTANUS Casey. Colorado, Casey.

OLOGLYPTUS ANASTOMOSIS Say. Pueblo; La Junta; West Las Animas.

ASTROTUS CONTORTUS Lec. Colorado, Hayward.

ASIDA OPACA Say. Denver; The Rustic; Poudre Cañon; Fort Collins; Pinewood; Trinidad; Sterling; Golden; Poncha Springs; La Junta; West Las Animas; Durango; Pueblo; Upper Arkansas Valley; west of South Park; Colorado Springs; Buena Vista; Bijou; West Cliff. Mr. Uhler writes—"Each hill west of Colorado Springs seems to afford a variety peculiar to itself. These variations are shown in the proportions of the thorax and elytra, the amount and prominence of their sculpture and the shape of their outline."

A. SORDIDA Lec. West Cliff; Wales' Cañon, Pueblo County, Cockerell; Holly; Dixon Cañon; Alder; Fort Collins; Trinidad; Denver; Colorado Chiquito River; Rio Grande; San Luis Valley; La Junta; Colorado Springs.

A. POLITA Say. Colorado Springs; Pueblo; Dutch George; West Las Animas; sometimes common.

A. ACTUOSA Horn. Southwestern Colorado, Strecker.

A. OBSOLETA Lec. Fort Collins; Trinidad; Holly; Sterling; all of the records come from the Agricultural College collection.

A. LECONTEI Horn. Durango, July, Agricultural College collection. The specimen represents a varietal form.

A. CONVEXA Lec. Pueblo; Holly; Trinidad; Pagosa Springs; West Las Animas.

A. CONVEXICOLLIS Lec. Colorado Springs; La Junta; West Las Animas.

A. MARGINATA Lec. West Cliff; the variety *rimata* Lec., is reported from Colorado by Leconte and Ulke.

A. ELATA Lec. Garland, Bowditch; South Park; Fort Collins; Pueblo; Berkeley; Colorado Springs; Cañon City; reported from southwestern Colorado by Strecker.

CONIONTIS OVALIS Esch. Fort Collins; Dome Rock; Veta Pass, 9,400 feet; plains south of Denver; Buena Vista.

C. OBESA Lec. San Luis Valley; Placerville; Durango; Cañon of Big Blue; Garland; Veta Pass, 11,500 feet; West Cliff; Trinidad; Salida; Long's Peak; Rist Cañon; Manitou; Golden; Buena Vista.

CYCLOSATTUS WEBSTERI Casey. Colorado, Casey.

EUSATTUS RETICULATUS Say. La Junta; Durango; West Las Animas; Pueblo; banks of Arkansas, west of Cañon City.

E. DIFFICILIS Lec. San Luis Valley; Berkeley; Fort Collins; Holly; Colorado Springs.

ELEODES OBSCURA Say. Greenhorn; Trinidad; San Luis Valley, Hayward. The form *dispersa* Lec., is recorded from the San Luis Valley by Mr. Bowditch, while *sulcipennis* Mann., is said by Dr. Strecker to occur in southwestern Colorado.

E. SUTURALIS Say. La Junta; Berkeley; Orchard; Cañons near Boulder, Gillette.

E. TRICOSTATA Say. La Junta; West Las Animas; Colorado Springs; Golden; Poudre Cañon; near Long's Peak; Estes Park; Lamar; Sterling; Holly; Fort Collins; La Veta; Veta Pass; Garland.

E. CARBONARIA Say. La Junta; Garland; Pleasant Valley on the Arkansas River, Snow.

E. OBSOLETA Say. La Junta; Golden; Durango; South Park; San Luis Valley; Pueblo; West Cliff; Cañon City; Colorado Springs; Denver.

E. QUADRICOLLIS Esch. South Park; Pagosa; Manitou.

E. HUMERALIS Lec. South Park, 8,000 to 10,000 feet, Bowditch; Buena Vista.

E. GRANULATA Lec. Leavenworth Valley, Bowditch.

E. EXTRICATA Say. Denver; Colorado Springs; Manitou; Idaho Springs; Fort Collins; Poudre Cañon; West Cliff; Wales' Cañon, Pueblo County; Buena Vista; La Junta; Pueblo; Monument Gulch to Montrose; Rico; Durango; Rio Grande; San Luis Valley; Pagosa Springs; Montrose; Placerville; Florissant.

E. LONGICOLLIS Lec. La Junta; Colorado Springs; southwestern Colorado, Strecker; Holly; Fort Collins; San Luis Valley; Trinidad.

E. GENTILIS Lec. Ouray; the name is from Dr. Horn.

E. NIGRINA Lec. Mountains southwest of Montrose; Durango; South Park; San Luis Valley; Ouray; Veta Pass, 9,200 feet; Buena Vista; Colorado Springs; Florissant; Garland; Idaho Springs; Georgetown; near Long's Peak; Fort Collins.

E. HISPILABRIS Say. La Junta; West Las Animas; Colorado Springs; Cañon City; San Luis Valley; Fort Garland; south of Denver; Trinidad; Holly; Fort Collins.

E. SPONSA Lec. Southern Colorado, Horn.

E. CAUDIFERA Lec. Colorado, Ulke.

E. SCABRIPENNIS Lec. Colorado, Bowditch.

E. LECONTEI Horn. Colorado, Leconte, under name *subaspera;* Colorado Springs; Buena Vista; Georgetown; Silver Plume; Ouray.

E. CONSOBRINA Lec. Horsefly Peak; Mountains southwest of Montrose.

E. PLANIPENNIS Lec. Manitou, Packard.

E. CORDATA Esch. Prof. Snow reports one specimen from Colorado.

E. BRUNNIPES Casey. Buena Vista, not rare about the roots of gooseberry bushes.

E. PIMELIOIDES Mann. Horsefly Peak; Idaho Springs; Garland; Aspen; Fort Collins; Leavenworth Valley, 9,000 to 10,000 feet; Roaring Fork; Monument Gulch to Montrose; Little Willow Creek; Cañon of Big Blue; Montrose and adjacent mountains.

E. OPACA Say. Trinidad; Colorado Springs, Snow; West Las Animas.

E. FUSIFORMIS Lec. Colorado, Horn; Bellevue; La Junta, Bowditch.

EMBAPHION MURICATUM Say. Fort Collins; Bellevue; West Las Animas; Colorado Springs.

E. CONTUSUM Lec. Fort Collins; Clear Creek; South Park region; San Luis Valley; Colorado Springs.

E. PLANUM Horn. San Luis Valley; Montrose, Bowditch; Dr. Horn reported it from Kansas and Colorado.

IPHTHIMUS SERRATUS Mann. Golden; Dome Rock; Engelmann's Cañon; Cañon City; North Fork of South Platte, Bowditch; Colorado Springs; lower slopes of Pike's Peak; Durango; Pagosa Springs. For the variety *lewisii* Horn, we have Packard's record, Blackhawk. The form *sublævis* Bland, is known from Colorado Springs; Rist Cañon; Durango; Upper San Juan; Pagosa Springs; Ouray; Mineral Point Trail, 9,000 to 10,000 feet.

CŒLOCNEMIS DILATICOLLIS Mann. North Fork of South Platte, 7,000 to 8,000 feet, Bowditch.

UPIS CERAMBOIDES Linn. Colorado, Snow.

TENEBRIO OBSCURUS Fab. Denver.

T. MOLITOR Linn. Fort Collins.

T. TENEBRIOIDES Beauv. La Junta, Hayward.

BLAPSTINUS INTERRUPTUS Say. Colorado, Casey; northern Colorado, Agricultural College collection.

B. DILATATUS Lec. Cañon City, name from Dr. Horn.

B. CASTANEUS Casey. Colorado, Casey.

B. PRATENSIS Lec. South Park, abundant, Snow; San Luis Valley; Durango; Gunnison; Cañon of Big Blue; Alamosa; Garland; Platte River Valley; West Cliff; Colorado Springs; Buena Vista; Leadville.

B. MŒSTUS Melsh. Alamosa; Veta Pass, 9,200 feet.

B. GREGALIS Casey. Veta Pass, Casey.

B. SUBSTRIATUS Champ. Durango; Placerville; Garland; South Park; all of these records are due to Mr. Bowditch.

B. VESTITUS Lec. West Cliff; Platte River Valley, Leconte; La Junta; Garland; Veta Pass.

B. HOSPES Casey. Garland, Casey.

B. LECONTEI Muls. West Cliff.

B. SULCATUS Lec. La Junta, Hayward.

TRIBOLIUM MADENS Charp. Fort Collins; Buena Vista; Pike's Peak, 7,000 to 8,000 feet.

T. CONFUSUM Duval. Bear Creek Cañon; Evans Peak region, Oslar.

PARATENETUS FUSCUS Lec. Pleasant Valley, Gillette; West Cliff.

PLATYDEMA EXCAVATUM Say. Rist Cañon, May.

P. OREGONENSE Lec. Colorado, Snow.

P. AMERICANUM Lap. Durango, Bowditch.

HYPOPHLŒUS PARALLELUS Melsh. Veta Pass, 9,400 feet; Rist Cañon; Ouray.

HELOPS PERNITENS Lec. Colorado, Hayward.

H. RUGICOLLIS Lec. Grand Junction, Hayward.

H. CONVEXULUS Lec. Mountains southwest of Montrose; Cañons near Fort Collins; Dome Rock; Garland; Veta Pass. The last two records appear under the name *montanus* Lec.

H. DIFFICILIS Horn. Cochetopa Pass; San Luis Valley; Trinidad; Buena Vista; Dr. Horn reports it as occurring in the mountains of western Colorado.

H. SPRETUS Horn. Colorado, Horn.

CISTELIDÆ.

HYMENORUS PILOSUS Melsh. Horsefly Peak; Mountains southwest of Montrose; Colorado Springs; Dome Rock.

H. NIGER Melsh. Mountains southwest of Montrose.

H. OBSCURUS Say. La Junta, Bowditch; Colorado Springs.

CISTELA PINGUIS Lec. Colorado Springs; Ouray.

ISOMIRA QUADRISTRIATA Coup. Colorado Springs.

MONOMMIDÆ.

HYPORHAGUS GILENSIS Horn. La Junta, Bowditch.

MELANDRYIDÆ.

TETRATOMA CONCOLOR Lec. Veta Pass, 9,200 feet.

XYLITA LÆVIGATA Hellw. West Cliff, in doubt.

SCOTOCHROA BASALIS Lec. Garland.

SERROPALPUS STRIATUS Hellw. Ouray.

EUSTROPHUS TOMENTOSUS Say. Rist Cañon.

E. ARIZONENSIS Horn. Durango, Bowditch.

HALLOMENUS SCAPULARIS Melsh. Durango, Bowditch.

H. SCAPULARIS Lec. Little Willow Creek, Bowditch.

CANIFA PALLIPES Melsh. La Veta.

LACCONOTUS PINICOLUS Horn. West Cliff; Veta Pass, 9,200 to 9,400 feet.

MYCTERUS CONCOLOR Lec. Colorado Springs, June; Dolores.

PYTHIDÆ.

LECONTIA DISCICOLLIS Lec. Dome Rock; Cochetopa Pass; Fort Collins and vicinity; West Cliff.

PYTHO PLANUS Oliv. Upper San Juan, Bowditch.

PRIOGNATHUS MONILICORNIS Rand. Toll road, above Ouray.

SALPINGUS VIRESCENS Lec. Leadville, rare. A species of this genus is reported from Garland and Veta Pass, which Mr. Bowditch suggests may be *elongatus* Mann.

ŒDEMERIDÆ.

CALOPUS ANGUSTUS Lec. Found at altitudes above 12,000 feet by Lieut. Carpenter; I took a specimen at Georgetown, in debris along Clear Creek, and it may well have been carried down by the current.

COPIDITA OBSCURA Lec. Colorado Springs and Manitou, not rare; Buena Vista; Ouray; Gunnison, on the train; Pueblo and Custer Counties, Cockerell; Salida; Durango.

ASCLERA PUNCTICOLLIS Say. Colorado, Horn.

CEPHALOIDÆ.

CEPHALOON VERSICOLOR Casey. Colorado; I have an undetermined species from Ouray.

MORDELLIDÆ.

DICLIDIA LÆTULA Lec. Cave near Manitou, Packard.

PENTARIA TRIFASCIATA Melsh. Montrose; Ouray; Fort Collins; Colorado Springs; Palmer Lake; La Veta.

P. FUSCULA Lec. Upper San Juan; Durango; Big Narrows of Poudre; Dixon Cañon; Fort Collins; Livermore; Manitou; lower slopes of Pike's Peak.

ANASPIS NIGRA Hald. Dome Rock; Garland; Veta Pass; Beaver Brook, Bowditch; lower slopes of Pike's Peak.

A. ATRA Lec. Durango; Cañon of Big Blue; Rico; San Luis Valley; Leavenworth Valley; West Cliff; Garland; Colorado Springs; Buena Vista; lower slopes of Pike's Peak; Black Lake Creek, Summit County, Cockerell; Denver; Beaver Creek.

A. FLAVIPENNIS Hald. Rist Cañon, August.

A. RUFA Say. Durango; Little Willow Creek; Montrose; Dolores; Ouray; Veta Pass; La Veta; South Park; Dome Rock; Micawber Mine; Estes Park; Little Beaver; Rocky Ford; Georgetown; Beaver Brook, Bowditch; Pike's Peak, lower slopes; Colorado Springs; Breckenridge; Leadville.

MORDELLA BOREALIS Lec. Leadville.

M. MELÆNA Germ. South Fork of San Miguel; Cañon of Big Blue; Little Willow Creek; Beaver Brook, Bowditch; Micawber Mine; West Cliff.

M. SCUTELLARIS Fab. Little Willow Creek; South Fork of San Miguel; Dome Rock; Red Mountain Road; Garland; Georgetown; Micawber Mine; lower slopes of Pike's Peak; Colorado Springs; Fort Collins; North Park; Dolores; Montrose.

MORDELLISTENA ARIDA Lec. Mouth of Cañon of the Arkansas, Uhler.

M. COMATA Lec. Fort Collins; Horsetooth Gulch, June.

M. NIGRICANS Melsh. Fort Collins, on *Chenopodium* and *Helianthus*.

M PUSTULATA Melsh. Denver; Fort Collins; La Veta; Garland.

M. MORULA Lec. Dolores; Bellevue; Montrose; Garland; Veta Pass; West Cliff; Mr. Baker writes that the larvæ are common during the winter in stems of *Iva xanthifolia*, at Fort Collins.

M. UNICOLOR Lec. Dolores; Lamar; Golden; Fort Collins; Durango; La Veta; Garland; Buena Vista; Colorado Springs; Denver.

M. MARGINALIS Say. Colorado, Putnam, under the name *divisa* Lec.

M. FUSCATA Melsh. La Veta.

M. ÆTHIOPS Smith. La Junta, Bowditch; Fort Collins.

M. SUTURELLA Hel. Colorado, Bull. Brooklyn Ent. Soc., VI, p. 5.

M. ANGUSTA Lec. Colorado, Putnam; Veta Pass, 9,000 to 9,400 feet.

M. ÆMULA Lec. West Cliff; Pueblo; Platte River; La Veta; Manitou; Garland.

ANTHICIDÆ.

EURYGENIUS CONSTRICTUS Lec. Colorado.

STEREOPALPUS GUTTATUS Lec. Gunnison; Placerville; found by Lieut. Carpenter at altitudes above 12,000 feet.

S. PRUINOSUS Lec. Durango, Bowditch; I have an undetermined species from Buena Vista.

CORPHYRA LEWISII Horn. Mountains southwest of Montrose; Horsefly Peak; Cañon of Big Blue; North Park; Fort Collins; Colorado Springs; lower slopes of Pike's Peak; Buena Vista; West Cliff; Beaver Brook, Bowditch; Ouray; Garland; La Veta; Veta Pass. The form *variabilis* Horn, I have from Georgetown and Ouray.

C. ABNORMIS Horn. Colorado, Horn.

C. PULCHRA Lec. Colorado, Putnam.

C. COLLARIS Say. Colorado, Horn.

C. LUGUBRIS Say. Colorado.

LAPPUS STURMI Laf. Colorado, Horn, as *Anthicus elegans* Laf.

L. NITIDULUS Lec. Colorado, Putnam; Pike's Peak, 7,000 to 8,000 feet.

L. ANIMATUS Casey. Colorado Springs, identity not quite certain.

THICANUS MIMUS Casey. Colorado Springs, June.

VACUSUS FORMICETORUM Wasm. Garland.

V. SUSPECTUS Casey. Supposed by the describer to have come from Colorado.

HEMANTUS RIXATOR Casey. Colorado Springs, July.

ANTHICUS FLAVICANS Lec. Salida; Colorado Springs.

A. BIGUTTULUS Lec. Fort Collins; Williams River Valley.

A. PUNCTULATUS Lec. Short Creek, Custer County, Cockerell; specimens doubtfully referred here, but smaller than the Californian form, were taken by Mr. Schwarz at Garland and La Veta.

A. CERVINUS Laf. Garland; the name is marked with doubt.

A. HALDEMANNI Lec. West Cliff.

A. STELLATUS Casey. Colorado Springs, June.

A. LECONTEI Champ. Gunnison, Bowditch.

A. NANUS Lec. Colorado, Horn.

A. LUTULENTUS Casey. Colorado Springs, June.

SAPINTUS FESTINANS Casey. Greeley.

AMBLYDERUS GRANULARIS Lec. Colorado, Snow.

NOTOXUS TALPA Laf. Colorado, Horn.

N. NUPERUS Horn. Buena Vista.

N. BIFASCIATUS Lec. Placerville; Durango; Fort Collins; Garland.

N. MONTANUS Casey. Ouray; Colorado Springs.

N. ANCHORA Hentz. Fort Collins; Little South; Greeley; Ula; West Cliff; Dome Rock; Garland; La Veta; Alamosa; Veta Pass.

N. SERRATUS Lec. Nathrop; Fort Garland; southern Colorado, Leconte, as *N. digitatus*.

MELOIDÆ.

MEGETRA VITTATA Lec. Southern Colorado and northern New Mexico, Leconte.

MELOE CARBONACEUS Lec. West Cliff, rather common on open prairie.

M. AFER Bland. Colorado, Putnam.

M. STRIGULOSUS Mann. Mt. Lincoln; Florissant; I have a specimen from Breckenridge that seems to belong here.

M. LÆVIS Leach. Berkeley; South Park region; Colorado Springs.

NOMASPIS PARVULA Hald. Colorado, Snow and Ulke; Trinidad, Gillette, found on *Astragalus* in May.

TRICRANIA STANSBURII Hald. Montclair, May; West Cliff.

NEMOGNATHA LURIDA Lec. Denver; Golden; Fort Collins; Colorado Springs; Ute Pass; Cañon City; Julesburg; Delta; Cimarron; Little Willow Creek; Rocky Ford; Dome Rock.

N. APICALIS Lec. Upper San Juan, Bowditch; Durango; Pueblo; southern Colorado, Leconte.

N. LUTEA Lec. Chimney Gulch; Texas Creek; Colorado Springs; Fort Collins; Delta; Big Narrows of Poudre.

N. BICOLOR Lec. Durango; Pagosa Springs; Poncha Springs; Rocky Ford; Fort Collins; Colorado Springs, common.

N. DICHROA Lec. Denver, Packard.

N. PALLIATA Lec. Upper San Juan, Bowditch.

N. PIEZATA Fab. Colorado, Horn.

N. NIGRIPENNIS Lec. Colorado, Snow.

N. NEMORENSIS Hentz. Atlantic to Colorado, Hamilton.

N. IMMACULATA Say. Denver; Golden; Antonito; Stove Prairie; Fort Collins; Bijou; Cañon City; Red Creek, Custer County; Dome Rock; Colorado Springs, July.

N. SPARSA Lec. Colorado Springs; Manitou; Golden; Fort Collins; Durango.

N. CRIBRICOLLIS Lec. Colorado, Bowditch.

GNATHIUM MINIMUM Say. Rocky Ford; Pueblo; Denver; Golden; Cañon City.

ZONITIS ATRIPENNIS Say. Lamar; Antonito; Golden; Cañon City; Colorado Springs; Pueblo.

Z. BILINEATA Say. Morrison, Bowditch; Pueblo; Cañon City; Colorado Springs.

MACROBASIS ALBIDA Say. Julesburg; Fort Collins; Pueblo.

M. TORSA Lec. Upper San Juan, Bowditch.

M. UNICOLOR Kirby. Cañons near Boulder; Fort Collins and vicinity; Golden.

M. IMMACULATA Say. Colorado, Horn; La Junta, Bowditch.

PLEUROPOMPHA COSTATA Lec. Fort Collins, July.

EPICAUTA FERRUGINEA Say. Durango; Denver; Cañon City; Golden; Colorado Springs; Clear Creek Cañon; Dome Rock; Engelmann's Cañon; Manitou; Ute Pass; Wales' Cañon; Livermore; Stove Prairie; Fort Collins.

E. SERICANS Lec. Colorado, Putnam; Denver, Oslar.

E. PRUINOSA Lec. Alma; South Park; Stove Prairie; Rist Cañon; Leadville; Pike's Peak, 9,000 to 10,000 feet; Mt. Lincoln; San Luis Valley.

E. CALLOSA Lec. Rocky Ford, July.

E. PARDALIS Lec. Southern Colorado, Packard.

E. MACULATA Say. La Junta; Julesburg; Delta; Trinidad; La Veta; Garland; Veta Pass, 9,200 feet; Chimney Gulch; Golden; Fort Collins; Little Beaver; Colorado Springs; Red Creek, Custer County, and Cottonwood Springs, Pueblo County, Cockerell.

E. STUARTI Lec. Holly; Fort Collins; Montclair.

E. WHEELERI Ulke. Little Willow Creek, Bowditch.

E. CINEREA Forst. Arkansas Valley, Cassidy; Colorado Springs and lower slopes of Pike's Peak; Boulder; The Rustic; Fort Collins; Rocky Ford; Trinidad.

E LEVETTEI Casey. Colorado, Casey.

E. CORVINA Lec. Colorado, Horn and Ulke.

E. PENNSYLVANICA De Geer. Pueblo; Montclair; Fort Collins; Veta Pass; Cusack Ranch; Arkansas Valley; Larimer County.

E. MAURA Lec. Southwestern Colorado, Strecker.

PYROTA MYLABRINA Chev. Denver; Pueblo; Rocky Ford; often common in August.

P. TERMINATA Lec. Thirty miles west of Denver, Ulke.

P. ENGELMANNI Lec. Chimney Gulch, May; Fort Collins, June; Bijou.

P. LINEATA Oliv. Pueblo, Bowditch; Denver, May, Oslar.

P. BILINEATA Horn. Colorado, Horn; Owl Cañon to Manhattan, Gillette.

CANTHARIS NUTTALLI Say. West Cliff and vicinity; Manitou; northern Colorado; Pinnacle; South Park; Mountains southwest of Montrose; Gunnison.

C. CYANIPENNIS Say. Southwestern Colorado, Strecker.
C. VIRIDANA Lec. West Cliff; Gunnison; Rico; Mountains southwest of Montrose; Ouray; Veta Pass, 9,400 feet; Georgetown; Little Beaver; Fort Collins.
C. PUBERULA Lec. Durango, July, Oslar.
C. BIGUTTATA Lec. Antonito; Trinidad; Cañon City; Fort Collins; Colorado Springs.
C. FULVIPENNIS Lec. Colorado, Horn.
C. SPHÆRICOLLIS Say. Denver; West Cliff; South Park; Poncha Springs; Alma; Upper San Juan; Little Willow Creek; The Rustic; Fort Collins; Blackhawk; Garland; Colorado Springs.
C. COMPRESSICORNIS Horn. Leavenworth Valley; Alma; Denver; West Cliff.
CALOSPASTA VIRIDIS Horn. Colorado, Horn.

RHIPIPHORIDÆ.

RHIPIPHORUS OCTOMACULATUS Gerst. Poncha Springs, July, Oslar.
R. PECTINATUS Fal. Colorado Springs, July.
MYODITES POPENOI Lec. Colorado, Leconte.

RHINOMACERIDÆ.

RHINOMACER COMPTUS Lec. Veta Pass, 9,200 to 9,400 feet.

RHYNCHITIDÆ.

AULETES CONGRUUS Walk. Veta Pass, 9,200 feet; Little Beaver; Leavenworth Valley, 10,000 to 11,000 feet; Upper San Juan; Rico.
RHYNCHITES CYANELLUS Lec. Colorado.
R. BICOLOR Fab. Ouray, on wild roses; West Cliff, on *Cnicus;* Fort Collins; North Park; Berkeley; Georgetown; La Veta; Dolores; South Fork of San Miguel; Little Willow Creek; Cañon of Big Blue; Colorado Springs; Breckenridge; Leadville.
R. EXIMIUS Lec. Colorado Springs, one of the most abundant insects during June, becoming scarcer during July.
R. ÆRATUS Say. Colorado Springs; Ouray; Bear Creek Cañon, Evans' Peak region, Oslar.
DEPORAUS GLASTINUS Lec. Mountains southwest of Montrose; Durango; Cimarron; La Veta; Veta Pass, 9,000 feet; Ouray.

ATTELABIDÆ.

ATTELABUS NIGRIPES Lec. Montrose, Gillette.
A. GENALIS Lec. Colorado Springs, one specimen.

BYRSOPIDÆ.

THECESTERNUS HUMERALIS Say. La Junta; Pueblo; Fort Collins; Cañon City; Colorado Springs; Denver.

OTIORHYNCHIDÆ.

MINYOMERUS INNOCUUS Horn. Florissant and South Park, Bowditch.

GRAPHORHINUS VADOSUS Say. Fort Collins and Denver, March to May.

EPICÆRUS IMBRICATUS Say. Denver; Dolores; Durango; Pagosa Springs.

CALYPTILLUS CRYPTOPS Horn. Spring Cañon, May.

OPHRYASTES VITTATUS Say. Northern Colorado; Holly; Pueblo; La Junta; Berkeley; Cañon City; Colorado Springs.

O. TUBEROSUS Lec. Holly; West Cliff; Wellsville, Fremont County, Cockerell.

O. LATIROSTRIS Lec. Colorado, Putnam.

O. SULCIROSTRIS Say. La Junta; San Luis Valley; Trinidad; Boulder; Greeley; Colorado Springs.

EUPAGODERES DECIPIENS Lec. Colorado, Putnam.

ANAMETIS GRISEA Horn. Colorado, Bowditch.

ORIMODEMA PROTRACTA Horn. Mountains southwest of Montrose; Horsefly Peak; Little Willow Creek; Veta Pass, 9,300 feet.

MIMETES SETULOSUS Lec. Placerville, Bowditch.

DIAMIMUS SUBSERICEUS Horn. Salida; Berkeley; Garland.

PERITAXIA RUGICOLLIS Horn. Cochetopa Pass; Cañon of Big Blue; Little Willow Creek; Rico Road; Rist Cañon; Dome Rock; Leadville; West Cliff; Garland; Veta Pass; this species does not seem to occur in abundance, in spite of the numerous records.

P. HISPIDA Horn. Garland, Bowditch; northern Colorado; Fort Collins.

THRICOMIGUS LUTEUS Horn. Rico, Bowditch.

THRICOLEPIS INORNATA Horn. Dolores; South Fork of San Miguel; Mountains southwest of Montrose; Placerville; Horsefly Peak; Little Willow Creek; Pagosa Springs; Ouray; Garland; Veta Pass, 9,000 to 9,400 feet.

ARAGNOMUS GRISEUS Horn. Garland.

RHYPODES BREVICOLLIS Horn. Garland.

PANDELETEJUS HILARIS Hbst. La Veta; Colorado Springs, on oak scrub.

COMPSUS AURICEPHALUS Say. Colorado, Horn.

PHACEPHOLIS CANDIDA Horn. Colorado, Horn.

SCYTHROPUS n. sp. Mountains southwest of Montrose; Little Willow Creek; Garland.

EVOTUS NASO Lec. Colorado, Horn.

CURCULIONIDÆ.

SITONES TIBIALIS Hbst. Colorado Springs; Fort Collins; Breckenridge; North Park; West Cliff; a species, which may be this occurs in Marshall Pass, and at Livermore and Cimarron. An undetermined species was taken at Durango by Mr. Bowditch.

ACMÆGENIUS HYLOBINUS Lec. Veta Pass; Rico.

TRICHALOPHUS DIDYMUS Lec. Breckenridge, one specimen.

T. ALTERNATUS Say. Steamboat Springs; Bellevue; Marshall Pass; Ouray; Argentine Road; Leavenworth Valley; Breckenridge; Leadville; Peak

Eight, up to timber line and occasionally above; peaks above 12,000 feet, Carpenter. Found under logs, usually not common.

T. PLANIROSTRIS Lec. South Park, Bowditch; Veta Pass, 9,200 feet.

LEPIDOPHORUS LINEATICOLLIS Kirby. West Cliff. A species of this genus, supposed to be new, is recorded from Veta Pass, 9,200 feet; Rico; and Durango.

APION ERRATICUM Smith. Colorado, Smith.

A. VIRILE Fall. Greeley.

A. ROBUSTUM Smith. La Junta, Bowditch.

A. OCCIDENTALE Fall. Colorado Springs, June.

A. PUNCTINASUM Smith. Colorado, Smith.

A. ACROPHILUM Fall. Buena Vista; Garland.

A. TENUIROSTRUM Smith. Colorado, Fall.

A. MODESTUM Smith. Colorado, Fall.

A. PROCLIVE Lec. Colorado, Smith.

A. WALSHII Smith. Colorado, Smith.

A. GRISEUM Smith. Colorado, Fall.

A. CENTRALE Fall. Colorado, Fall.

A. COLORADENSE Fall. Colorado Springs, June.

A. OBLITUM Smith. Colorado Springs, June.

A. VARICORNE Smith. Colorado Springs, June, rather common.

A. VENTRICOSUM Lec. Colorado, Fall.

PHYTONOMUS COMPTUS Say. Spring and Dixon Cañons, June, on willows.

LEPYRUS GEMELLUS Kirby. Argentine Pass, Bowditch.

L. PINGUIS Casey. Colorado, (Rocky Mountains), Casey.

L. GEMINATUS Say. Dome Rock; Greeley; Garland; Berkeley; Fort Collins; Dr. Horn reports *L. colon* Linn., from eastern Colorado. Dr. Hamilton includes under the name *palustris* Scop., both of the following:—*L. colon* Linn., Kirby and Leconte; *L. geminatus* Say and Casey.

LISTRONOTUS TESSELATUS Casey. Denver, Casey.

L. LATIUSCULUS Boh. Alamosa, in doubt.

MACROPS SOLUTUS Boh. Fort Collins; Alamosa; Colorado Springs.

M. INDISTINCTUS Dietz. Colorado Springs.

M. TENEBROSUS Dietz. Greeley.

M. MONTANUS Dietz. Greeley.

M. LONGULUS Dietz. Leadville; the identity is not quite certain.

M. ECHINATUS Dietz. Colorado, Dietz.

M. MYASELLUS Dietz. South Park, Dietz.

M. VITTATICOLLIS Kirby. West Cliff; Alamosa; Veta Pass, 9,400 feet.

PISSODES COSTATUS Mann. Southwestern Colorado, Strecker; Veta Pass, 9,200 to 9,400 feet.

P. FASCIATUS Lec. Leadville; Breckenridge; above Ouray, 9,000 to 10,000 feet.

LIXUS PLACIDUS Lec. Colorado, Casey.

L. MUSCULUS Say. La Veta.

L. PARCUS Lec. Fort Collins, May and June; Boulder.

L. CONCAVUS Say. Fort Collins, April; Berkeley, June.

L. MIXTUS Lec. Colorado, Casey.

L. MACER Lec. Colorado, Leconte; Fort Collins.

DINOCLEUS ANGULARIS Lec. La Junta, Bowditch; northern Colorado, Gillette; Cañon City.

STEPHANOCLEONUS PLUMBEUS Lec. Southern Colorado, Leconte; La Junta, Bowditch.

S. CRISTATUS Lec. Florissant; Leadville.

CLEONASPIS LUTULENTUS Lec. Southern Colorado, Leconte.

CLEONUS COLLARIS Lec. Colorado, Leconte; Fort Collins, June and August; northern Colorado, February and March.

C. CANESCENS Lec. La Junta, Bowditch; northern Colorado, March and April; Golden; Fort Collins; Poncha Springs; Berkeley; Cañon City.

C. CARINICOLLIS Lec. Colorado, Leconte.

C. TRIVITTATUS Say. Northern Colorado, March; Dixon Cañon, February and September.

C. SPARSUS Lec. Cochetopa Pass, Bowditch.

C. FRONTALIS Lec. Northern Colorado, March; the form *puberulus* Lec., comes from Fort Collins and Greeley.

C. QUADRILINEATUS Chev. West Cliff; reported from Colorado by Prof. Snow.

C. KIRBYI Casey. Southern Colorado, Leconte, as *vittatus* Kirby.

C. CIRCUMDUCTUS Casey. Fort Collins, March to May, also in September.

C. TEXANUS Lec. La Junta, Bowditch. Heretofore included in *Lixus*, but now placed in *Cleonus* by Maj. Casey.

DORYTOMUS MUCIDUS Say. La Junta, Bowditch; Fort Collins; Golden; La Veta.

D. LATICOLLIS Lec. Greeley, on cottonwoods; Denver; Cameron Pass.

D. AMPLUS Casey. Colorado, Casey.

D. HISPIDUS Lec. Garland.

D. FILIOLUS Casey. Colorado.

D. NUBECULINUS Casey. Colorado, Casey.

D. LURIDUS Mann. Garland; Lamar.

D. BREVICOLLIS Lec. Denver, Packard.

D. SQUAMOSUS Lec. Garland; North Park.

GRYPIDIUS EQUISETI Fab. Fort Collins; a specimen doubtfully referred to this species was taken by Mr. Schwarz at Garland.

G. BRUNNIROSTRIS Fab. North Park; Garland; Veta Pass, 9,200 feet; Leadville.

ERYCUS MORIO Mann. Leavenworth Valley, 10,000 to 11,000 feet; Leadville.

E. PUNCTICOLLIS Lec. Fort Collins, March, April and July.

PROCAS sp. Veta Pass, 9,400 feet.

DESMORIS CONSTRICTUS Say. Eastern Custer County, Cockerell; Colorado Springs, common on *Helianthus*.

SMICRONYX FULVUS Lec. Eastern Custer County, Cockerell; Durango; Colorado Springs, on *Helianthus*.

S. VESTITUS Lec. West Cliff; Fort Collins; La Veta.

S. SPARSUS Casey. Colorado, Casey.
S. SERIATUS Lec. Gunnison; Durango, Bowditch.
S. CONGESTUS Casey. Colorado, Casey.
S. TYCHOIDES Lec. La Veta; Durango; La Junta.
PHYLLOTROX NUBIFER Lec. West Cliff, July; Leadville, abundant; Fort Collins; Horsetooth Mountain; The Rustic; Cerro Summit; Veta Pass, 9,200 feet; Ouray.
ENDALUS LIMATULUS Gyll. Fort Collins. A species near *æratus* Lec., was taken at Alamosa and Garland by Mr. Schwarz.
E. OVALIS Lec. Alamosa and Garland.
LIXELLUS FILIFORMIS Lec. Alamosa.
BAGOUS CALIFORNICUS Lec. Alamosa; a new species was taken at Garland.
PROMECOTARSUS FUMATUS Casey. The Rustic, August.
MAGDALIS CUNEIFORMIS Horn. Dome Rock.
M. LECONTEI Horn. Fort Collins; Dome Rock; West Cliff; Garland; Veta Pass, 9,400 to 11,000 feet; Mountains southwest of Montrose; Little Willow Creek.
M. IMBELLIS Lec. Leavenworth Valley, 10,000 to 11,000 feet.
M. ÆNESCENS Lec. Placerville, Bowditch.
M. GRACILIS Lec. Montrose, June.
M. GENTILIS Lec. Little Willow Creek; Mountains southwest of Montrose; Garland; Veta Pass, 9,000 to 11,000 feet.
M. HISPOIDES Lec. Specimens belonging near this species are recorded from Garland; Veta Pass, 9,000 to 11,000 feet; Rico; Horsefly Peak; Mountains southwest of Montrose.
M. INCONSPICUA Horn. Alamosa.
M. ARMICOLLIS Say. Described under the name *alutacea* Lec., from the Leavenworth Valley; Mr. Bowditch has it from the Upper San Juan and Cañon of Big Blue. Several records exist referring to the occurrence of new species of *Magdalis* in Colorado, but it does not seem worth while to enter them here.
TACHYPTERUS QUADRIGIBBUS Say. South Fork of San Miguel; Montrose; Fort Collins; Colorado Springs.
ANTHONOMUS SCUTELLARIS Lec. Fort Collins, on wild plums; Rocky Ford.
A. RUFIPENNIS Lec. Garland.
A. SYCOPHANTA Walsh. Denver; Dolores; Fort Collins.
A. SQUAMOSUS Lec. Fort Collins, larva on *Grindelia squarrosa;* Colorado Springs; La Junta, Bowditch; Trinidad, Cockerell; Montclair; Dome Rock; La Veta.
A. TECTUS Lec. Colorado, Dietz.
A. MURINUS Dietz. Colorado, Dietz.
A. JACOBINUS Dietz. Colorado, Dietz.
A. CANUS Lec. West Cliff; Garland; Veta Pass, 9,200 feet. A closely allied form occurs on the lower slopes of Pike's Peak.
A. NANUS Lec. Dolores; Livermore; Bellevue; Fort Collins; Stove Prairie; Golden.

A. ELONGATUS Lec. Dolores; larva on *Bigelovia*, Baker.

ANTHONOMOPSIS MIXTUS Lec. Fort Collins; Colorado Springs.

PSEUDANTHONOMUS VALIDUS Dietz. Colorado, Dietz. I have a species of this genus from Colorado Springs, where it was abundant on wild cherry.

CHELONYCHUS LONGIPES Dietz. Colorado, Dietz.

ORCHESTES NIGER Horn. La Veta; Garland; Veta Pass, 9,200 feet.

O. PARVICOLLIS Lec. Colorado, Dietz.

O. CANUS Horn. Horsetooth Gulch; Rist Cañon; San Juan.

O. RUFIPES Lec. Near Swift Creek, Custer County, above 8,000 feet, Cockerell; Buena Vista; West Cliff; La Veta; Garland; Veta Pass, 9,200 feet.

O. SUBHIRTUS Horn. Durango, Bowditch.

ELLESCHUS EPHIPPIATUS Say. Alamosa; Garland; La Veta; Fort Collins.

MACRORHOPTUS HISPIDUS Dietz. Greeley.

PROCTORUS DECIPIENS Lec. La Veta; Garland.

TYCHIUS LINEELLUS Lec. A variety of this species is reported by Packard from Golden and Manitou.

T. TECTUS Lec. Garland; Montrose; cañons near Boulder; Pleasant Valley; Fort Collins; Buena Vista; often very abundant.

NANOPHYES PALLIDULUS Grav. Alamosa, Schwarz.

LÆMOSACCUS PLAGIATUS Fab. Southern Colorado, Leconte.

CONOTRACHELUS AFFINIS Boh. Rist Cañon, May.

C. NIVOSUS Lec. Rist Cañon; Trinidad; vicinity of Fort Collins in general.

C. LEUCOPHÆATUS Fah. Fort Collins, Cassidy; Colorado Springs; Chimney Gulch.

RHYSSEMATUS LINEATICOLLIS Say. Fort Collins, on *Asclepias speciosa*.

ACALLES BASALIS Lec. Colorado, Leconte; La Junta, Bowditch.

A. POROSUS Lec. Colorado Springs, abundant on cacti; La Junta; Trinidad; what seems to be the same species was taken by Prof. Gillette in northern Colorado in February.

A. CLATHRATUS Lec. West Cliff, Cockerell.

CNEMOGONUS EPILOBII Payk. Durango, Bowditch.

ACANTHOSCELIS CURTUS Say. West Cliff; La Veta.

A. ACEPHALUS Say. Colorado, Dietz; Fort Collins, on *Œnothera biennis;* I have the variety *tenebrosus* Dietz, from Colorado Springs.

AULEUTES ASPER Lec. Colorado, Dietz.

CŒLIODES APICALIS Dietz. Colorado, Dietz; Fort Collins, June and July.

CEUTORHYNCHUS RAPÆ Gyll. Mr. Bowditch reports it from the mountains southwest of Montrose. Dr. Dietz thinks that the specimens referred to *rapœ* in this country are really different and gives to them the name *affluentus*.

C. SERICANS Lec. Alamosa; Garland; Veta Pass, 9,200 feet.

C. DECIPIENS Lec. Garland; Veta Pass, 9,400 feet; Colorado Springs; Fort Collins.

C. PUSIO Mann. Buena Vista; Leadville; North Park; Dolores; Mineral Point Trail, above Ouray, 9,000 to 10,000 feet.

C. PUSILLUS Lec. Alamosa; Garland; Fort Collins; North Park; Dolores.
C. CONVEXICOLLIS Lec. Leadville.
C. SEPTENTRIONALIS Gyll. Fort Collins, May.
C. PUBERULUS Lec. La Junta, Bowditch.
C. ZIMMERMANNI Gyll. Spring Cañon; North Park.
PELENOMUS GRACILIPES Dietz. Garland, Dietz.
P. SQUAMOSUS Lec. Garland. Possibly this may be the same as the preceding species.
RHINONCUS PYRRHOPUS Boh. Colorado, Leconte.
TYLODERMA FOVEOLATUM Say. Northern Colorado, March.
T. ÆREUM Say. Dolores; Durango.
T. BARIDIUM Lec. Dolores, June.
ZASCELIS IRRORATA Lec. Colorado, Leconte.
PIAZURUS CALIFORNICUS Lec. Mountains southwest of Montrose, Bowditch.
COPTURUS OPERCULATUS Say. Colorado, Putnam.
C. NANULUS Lec. Garland.
C. ADSPERSUS Lec. Colorado Springs;Fort Collins; Palmer Lake; La Junta, Bowditch; La Veta.
C. OBSCURELLUS Casey. Colorado, Casey.
TACHYGONUS CENTRALIS Lec. Raton Mountain, on *Rhus aromaticum*, Leconte.
BARIS STRIATA Say. Southern Colorado, Leconte; La Veta.
B. UMBILICATA Lec. Denver, Casey.
B. HISPIDULA Casey. Colorado, Casey.
B. STRENUA Lec. La Junta, Bowditch; Fort Collins.
B. TUMESCENS Lec. Cañon City.
B. SOLUTA Casey. Colorado, Casey.
B. OBLONGULA Casey. Colorado, Casey.
B. TRANSVERSA Say. Golden; Manitou; La Junta; West Cliff.
B. APRICA Casey. Colorado, Casey.
B. POROSICOLLIS Casey. Greeley, Casey. Differs from the type in having a single series on the fifth interval.
B. INCONSPICUA Casey. Colorado, Casey.
PYCNOBARIS PRUINOSA Lec. Colorado, Casey.
ONYCHOBARIS CORROSA Casey. Colorado, Casey.
O. MILLEPORA Casey. Colorado, Casey.
O. SUBTONSA Lec. La Veta.
O. ILLEX Casey. Colorado, Casey.
AULOBARIS IBIS Lec. South Park, Snow.
PSEUDOBARIS FARCTA Lec. Colorado, Leconte.
P. ANGUSTA Lec. Alamosa.
TRICHOBARIS TRINOTATA Say. La Junta, Bowditch.
T. TEXANA Lec. Colorado, Casey; Fort Collins; Golden.
RHOPTOBARIS CANESCENS Lec. Colorado, Casey; La Junta, Bowditch.
ORTHORIS CROTCHII Lec. Durango, Bowditch; Colorado Springs, common; vicinity of Fort Collins.

CENTRINUS PUNCTIROSTRIS Lec. Colorado, Casey.

C. SALEBROSUS Casey. Colorado, Casey.

C. PULVERULENTUS Casey. Colorado, Casey.

CALANDRINUS GRANDICOLLIS Lec. Colorado Springs, a few specimens taken about the roots of plants on the prairies and foothills; Dixon Cañon; West Cliff; Bellevue.

C. INSIGNIS Casey. Colorado, Casey.

C. OBSOLETUS Casey. Colorado, Casey.

CENTRINOGYNA STRIGATA Lec. Greeley.

LIMNOBARIS CONFUSA Boh. Colorado, Casey.

L. PROLIXA Lec. Greeley.

BARILEPTON FAMELICUM Casey. New Windsor, September, Gillette; Fort Collins; Greeley.

BALANINUS UNIFORMIS Lec. Durango, Bowditch; La Veta.

B. LONGIPES Casey. Manitou, Casey.

B. MONTICOLA Casey. Colorado Springs, on scrub oaks.

B. NASICUS Say. Dome Rock; several state records are extant.

B. QUERCUS Horn. Colorado, Snow.

BRENTHIDÆ.

EUPSALIS MINUTA Drury. Colorado, Leconte.

CALANDRIDÆ.

SCYPHOPHORUS ACUPUNCTATUS Gyll. La Junta, Bowditch.

CACTOPHAGUS VALIDUS Lec. West Cliff.

RHODOBÆNUS TREDECIMPUNCTATUS Ill. Lamar; Rocky Ford.

SPHENOPHORUS SIMPLEX Lec. A specimen supposed to come from Colorado is in the Agricultural College collection.

S. VOMERINUS Lec. La Junta, Bowditch; Prof. Snow reports a specimen of the variety *baridioides* Lec.

S. ULKEI Horn. Alamosa; Garland; Durango; Fort Collins; Berkeley; Chimney Gulch; Colorado Springs.

S. OCHREUS Lec. Rocky Ford.

S. VARIOLOSUS Lec. Colorado, Horn.

TRICHISCHIUS CRENATUS Lec. Colorado, Leconte and Horn.

COSSONUS PLATALEA Say. La Junta, Bowditch; North Park.

C. SUBAREATUS Boh. Durango; Upper San Juan.

STENOSCELIS BREVIS Boh. Rist Cañon.

SCOLYTIDÆ.

This family is in very chaotic state at present, and seems to have been but little understood by cataloguers. The records that follow are those published in the papers referred to in the earlier pages of this work, and the authority for each can be readily determined by consulting the list of localities; the few exceptions are properly noted. Prof. A. D. Hopkins has been at work on the Scolytidæ for several years, and has kindly sent a list of many forms from Colorado. Most of these are manuscript names however, and as he does not wish them used in anticipation of the descriptions they are not available for our purpose.

GNATHOTRICHUS MATERIARIUS Fitch. Mr. Bowditch has a specimen from H. K. Morrison, with the label Colorado, that he refers to this species. Prof. Hopkins will describe a new form from Ouray.

G. RETUSUS Lec. Dome Rock, Snow; Veta Pass.

PITYOPHTHORUS CARINICEPS Lec. This is reported by Dr. Leconte as occurring at Veta Pass among the Schwarz collections.

P. FOSSIFRONS Lec. Garland; Veta Pass, 9,000 feet.

P. NITIDULUS Mann. Garland; Veta Pass, 9,000 to 9,400 feet.

P. DELETUS Lec. Garland; Veta Pass, 9,000 to 9,400 feet.

PITYOGENES CARINULATUS Lec. Colorado, Hopkins *in litt.*

XYLOTERUS LINEATUS Oliv. Colorado, Putnam; Garland.

CRYPHALUS MUCRONATUS Lec. Veta Pass, 9,300 feet.

DRYOCŒTES SEPTENTRIONIS Mann. Colorado, Ulke, as *Xyleborus*.

D. AFFABER Mann. Gray's Peak, 11,200 feet, Packard; Leavenworth Valley, 10,000 to 11,000 feet.

TOMICUS INTEGER Eich. Veta Pass and Rico, as *T. plastographus*. Specimens were taken at Boulder, (Hopkins) and Buena Vista, (Wickham), the determinations being due to Prof. Hopkins in these last two cases.

T. RECTUS Lec. Veta Pass; Leavenworth Valley; Rico, Bowditch.

T. PINI Say. Southern Pueblo County, Cockerell; Gray's Peak, Packard; Dome Rock.

T. CÆLATUS Eich. Veta Pass.

T. HUDSONICUS Lec. Leavenworth Valley, 10,000 to 11,000 feet.

T. INTERRUPTUS Mann. Leavenworth Valley, 10,000 to 11,000 feet.

T. TRIDENS Mann. Boulder, Hopkins, in bark of Engelmann's spruce; Leadville and the Argentine Pass Road, Wickham; all of the identifications are by Prof. Hopkins.

T. LATIDENS Lec. Veta Pass.

T. OREGONI Eich. Boulder, Hopkins, common in bark of Engelmann's spruce; Leadville; Colorado Springs; Leavenworth Valley; Peak Eight, above timber line. All of the identifications are from Prof. Hopkins.

SCOLYTUS UNISPINOSUS Lec. Veta Pass, 9,200 feet.

POLYGRAPHUS RUFIPENNIS Kirby. Gray's Peak, Packard.

PHLŒOTRIBUS PUBERULUS Lec. Veta Pass, 9,400 feet.

HYLESINUS SERICEUS Mann. Garland.

H. NEBULOSUS Lec. Colorado Springs, Wickham; name from Hopkins.

PHLŒOSINUS SERRATUS Lec. This "or a new species" is reported from Garland.

DENDROCTONUS TEREBRANS Oliv. Red Creek, Custer County, Cockerell; West Cliff; Rio Grande, Ulke; Colorado Springs; Ouray. The variety *valens* Lec., is reported from Garland.

D. RUFIPENNIS Kirby. Colorado, Dietz; Leavenworth Valley; Leadville; Rico; Blackhawk and Manitou, Packard; peaks above 12,000 feet, Carpenter.

D. SIMILIS Lec. Garland; Leavenworth Valley.

D. PICEAPERDA Hopk. Boulder, Hopkins, in bark of Engelmann's spruce; Leadville; Silver Plume; Argentine Road. The specimens were all named by Prof. Hopkins and belong to a new variety or subspecies which will be characterized by him in due time. There is little doubt that some of the older records for Colorado Dendroctoni belong really to this species, which has been confounded with *D. rufipennis*.

D. SIMPLEX Lec. Colorado, Dietz.

D. APPROXIMATUS Dietz. Colorado, Dietz.

HYLASTES MACER Lec. Colorado, Snow.

H. LONGUS Lec. Leadville; West Cliff; Garland; Veta Pass.

H. POROSUS Lec. Boulder, Hopkins, in bark of pine; Rico, in doubt.

H. GRACILIS Lec. Colorado, Putnam.

HYLURGOPS RUGIPENNIS Mann. Veta Pass, 9,400 feet; Leadville.

ANTHRIBIDÆ.

GONOTROPIS GIBBOSUS Lec. West Cliff.

EURYMYCTER FASCIATUS Oliv. Northern Colorado, May, Gillette.

ALLANDRUS BIFASCIATUS Lec. Garland; Ouray; Horsefly Peak; Rico.

BRACHYTARSUS ALTERNATUS Say. La Veta; Colorado Springs.

B. GRISEUS Lec. South Park, Snow, common on *Actinella richardsonii;* Buena Vista.

ADDENDA.

After the first part of this catalogue had been printed, a "Revision of the Cicindelidæ of Boreal America" by Mr. Chas. W. Leng, appeared in the Transactions of the American Entomological Society. The following records should be added to those which I have already given for that family.

CICINDELA OSLARI Leng. Bronze specimens from King Solomon's Peak, Needle Mountains, San Juan Range, 9,500 feet, July and August; green specimens from southwest slope of Mount Wilson, San Miguel Range, 12,000 feet, July. Both lots were collected by E. J. Oslar. This form will rank as a not very pronounced race or variety of *C. longilabris*.

C. BOWDITCHI Leng. Vicinity of Durango, July and August, Bowditch.

C. UNICOLOR Dej. Colorado.

C. OBLIQUATA Dej. Mr. Leng revives this name for the broadly marked forms of *C. vulgaris;* I have a specimen from Buena Vista.

DESCRIPTIONS OF AMERICAN UREDINEÆ, IV.

BY J. C. ARTHUR AND E. W. D. HOLWAY.

The following descriptions apply to American plant-rusts inhabiting species of *Gramineæ* belonging to the sections *Agrostideæ* and *Chlorideæ*, with their accompanying æcidia so far as known. Of the sixteen species included in this paper, only one, however, has had its full cycle of development traced. That one is the very conspicuous rust on the leaves of cord grass, which produces æcidia on ash trees, and in the latter stage also occasionally attracts much attention.

The present article, like the three 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, the second (4:377–402) December, 1898, and the third (5:171–193) May, 1901.

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 numerals O, I, II, III, X, are used to designate the spermogonial, æcidial, uredo, teleutosporic, and amphisporic stages of the rust. When placed in capital type the material employed for study and distribution showed well developed sori, when in lower case type, thus, o, i, ii, iii, x, the particular stage so indicated was in comparatively small amount or inferior development.

The nomenclature of the hosts is that used in the first edition of Britton's *Manual*, so far as there represented.

The first article of this series contained descriptions of species numbered from one to seventeen, the second article contained numbers eighteen to thirty-four, the third thirty-five to forty-four, and the present article contains numbers forty-five to sixty.

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45. UROMYCES ARISTIDÆ *E. & E.* (1887. Jour. Myc. 3: 56.)

45*a*. On *Aristida basiramea* Engelm., III, Long Pine, Neb., *Bates*.
45*b*. On *Aristida oligantha* Michx., III, Denton, Texas, *Long*.

ORIG. DESCR. "III. Sori linear, 1–2 millim. long, naked (when mature), dark ferruginous-brown; spores loosely compacted in the sori, elliptical or obovate, 25–35 × 18–22μ, smooth, yellowish-brown, on long (80–100μ), stout but deciduous pedicels, epispore not distinctly thickened above.

II. Uredospores nearly globose, 24–27μ in diameter, wall rather thin, golden yellow, minutely verrucose.

III. Teleutosori epiphyllous, oblong to linear, intercostal, early naked, dark ferruginous brown; teleutospores broadly oblong or obovate, to nearly globose, 18–26 by 28–38μ, side walls rather thick, apex considerably thickened, pedicel stout, tinted, once to twice and a half the length of the spore.

EXSIC:

Carleton, Ured. Amer., 26.
Shear, Ell. & Ev., Fungi Columb. Cont., 1469.

We have not been so fortunate as to secure satisfactory uredosporic material for distribution or study. The emended description for the second stage was drawn from the few spores associated with the teleutospores, and is necessarily imperfect.

The original description of the teleutospores does not accord exactly with the appearance of the spores in the several collections we have examined (we have not seen the type), more particularly regarding the thickness of the apex, and yet there is little reason for supposing there is more than one species represented.

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46. PUCCINIA ARISTIDICOLA *Henn.* (1896. Hedw. 35:243.)

46*a*. On *Aristida fasciculata* Torr. (*A. dispersa* Trin. & Rupr.), III. Torreon, Mex., *Holway*.

46*b*. On *Aristida fasciculata* Torr. III. Chapala, Mex., *Holway*.

ORIG. DESCR. "Soris foliicolis oblongis vel striiformibus, atris epidermide rupta cinctis; uredosporis subglobosis vel late ellipsoideis, brunneis, levibus, 24–30 × 22–25μ, episporio 4.6μ crasso, levi; teleutosporis intermixtis late ellipsoideis, oblongis vel subclavatis, atrobrunneis vel castaneis, utrinque rotundatis apice incrassatis, medio leniter constrictis, 28–40 × 18–28μ, episporio atrocastaneo, levi, 4–6μ crasso, pedicello usque ad 120μ longo, 6–8μ crasso, subhyalino apice brunneolo."

II. Uredospores globose or broadly elliptical, 22–30 by 26–32μ, wall pale-yellow, thick, 4μ or more, finely verrucose, pores 4, equatorial.

III. Teleutosori epiphyllous, between the veins, oblong to elongated linear, prominent, very dark-brown; teleutospores oblong or elliptical, rounded at both ends, 22–30 by 30–40μ, slightly or not constricted at the septum, side walls thick, up to 6μ, apex somewhat thicker, pedicel thick, firm, slightly tinted, long, once to thrice the length of the spore.

The type of this species was collected in Argentine in 1881, upon an undetermined *Aristida*. It appears to differ materially from *Puc. aristidæ* Tracy, coming from Africa. One of the numbers of this distribution has been mistaken for *Puc. subnitens* Diet. (*Bot. Gaz.* 24: 28), a species having a close resemblance in both gross and microscopic appearance. The uredospores, however, show marked differences, especially in the number and arrangement of the germ-pores.

A collection upon *Aristida gracilis* Ell., made in Nebraska by Rev. J. M. Bates agrees well with the two numbers of this distribution, except that both uredo and teleutospores are smaller and thinner walled, in which respects it seems to be intermediate between this species and *P. aristidæ*.

47. Uromyces epicampus *Diet. & Holw.* (1897. Bot. Gaz. 24:23).

47*a*. On *Epicampes macroura* Benth. III. Near City of Mexico, Mex., *Holway*.

Orig. Descr: "Sori epiphyllous, between the veins, linear, naked: uredosori yellowish-brown; spores mostly round, 28–32μ; epispore thickly set with short spines; germ-pores numerous, scattered over the whole surface: teleutosori black-brown; spores round or ovate, rarely conical at apex, 26–35 by 20–26μ, chestnut-brown, epispore rather thin, apex darker and strongly thickened (5–7μ), pedicel firm, up to 100μ long."

The specimens of this distribution are part of the type collection.

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48. Uromyces minimus *Davis*. (1894. Bot. Gaz. 19:415.)

48*a*. On *Muhlenbergia sylvatica* Torr., III, Somers, Wis., *Davis*.

Orig. Descr. "Hypophyllous. Uredosori light brown, teleutosori black, oblong or linear, soon naked. Uredospores globose or oval, light brown, echinulate, 12–19μ in diameter, usually 14–16. Teleutospores brown, smooth, spheroidal, oval or oblong, 14–22 $\times$ 12–19μ, usually 17–20 $\times$ 15–17μ, apex rounded, conical or occasionally truncate, very strongly thickened, the apical thickening constituting nearly half the length of the spore; pedicels moderately stout, tinted, once to twice the length of the spore. Colorless clavate paraphyses present."

II. Uredosori hypophyllous, light brown; uredospores globose or nearly so, 12–20μ in diameter, average about 18μ, wall rather thin, yellowish-brown, strongly and densely echinulate, pores about 4, scattered.

III. Teleutosori hypophyllous, dark brown, linear-oblong; teleutospores spheroidal, oval or oblong, 12–20 by 14–22μ, apex rounded or obtuse, very strongly thickened, even to half the length of the spore, base rounded or somewhat narrowed, pedicel moderately stout, firm, tinted, about once the length of the spore.

Exsic:

Ellis & Everhart, N. Am. Fungi, 3240.

Until recently this species has been known from only the type locality at Somers, in Kenosha Co., Wis. It was first observed in October, 1893; and in June, 1894, an undescribed species of Æcidium was found in the type locality, abundantly covering *Mesadenia reniformis* (Muhl.) Raf. (*Cacalia reniformis* Muhl.), which the discoverer and describer (l. c.) suggested might be a part of the same species. In a communication dated Dec. 7, 1901, Dr. Davis says of the species: "I know of but one station for it. The land on which that is situated has been enclosed and used for grazing, and for the last two or three years I have not found the rust. Coincidently the æcidium on *Cacalia reniformis* disappeared, although grazing has seemed to disturb the Cacalia very little. From 1894 to 1897 all three forms were abundant, but over a very limited area." There appears to be great probability that we have in hand the æcidiostage of this species, but so far no cultures have been made.

In July, 1900, the species was collected by Mr. Wm. C. Cusick at Wallowa Valley, Oregon, on *Muhlenbergia racemosa* (Michx.) B. S. P. and on *M. comata* Benth. No information about the collection has been received, other than what the specimens furnished, which appear to be entirely typical.

The species is quite distinct from the *Uromyces* found upon *Muhlenbergia* in Mexico, which has been referred to *Urom. Peckianus* Farl. (Bot. Gaz. 24: 23). The latter has much larger uredospores with equatorial pores. The spores of *Uredo muhlenbergiæ* Diet. are also larger, and have equatorial pores.

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49. PUCCINIA DOCHMIA *Berk. & Curt.* (1858. Proc. Am. Acad. Sci. 4: 126.)

49*a*. On *Muhlenbergia ciliata* Trin., III, Chapala, Mex., *Holway*.
49*b*. On *Perieilema crinitum* Presl., III, Chapala, Mex., *Holway*.

ORIG. DESCR. "131. P. dochmia, Berk. & Curt.: soris oblongis; sporis brevibus obtusissimis fuscis; pedunculo hyalino laterali. On leaves of grasses, Nicaragua."

SYN:

1891. *Puccinia windsoriæ australis* Anders. Jour. Myc. 6: 123.

1898. *Dicæoma dochmia* Kuntze. Rev. Gen. Pl. 3:468.

O, I. Spermogonia and æcidia unknown.

II, III. Sori hypophyllous or sparingly amphigenous, small, oblong or linear-oblong, soon naked, ruptured epidermis inconspicuous. II. Uredosori brownish-yellow; uredospores globose or nearly so, 16–24μ in diameter, wall thin, brownish-yellow, minutely tuberculate or barely echinulate, pores indistinct, scattered. III. Teleutosori chocolate-brown; teleutospores globoid or somewhat longer than broad, dark brown, average diameter of 26μ, ranging 24–28 by 25–35μ, not constricted, septum more or less oblique, walls rather thick, somewhat thicker opposite the insertion of the pedicel, which is hyaline and almost colorless, slender, delicate, one to three times the length of the spore.

Although the name of this species has been much used, the species itself is little known. So far as we know no specimen has appeared in any published exsiccati.

The type collection was made by Charles Wright in Nicaragua while on the North Pacific Exploring Expedition. The type is in the Royal Kew Herbarium, London, and a part in the National Herbarium at Washington; both specimens are small and fragmentary. The host is unnamed, "leaves of grasses" so the record reads; and after an extended comparison of the Washington specimen with Mexican and Central American grasses in the National Herbarium nothing more definite was ascertained than that it probably is some species of *Muhlenbergia* or *Peri-eilema*. It is usually assumed to belong to the former genus, possibly because that is more generally known.

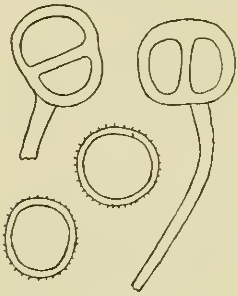

Fig. 1.
PUCCINIA DOCHMIA *B. & C.* From type collected in Nicaragua, now in the Royal Kew Herbarium.

We have examined both the Kew and Washington type material, and it agrees closely in all essential respects with the material of the present distribution. There is also in the

National Herbarium a scanty specimen of the same rust on an undetermined species of *Muhlenbergia*, but which Prof. F. L. Scribner has kindly examined for us and considers to be *M. exilis*, collected by E. Palmer in Mexico in 1886, and also an ample specimen on *Muhlenbergia tenella* collected by C. G. Pringle in Mexico in 1890.

This species does not appear to have been collected north of Mexico. The name has often been applied, however, to the species following, which it somewhat resembles.

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50. PUCCINIA MUHLENBERGIÆ *sp. nov.*

50*a*. On *Muhlenbergia diffusa* Willd., II. iii, Lafayette, Ind., *Miss Snyder*.

50*b*. On *Muhlenbergia mexicana* (L.) Trin., III, Decorah, Iowa, *Holway*.

50*c*. On *Muhlenbergia mexicana* (L.) Trin., III, Rockport, Kans., *Bartholomew*.

50*d*. On *Muhlenbergia racemosa* (Michx.) B. S. P. (M. glomerata *Trin.*), III, O'Neill, Neb., *Bates*.

50*e*. On *Muhlenbergia racemosa* (Michx.) B. S. P., III, Phillips Co., Kans., *Bartholomew*.

SYN:

1885. *Puccinia windsoriæ* Burrill non Schw., Bull. Ill. Lab. Nat. Hist. 2: 197.

O. I. Spermogonia and æcidia unknown.

II. III. Sori hypophyllous or sparingly amphigenous, prominent, oblong or linear-oblong, soon naked, ruptured epidermis inconspicuous. II. Uredosori light brown, pulverulent; uredospores globose or globose-elliptical, 22–30μ in diameter, wall thin, yellowish brown, closely and distinctly echinulate, pores about 5, scattered. III. Teleutosori chocolate-brown; teleutospores obovate or oblong-obovate, dark brown, 19–27 by 30–40μ, not constricted at the septum, narrowed somewhat toward the base, side walls rather thin, apex rounded and somewhat thickened, pedicel hyaline, tinted, stout, firm, about the length of the spore.

EXSIC:

Ellis & Everhart, N. Am. Fungi, 1854, 2886.
Shear, Ellis &Everhart's Fungi Columbiani, 1467.
Sydow, Uredineen, 1068, 1173.
Rabenhorst-Pazschke, Fungi Europ. et extraeurop., 4220.
Griffiths, West Am. Fungi, 296.

This species is rather common throughout the United States east of the Rocky mountains. It has heretofore passed indifferently under the names of *Puc. Windsoriæ* and *Puc. dochmia.* The former name belongs to a wholly different species inhabiting *Tricuspis* (*Triodia*). The error was introduced by Burrill in his *Parasitic Fungi of Illinois*, and has been followed by De Toni in Saccardo's *Sylloge fungorum* (7:664), Farlow and Seymour, *Host Index of Fungi*, page 152, and by many others. It is readily separated from the true *P. windsoriæ*, from *P. emaculata* and many other gramineous species by its small and delicate uredospores.

There is, however, much resemblance between this species and *P. dochmia*, both macroscopically and microscopically. The most pronounced differences are the larger and more echinulate uredospores, and the larger and differently shaped teleutospores. Oblique septa in *Puc. muhlenbergiæ* are not common, while in *Puc. dochmia* they are the rule.

The uredosporic pores of this species are not readily counted. They are usually without order, but occasionally four are placed in the equatorial zone and one at the apex.

The *Uredo muhlenbergiæ* Diet., found in Alabama, is wholly distinct, having much larger spores and equatorial pores. It is an isolated form more likely to belong to the genus *Uromyces*, than to *Puccinia*.

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51. PUCCINIA AMPHIGENA *Diet.* (1895. Hedw. **34**:291.)

51*a*. On *Calamovilfa longifolia* (Hook.) Hack. (Calamagrostis longifolia *Hook.*), III, Chicago, Ill., *Arthur*.

51*b*. On *Calamovilfa longifolia* (Hook.) Hack., III, Chicago, Ill., *Arthur*.

51*c*. On *Calamovilfa longifolia* (Hook.) Hack., III, Bassett, Neb., *Bates*.

ORIG. DESCR. "Uredolager klein, rostbraun, keine Paraphysen enthaltend. Uredosporen kugelig, ca. 21μ in Durchmesser oder eiförmig, 21–25μ lang, 19–24μ breit, blassbraun, stachelig. Teleutosporenlager auf beiden Seiten der Blätter und an den Blattscheiden, in Form von kurzen oder längeren Strichen, polsterförmig, fest, schwarz. Teleutosporen von verschiedener Gestalt, kurz keulenförmig bis lang spindelförmig, an der Basis in den Stiel verschmälert, an der Spitze abgerundet, abgestutzt oder, in der Mitte zugespitzt, wenig eingeschnürt 33–60μ lang, 13–22μ breit. Membran glatt, intensiv gelbbraun, am Scheitel mässig oder stark verdickt. Stiel etwas kürzer oder länger als die Spore, gebräunt, fest.

SYN:

1898. *Dicæoma amphigenum* Kuntze. Rev. Gen. Pl. 3:467.

O. I. Spermogonia and æcidia unknown.

II. Uredosori amphigenous, small, brownish-yellow, oblong to linear, ruptured epidermis noticeable, paraphyses none; uredospores globose, about 24μ in diameter, or ovoid, 19–24 by 21–28μ, wall rather thin, golden brown, echinulate with low, blunt points, pores 6–8, scattered.

III. Teleutosori amphigenous, oblong to linear, prominent, ruptured epidermis conspicuous, nearly black; teleutospores cuneate to obovate-oblong, 18–26 by 35–56μ, very little constricted at the septum, apex rounded, obtuse or acutish, much thickened, lower cell longer than the upper and narrowed into the pedicel, which is stout, firm, golden yellow, and the length of the spore or shorter.

EXSIC:

Sydow, Uredineen, 910.

This species extends from Michigan and Illinois to Kansas and Montana. It is especially variable in the size of the spores, a fact noted by Dietel in drawing up the original description. A specimen collected by F. W. Anderson in Montana, Sept., 1888, has teleutospores that are 22–33 by 41–67μ (according to measurements by E. M. Fisher), and the uredospores average about 27μ in diameter. On the other hand a specimen secured from a phanerogamic collection made by L. H. Bailey at South Haven, Mich., Sept., 7, 1882, possesses teleutospores measuring 16–20 by 30–48μ, and the uredospores average about 20μ in diameter. The gross appearance of the fungus does not vary much, and the microscopic appearance, except for size, is also quite uniform.

The material of number 51*a* of the accompanying distribution is part of the same collection as that distributed by Sydow in his Uredineen No. 910, and both are of the type collection. An error occurs on the label of the Sydow exsiccatæ: the host is given as *Calamagrostis Canadensis*, but is in reality *Calamovilfa longifolia*, as any one may convince himself by examining the fragments of inflorescence that accompany the specimens. Number 51*b* is also a collection from the type locality.

The species resembles *Puc. poculiformis* in its teleutospores, but is easily distinguished by the uredospores, both by their form and the number and arrangement of their pores.

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52. UROMYCES ACUMINATUS *Arth.* (1883, May. Bull. Minn. Acad. Sci. **2**: 35.)

52*a*. On *Spartina cynosuroides* (L.) Willd., II. iii, Spirit Lake, Iowa, *Arthur*.

52*b*. On *Spartina cynosuroides* (L.) Willd., III, Decorah, Iowa, *Holway*.

52*c*. On *Spartina cynosuroides* (L.) Willd., III, Spirit Lake, Iowa, *Arthur*.

52*d*. On *Spartina cynosuroides* (L.) Willd., III, Fargo, N. D., *Bolley*.

ORIG. DESCR. "I. Unknown. II and III. Sori linear, narrow, elongated, on the under surface of the leaves, plane or slightly convex, sunken, soon naked; encircling epidermis somewhat conspicuous. II. Uredosori yellowish, inconspicuous; uredospores large, round or elliptical, finely and plentifully echinulate, brownish yellow, 22 to 30μ broad by 26 to 35μ long. III. Teleutosporesori brownish-black; teleutospores oblong-club-shape and oblong-lanceolate to obovate, smooth, golden-brown, darker at the apex, 15 to 22μ broad by 25 to 42μ long; wall thin; apex much thickened, 8 to 12μ thick, more or less obliquely acuminate, or rarely only apiculate, sometimes with two pointed terminations, one longer than the other, very rarely obtuse or rounded, base narrowed or only acute; pedicel of uniform thickness, as long as the spore, or shorter, very rarely longer, colored."

SYN:

1883, July. *Uromyces spartinæ* Farl. Proc. Amer. Acad. Sci. 18:77.

O, I. Spermogonia and æcidia unknown.

II, III. Sori epiphyllous, between the nerves, linear, soon naked, ruptured epidermis conspicuous. II. Uredosori yellowish, inconspicuous; uredospores globose or broadly elliptical, large, 22–35μ in diameter, average 30μ, wall golden yellow, thick while immature, becoming thin, echinulate with low stout points, pores 5 to 8, scattered. III. Teleutosori blackish-brown, sunken between the nerves or protruding; teleutospores dark brown, obovate or oblong-clavate, 15–22 by 25–40μ, apex darker, acuminate or obtuse, or with two or more projections, much thickened, 8–12μ, base narrowed, pedicel colored, firm, once to thrice length of the spore, often shorter.

EXSIC:

Rabenhorst-Winter, Fungi Europaei, 3623.
Sydow, Ured., 251.
Ellis, N. Amer. Fungi, 239, 1443.
Seymour and Earle, Econ. Fungi, 67, 68, 546.

This species is very abundant in the upper Mississippi valley, but is also found throughout the northern United States and Canada. It is unusually variable in both sori and spores, and until recently (see Bot. Gaz. 34:3) has been separated into two species, the larger form, well represented by the accompanying 52*d*, being called *Urom. spartinæ*, and best shown in sea coast collections. The differences, however, appear to be of an ecological character, and scarcely worthy of taxonomic recognition.

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53. PUCCINIA SEYMOURIANA *Arth.* (1902. Bot. Gaz. 34:11.)

53*a*. On *Spartina cynosuroides* (L.) Willd., ii. III, Racine, Wis., *Davis*.
53*b*. On *Spartina cynosuroides* (L.) Willd., III, Racine, Wis., *Davis*.

ORIG. DESCR. "Sori epiphyllous, intercostal, prominent, oblong, ruptured epidermis inconspicuous. II. Uredospores globose, or broadly elliptical, 26–39 by 30–45μ, contents orange when fresh, becoming faintly yellow when old, at first globose, afterward angular and shrunken, wall colorless, thickened above, sometimes to more than half the diameter of the spore, prominently tuberculate, pores obscure. III. Teleutosori pulvinate, chocolate brown; teleutospores elliptical or oblong, 20–26 by 37–52μ, slightly constricted at the septum, apex obtuse, thickened; pedicel firm, slender, tinted, once to thrice the length of the spore."

EXSIC.

Ellis and Everhart, N. Am. Fungi, 1474.
Seymour and Earle, Econ. Fungi, 69.
Rabenhorst-Winter-Pazschke, Fungi Europaei, 4026.

This species is not so common as the following one, and does not have so wide a distribution. It is at present known from Massachusetts, Wisconsin, Illinois, Iowa, North Dakota and Ontario. Until recently (see Bot. Gaz. 34:12) it has been confounded with the following species, from which it can be readily distinguished by the position of the teleutosori on the upper (rough) side of the leaf, and by the unique uredospores. Number 53*a* of the accompanying distribution is part of the type collection.

There is reason to believe, especially from the similarity of spore structure, that the æcidial stage of this species inhabits *Cephalanthus* (*Æcidium cephalanthi* Seym.), but no cultures have yet been successfully carried out.

In Ellis and Everhart's exsiccati No. 1474 the host is erroneously stated to be *Phragmites communis;* it has not yet been observed upon any other host than *Spartina cynosuroides.*

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54. Puccinia fraxinata (*Lk.*) *Arth.* (1902. Bot. Gaz. 34:6.)

54*a*. On *Fraxinus lanceolata* Borck. (F. viridis Michx. f.) O, I. Rockport, Kas., *Bartholomew.*

54*b*. On *Fraxinus lanceolata* Borck. I. Spirit Lake, Iowa, *Arthur.*

54*c*. On *Fraxinus lanceolata* Borck., I. South Hero, Vt., *Jones.*

54*d*. On *Fraxinus pennsylvanica* Marsh., (F. pubescens Lam.) O, I. Long Pine, Neb., *Bates.*

54*e*. On *Fraxinus pennsylvanica* Marsh., I, South Hero, Vt., *Jones.*

54*f*. On *Spartina cynosuroides* (L.) Willd., II, South Hero, Vt., *Jones.*

54*g*. On *Spartina cynosuroides* (L.) Willd., II, iii., Ames, Iowa, *Hume*.
54*h*. On *Spartina cynosuroides* (L.) Willd. ii, III., Palco, Kas., *Bartholomew*.
54*i*. On *Spartina cynosuroides* (L.) Willd., III, Rooks county, Kas., *Bartholomew*.
54*j*. On *Spartina cynosuroides* (L.) Willd., III, Decorah, Iowa, *Holway*.
54*k*. On *Spartina cynosuroides* (L.) Willd., III, Ames, Iowa, *Hume*.

ORIG. DESCR. "430. 1. Fraxini Sz. A peridiis in conum badium depressum elevatis, demum in lacinias latas fissis. Maculas badias rotundas in foliis subtus prominulas, supra planas, margine fusco cinctas efficit." Schweinitz in *Schrift. d. nat. Ges. zu Leipzig* **1**: 66.

SECOND DESCR. "Uredo peridermiospora, *n. s.* On *Spartina glabra*, Ocean Springs, Miss., Tracy, September, 1889. Epiphyllous, sori linear, near the base of the leaf, long covered by the remains of the ruptured epidermis; spores bright red, pyriform, echinulate, much thickened at the apex, 19–22 by 36–45µ; pedicel short but distinct." Ellis and Tracy in *Jour. Myc.* **6**: 77.

SYN:

1822. *Æcidium fraxini* Schw. Schrift. d. nat. Ges. zu Leipzig **1**: 66.
1825. *Cæoma fraxinatum* Link. Linné Sp. Pl. 6²: 62.
1890. *Uredo peridermiospora* E. & T. Jour. Myc. **6**: 77.
1896. *Puccinia sparganioides* E. & B. Erythea **4**: 2.
1899. *Puccinia peridermiospora* Arth. Science **10**: 565.

O. I. Spermogonia epiphyllous, yellow, inconspicuous, spermatia obovate or oblong, about 3 by 5µ. Æcidia hypophyllous or on petioles and fruit, in dense rounded groups, usually on swollen and discolored spots; peridia cylindrical, often elongated, margin lacerated; æcidiospores obovate or elliptical, 22–26 by 33–37µ, contents orange when fresh, becoming pale, wall colorless, thin at the sides but greatly thickened at the rounded apex, tuberculate.

II. III. Sori hypophyllous, amphigenous on some hosts, supercostal, very prominent, large, oblong, elongated on sheaths and culms, ruptured epidermis attached in shreds or disappearing. II. Uredosori pulverulent, at first bright orange, becoming yellowish and indistinct; uredospores obovate or elliptical, 22–30 by 33–44µ, contents orange when fresh, becoming pale, wall colorless, thin at the sides but greatly thickened at the rounded apex, prominently tuberculate, pores obscure. III. Teleutosori pulvinate, blackish-brown; teleutospores elliptical or oblong, 16–22 by 35–62μ, dark-brown, slightly constricted at the septum, apex obtuse, thickened, pedicel firm, slender, tinted, once to twice the length of the spore.

EXSIC.

Sydow, Uredineen, 262, 1167.
Ellis and Everhart, N. Am. Fungi, 1851, 3475.
Ellis and Everhart, Fungi Columb., 1288.
Carleton, Ured. Amer., 33.

This species is one of the most common of American grass rusts wherever *Spartina* grows. Until recently (see Bot. Gaz. 29 : 275, and 34 : 9) it was not given autonomous rank, but was associated with the rusts on *Phragmites* and *Arundinaria*. In its teleutosporic stage it is especially conspicuous on account of the large, blackish, and exceedingly numerous sori, which come upon the upper and exposed side (morphological under side) of the leaves as they stand on the plants in the field. When the leaves roll up in drying, the sori are still outside and attract attention.

The uredostage is of short duration, and is very rarely collected. We are especially indebted to L. R. Jones of Vermont and H. H. Hume, formerly of Iowa, for the collections in the present distribution, search having been made particularly for this purpose. The uredospores are remarkable for their greatly thickened apices. By removing the spores from an unbroken sorus with a point of a knife the spores with the pedicels attached may be secured, as in 54*g*.

The æcidiostage upon the various species of *Fraxinus* is often so abundant as to attract marked attention. The clusters of æcidia may be small or they may cause hypertrophy of the tissues and thickly cover swellings a half inch or more in diameter. This is especially likely to occur when the midrib or petiole of the leaf is attacked. The æcidial cups, when well grown, are long and cylindrical, which induced Schweinitz, undoubtedly, to transfer the form to the genus *Roestelia*, in his latter work, but the cups are fragile and herbarium specimens often fail to show the true structure of the uninjured form.

The æcidiospores are not only remarkable for their thickened apices, but for the close morphological resemblance between them and the uredespores. Both have a colorless wall, which is apically thickened, and studded with minute papillæ, and have protoplasmic contents of the same orange hue. The shape is also the same, except that the æcidiospores, receiving pressure from all sides while forming, are nearer isodiametric than the uredospores, which are somewhat elongated by the greater lateral pressure while in the sorus.

The record of cultures establishing the connection between the *Fraxinus* and *Spartina* forms may be found in the Botanical Gazette (29:275).

Number 54*h* of the present distribution is part of the type collection for *Puccinia sparganioides* Ellis & Barth. When first collected and described the host was supposed to be *Carex sparganioides*, afterwards it was considered to be *Carex stricta*, as stated on the label in Ellis and Everhart's N. A. F. No. 3475, but it is now known beyond question to be *Spartina cynosuroides*.

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55. PUCCINIA DISTICHLIDIS E. & E. (1893. Proc. Phila. Acad. Sci. for 1893: 152.)

55*a*. On *Spartina gracilis* Trin. III. Ten-mile Creek, Mont., *Anderson*.

ORIG. DESCR. "III. Sori elongated, 2–10 mm. long and 1–2 mm. wide, erumpent, naked, nearly black. Teleutospores oblong or oblong-elliptical, 45–70x15–20μ, constricted in the middle, pale brown, becoming deep chestnut brown; epispore smooth, thickened at summit which is either regularly rounded or sub-acuminately or mucronately pointed. Pedicels 80–100μ long, stout (6–7μ thick) and persistent, yellowish-hyaline."

SYN:

1898. *Dicæoma distichlidis* Kuntze. Rev. Gen. Pl. 3:468.

O. I. Spermagonia and æcidia unknown.

II. III. Sori epiphyllous, intercostal, early naked, ruptured epidermis conspicuous. II. Uredospores broadly elliptical, broadly obovate or globose, 26–32 by 27–40μ, wall pale yellow, thick, abundantly echinulate with stout points, pores six or more, scattered, indistinct, contents sometimes centrally shrunken. III. Teleutosori blackish, prominently linear-lanceolate with acute ends; teleutospores obovate or lance-oblong, 17–21 by 48–56μ, slightly constricted at the septum, apex obtuse or sub-acute, thickened, side-walls thin, base somewhat narrowed, pedicel firm, rather thick, tinted, as long as the spore or longer.

EXSIC:

Ellis and Everhart, N. Am. Fungi, 2890.
Griffiths, West Amer. Fungi, 14*a*.

This species, which occurs on *Spartina cynosuroides* as well as on *S. gracilis*, is at present known only from the northwestern United States: Montana, Wyoming, North Dakota, and northwestern Iowa. Until recently (Bot. Gaz. 34:14) it has been supposed to inhabit *Distichlis spicata*, owing to an error in determining the host of the type collection, and hence the specific name. The specimen in Ellis & Everhart's N. A. F. is in reality on *Spartina gracilis*, although stated to be on *Distichlis*. The very different *Puc. subnitens* Diet. is a true *Distichlis* rust, however.

The dark, pointed, epiphyllous teleutosori and the uredospores with their colored and uniformly thick walls readily distinguish this species from the other forms upon *Spartina*.

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56. PUCCINIA CHLORIDIS *Speg.* (1891. Fungi Guaranitici: 17).

56*a*. On *Chloris elegans* H. B. K., ii. III, Cardenas, Mex., *Holway*.
56*b*. On *Chloris elegans* H. B. K. III, Acamboro, Mex., *Holway*.

ORIG. DESCR. "Hemi puccinia; uredosporæ ovatæ minutissime asperulæ subhyalinæ; teleutosporæ obscure cinnamomeæ ellipsoideæ constrictulæ, læves non v. vix umbonatæ, pedicello hyalino elongato.

Hab. Ad folia viva Chloridis speciei cujusdam in herbosis propre Paraguari, Febr., 1884 (sub. n. 4310 et 4312).

Obs. Maculæ nullæ v. totum folium vix pallescens: sori hypophylli densiuscule gregarii, uredosporici teleutosporicis commixti. Sori uredospori minutissimi (100–150μ diam.) sublineares, epidermide lacerata cincti vix prominuli pallide flavescentes: uredosporæ e globoso-ovatæ (18–24 × 12–20μ) episporio, crassiusculo hyalino laxe minutissimeque papillato, endoplasmate nubiloso e hyalino flavescente farctæ non v. 1-guttulæ. Sori teleutosporici majores (300–600μ diam.) ex orbiculari elliptici, pulvinulato-prominuli subcompactiusculi, intense atro-fuliginei: teleutosporæ pulchre intenseque cinnamomeæ ellipticæ v. vix obovatæ (28–24 × 18–20μ) medio non v. vix constrictæ, episporio subcrassiusculo, præcipue ad apicem ubi sæpe parce umbonato, lævissimo, medio 1-septatæ, parce constrictæ, loculis sæpius minute 1-guttulatis, infero non v. vix minore, pedicello cylindraceo longiusculo (50–100 × 5μ) deorsum attenuato, antice chlorinulo, cæterum hyalino suffultæ: paraphyses non visæ."

SYN:

1892. *Puccinia chloridis* Diet. Hedw. 31:290.

O, I. Spermogonia and æcidia unknown.

II, III. Sori amphigenous and on stems and sheaths, oblong to oblong-linear, soon naked, ruptured epidermis evident. II. Uredosori pale, uredospores obovate or elliptical, small, 15–22 by 20–26μ, wall colorless or nearly so, comparatively thick, 2.5μ, and often twice as thick at the apex, minutely verrucose, pores minute and obscure. III. Teleutosori blackish, teleutospores oblong, oblong-globose or more rarely oblong-obovate, very dark brown, 19–26 by 28–40μ, slightly or not constricted at the septum, wall thick, 4μ, somewhat thicker at the apex, which is rounded or obtusish, base rounded or rarely somewhat narrowed, pedicel tinted, much more colored next the spore, collapsing into ribbon-form and becoming twisted, thick, two to three times the length of the spore, often attached obliquely.

Type material of Spegazzini's species, which was gathered in Brazil, has not been available for comparison with the North American forms. The description, however, so exactly accords with the specimens in hand, even to the uredospores, that we have no hesitancy in declaring them to be but one species. The statement in the original description that the teleutospores measure "28–24μ" is undoubtedly a misprint for 28–34, for the author everywhere else places the larger number last.

The type material of Dietel's species, which was gathered in Kansas on *Chloris verticillata*, has been examined, and does not differ materially from the Mexican collections. The gathering was made in the last of March and was considerably weathered. This undoubtedly accounts for the yellowed walls of the uredospores and for the more delicate and twisted pedicels of the teleutospores.

The uredospores of this species are especially interesting because they belong to a class having a colorless wall, often noticeably thickened at the apex, and roughened with minute equidistant papillæ, of which *Puc. fraxinata* is the best known example. It is likely that the æcidium when discovered will be found to have spores with corresponding characteristics.

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57. PUCCINIA SCHEDONNARDI *Kell. & Sw.* (1888. Jour. Myc. 4:95.)

57*a*. On *Schedonnardus paniculatus* (Nutt.) Trel. (S. Texanus *Steud.*), III, Rooks county, Kans., *Bartholomew*.

57*b*. On *Schedonnardus paniculatus* (Nutt.) Trel., III, Long Pine, Neb., *Bates*.

ORIG. DESCR. II. Sori amphigenous, but mostly hypophyllous, soon erumpent, surrounded by the ruptured epidermis, small (one-fifth to one-half millimetre in diameter) oval or oblong, solitary. Uredospores dull orange, globular, 20–25 micr. diameter, mostly 22 micr., always free from pedicels when mature, covered with short sparse tubercles; pedicels subpersistent, hyaline or slightly tinted, enlarged at tip, base 3–5 micr. in diameter, tip 5–8 micr.

III. Sori amphigenous, small (one-sixth to one-half millimetre in diameter) mostly circular, solitary or rarely confluent, though often abundant, teleutospores clear brown, slightly constricted at the middle and often slightly thickened at the apex, subglobose, oval or oval-oblong, 27–35 × 20–26, mostly 28–30 × 21–24, pedicel variable, tapering, tinted, usually once to thrice as long as the spores."

SYN:

1898. *Dicæoma schedonnardi* Kuntze. Rev. Gen. Pl. 3:470.

EXSIC:

Kellerman and Swingle, Kansas Fungi, 44.

Not a very abundant or widely distributed species. The uredospores have golden yellow walls, that are thin, and are minutely and closely verrucose. The pores are small and difficult to count, but are certainly more than four, and scattered over the surface without order.

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58. PUCCINIA VEXANS *Farl.* (1883. Proc. Amer. Acad. Sci. 18:82.)

58*a*. On *Atheropogon curtipendulus* (Michx.) Fourn. (Bouteloua curtipendula *Torr*, and B. racemosa *Lag*.), II. iii, Lafayette, Ind., *Stuart*.

58*b*. On *Atheropogon curtipendulus* (Michx.) Fourn, X. iii, Long Pine, Neb., *Bates*.

58*c*. On *Atheropogon curtipendulus* (Michx.) Fourn., X. ii, Hot Springs, N. M., *Holway*.

58*d*. On *Atheropogon curtipendulus* (Michx.) Fourn., x. III, Lafayette, Ind., *Stuart*.

58*e*. On *Atheropogon curtipendulus* (Michx.) Fourn., III, Decorah, Iowa, *Holway*.

ORIG. DESCR. "Uromyces Brandegei.—Spots none; sori scattered, rarely slightly confluent, prominent, orbicular, elliptical or oblong, black; spores subglobose or broadly elliptical, rough with minute warts or papillæ, .0012–.0016 of an inch long, .0011–.0015 broad; pedicel hyaline, usually equal to or exceeding the spore in length."—Peck, l. c.

SECOND DESCR. "The two-celled spores are oval, obtuse at both ends, smooth or somewhat roughened in the upper part, and measure from 30–38μ × 19–24μ. The one-celled spores are dark brown, like the two-celled, obovate, distinctly papillate or roughened in the upper part, and of about the same dimensions as the two-celled, perhaps a trifle smaller." Farlow, l. c.

SYN:

1879. *Uromyces brandegei* Peck. Bot. Gaz. 4:127.

O. I. Spermogonia and æcidia unknown.

II. Uredosori amphigenous, oblong, tardily naked, brownish-yellow, inconspicuous; uredospores globose, 23–33μ in diameter, wall golden-brown, thin, echinulate, pores 8, scattered.

III. Teleutosori amphigenous, oblong, pulvinate, early naked, ruptured epidermis inconspicuous, blackish-brown; teleutospores oval, very dark brown, rounded at both ends or somewhat narrowed below, 18–25 by 28–40μ, wall medium thickness, about 3μ, very slightly thickened above, smooth or rarely roughened in the upper part, (not constricted at the septum) pedicel moderately stout, firm, tinted, once to twice the length of the spore.

X. Amphisori amphigenous, resembling the teleutosori but a little lighter brown; amphispores broadly obovate to globose, of the same dark brown color as the teleutospores, 28–34 by 32–45μ, side-walls thick, 5μ, much thicker above, strongly papillate above, becoming less so toward the base, pores 3, equatorial, inconspicuous, pedicel persistent, like that of the teleutospores.

EXSIC:

Seymour and Earle, Econ. Fungi, 532*a*, 532*b*.
Sydow, Uredineen, 1086.
Ellis, N. Am. Fungi, 1051.
Rabenhorst-Winter, Fungi Europæi, 3718.
Griffiths, West Am. Fungi, 253.

The amphispores of this species were the first form to attract attention, being described as a species of *Uromyces*. Not long afterwards the supposed uredo form was described by one of the present writers, first as an emendation to the original description (*Bull. Minn. Acad. Sci.* 2:36), and subsequently as a species of *Uredo* (*Uredo boutelouæ* Arth., in *Bull. Iowa Agric. College* for Nov. 1884: 164), some doubt having arisen of the wisdom of the first assignment, as no teleutospores had been found closely associated with it. The author of the species has now ascertained beyond question that the host of *Uredo boutelouæ* is not a *Bouteloua*, but is *Poa pratensis* and the name, therefore, does not apply to the uredo of *Puc. vexans* and is not a synonym of that species.

About the time of this unfortunate error, it was shown by Dr. W. G. Farlow, (l. c.) in comments upon a collection made by one of the present writers and distributed in Ellis' N. Am.

Fungi, No. 1051, that the supposed *Uromyces* was associated with genuine bilocular teleutospores, even in the same sorus, and that the species must be transferred to the genus *Puccinia*. He says regarding the Uromyces-like spores: "I have not been able to find any other spores which represent the uredo of the species, and never having seen the unicellular spores in germination, there is, so far as we yet know, no reason why they may not be the uredo spores." The true nature of these spores remained in doubt until within a year or so. They were brought to germination by Mr. M. A. Carleton (Science **13**:249) who found that they were neither uredospores nor teleutospores, but a new sort, to which he has given the name *amphispore*. On account of their abundance and highly attractive form the amphispores of *Puc. vexans* are likely always to be considered the best representative of this kind of development.

The true uredo form of this species, which has the general characteristics of the uredo of other grass forms, has rarely been collected, or even seen. So far as we know, the only genuine record of it is in the Catalogue of the Flora of Nebraska, 1890. It was found by Mr. H. J. Webber, the author of the Catalogue, at Crawford, Neb., in the latter part of July. He feels sure of the genetic connection, "having several times found the uredospores and teleutospores in the same sorus" (p. 68). From the context we learn that the specimens bore only uredospores and amphispores, not true teleutospores. It should be noted that the spores of this species of whatever form are without paraphyses.

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59. PUCCINIA BARTHOLOMÆI *Diet.* (1892. Hedw. **31**:290.)

59*a*. On *Bouteloua oligostachya* (Nutt.) Torr., II. III., Rooks county, Kans., *Bartholomew*.

59*b*. On *Bouteloua oligostachya* (Nutt.) Torr., III, Valentine, Neb., *Bates*.

59*c*. On *Bouteloua hirsuta* Lag., III, Simeon, Neb., *Bates*.

59*d*. On *Atheropogon curtipendulus* (Michx.) Fourn. (Bouteloua curtipendula *Torr.*), III, Austin, Texas, *Long*.

59*e*. On *Leptochloa dubia* Nees., ii. III, near Tula, Mex., *Holway*.

ORIG. DESCR. "Puccinia Bartholomewii n. sp. Amphigena, sori nudi, pulvinati, elliptici vel oblongi, ⅓–2 mm. longi, interdum confluentes. Uredosporæ globosæ vel ovoideæ, flavo-brunneæ, dense et breviter echinulatæ, ca. 24μ longæ, 22μ latæ. Sori teleutosporiferi fusco-atri; teleutosporæ utrinque rotundatæ, medio vix constrictæ, apice parum incrassatæ, leves, longe (usque 140μ) pedicellatæ, obscure brunneæ. Longitudo sporarum 32–40μ, latitudo 20–24μ.

In foliis Boutelouæ oligostachyæ, Kansas (Amer. bor.) Martio 4, 1892, legit E. Bartholomew (No. 522), comm. J. B. Ellis."

SYN:

1898. *Dicæoma Bartholomewii* Kuntze. Rev. Gen. Pl. 3:468.

O. I. Spermogonia and æcidia unknown.

II. Uredosori amphigenous, oblong, pale yellow, incompletely uncovered, pulverulent, ruptured epidermis conspicuous; uredospores ovoid or globose, 18–23 by 23–26μ, contents orange-yellow when fresh, wall medium thick, colorless, minutely tuberculate or sometimes barely echinulate, pores obscure, 4 or more, scattered.

III. Teleutosori amphigenous but especially hypophyllous, pulvinate, early naked, blackish-brown, ruptured epidermis usually noticeable; teleutospores broadly oblong, elliptical, or nearly globose, dark brown, not constricted at the septum, 20–25 by 27–40μ, side-walls medium thick, apex rounded or very obtuse, slightly thickened, base rounded, pedicel once to twice the length of the spore, 4–8μ thick, delicate and often collapsed, tinted.

EXSIC:

Ellis & Everhart, N. Am. Fungi, 2990, 3349.
Bartholomew, Ellis & Everhart's Fungi Columbiani, 1569.
Sydow, Uredineen, 1061.
Griffiths, West Amer. Fungi, 269.

This species is common on different species of *Bouteloua*, especially on *B. oligostachya*, from Iowa, Nebraska, and Kansas to Texas, but rare on *Atheropogon*. Its gross appearance is not materially different from that of *Puc. vexans*, which occurs on the same hosts throughout the same region.

It does not, however, like that species, possess amphispores, and its uredospores are of an entirely different class.

Dietel (Hedwigia 31:290) has called attention to the resemblances between *Puc. chloridis*, *Puc. dochmia* (by which is meant the *Puc. muhlenbergiæ* of this article), and *Puc. bartholomæi*. There is indeed much similarity between the first and last named, in both teleutospores and uredospores, as may be seen at a glance by comparing the figures under numbers 56 and 59, or by comparing descriptions. The uredospores, especially, are notably alike in being small, with colorless, verrucose, and rather thick walls. Those of *Puc. bartholomæi*, however, seem to have no tendency toward apical thickening.

In all three species referred to by Dietel the teleutospores show a considerable intermixture of globoid spores with the septum oblique or even vertical. This tendency is still more marked in the true *Puc. dochmia*. A form on *Bouteloua curtipendula* was collected at College Station, Texas, in 1889, by N. S. Jennings, and was described by the collector (Bull. Texas Exper. Sta. No. 9:25) in 1890 under the name of *Diorchidium boutelouæ*, which appears to bear about the same relation to *Puc. bartholomæi* that *Puc. dochmia* does to *Puc. muhlenbergiæ*, or possibly a closer relation. The uredospores are very similar in size and other characters to those of *Puc. bartholomæi*, but the teleutospores differ in being almost wholly diorchidium-like. This form does not appear to have been collected but once. The specimen in the present distribution shows no unusual diorchidium tendency.

The spelling of the specific name here used is in accord with correct Latin form, as pointed out by Mr. E. Bartholomew being slightly changed from the spelling in the original publication.

---

60. PUCCINIA KANSENSIS *Ell. & Barth.* (1896. Erythea 4:1.)

60*a*. On *Bulbilis dactyloides* (Nutt.) Raf. (Buchloe dactyloides *Engelm.*) ii. III, Rooks county, Kans., *Bartholomew*.

ORIG. DESCR. "II and III. Sori amphigenous or mostly epiphyllous, sparsely scattered, very small, sublinear to linear by confluence. Uredosori soon appearing through the ruptured epidermis, which falls away leaving the spore-mass mostly superficial. Uredospores subglobose or ovate, 16–20 × 14–16μ, epispore smooth but irregular, thick (about 2–3μ), hyaline; nucleus consisting of coarse, bright golden-yellow, granular matter. Teleutosori almost wholly superficial. Teleutospores bright yellowish-brown, short-elliptical, rounded, slightly constricted, nearly equal, lower cell sometimes wedge-shaped, not thickened at apex, 25–30 × 15–18μ. Pedicels hyaline, short, weak and shriveled, inclining to fall away. Differs from *Puccinia buchloes* Schaf. on the same host, in its smaller teleutospores, not thickened at the apex, and in its weak, shriveled, hyaline pedicels."

EXSIC:

Ellis and Everhart, N. Am. Fungi, 3351.
Seymour and Earle, Econ. Fungi Suppl., B 13.
Sydow, Uredineen, 1073.

This species has very small spores, without apical thickenings. The uredospores have colorless walls and orange-yellow contents when fresh. The surface is minutely and densely verrucose with occasional slight echinulation. The pores are minute, obscure, and scattered over the surface without order.

The species has not yet been reported from any locality outside the state of Kansas. The type was collected Sept. 18, 1894.

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 milimeters by two, the result being in microns (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.

45*a*. Uromyces aristidæ *E. & E.*
On *Aristida basiramea* Engelm., from Nebraska.
Two uredospores and five teleutospores.

45*b*. Uromyces aristidæ *E. & E.*
On *Aristida oligantha* Michx., from Texas.
Five teleutospores.

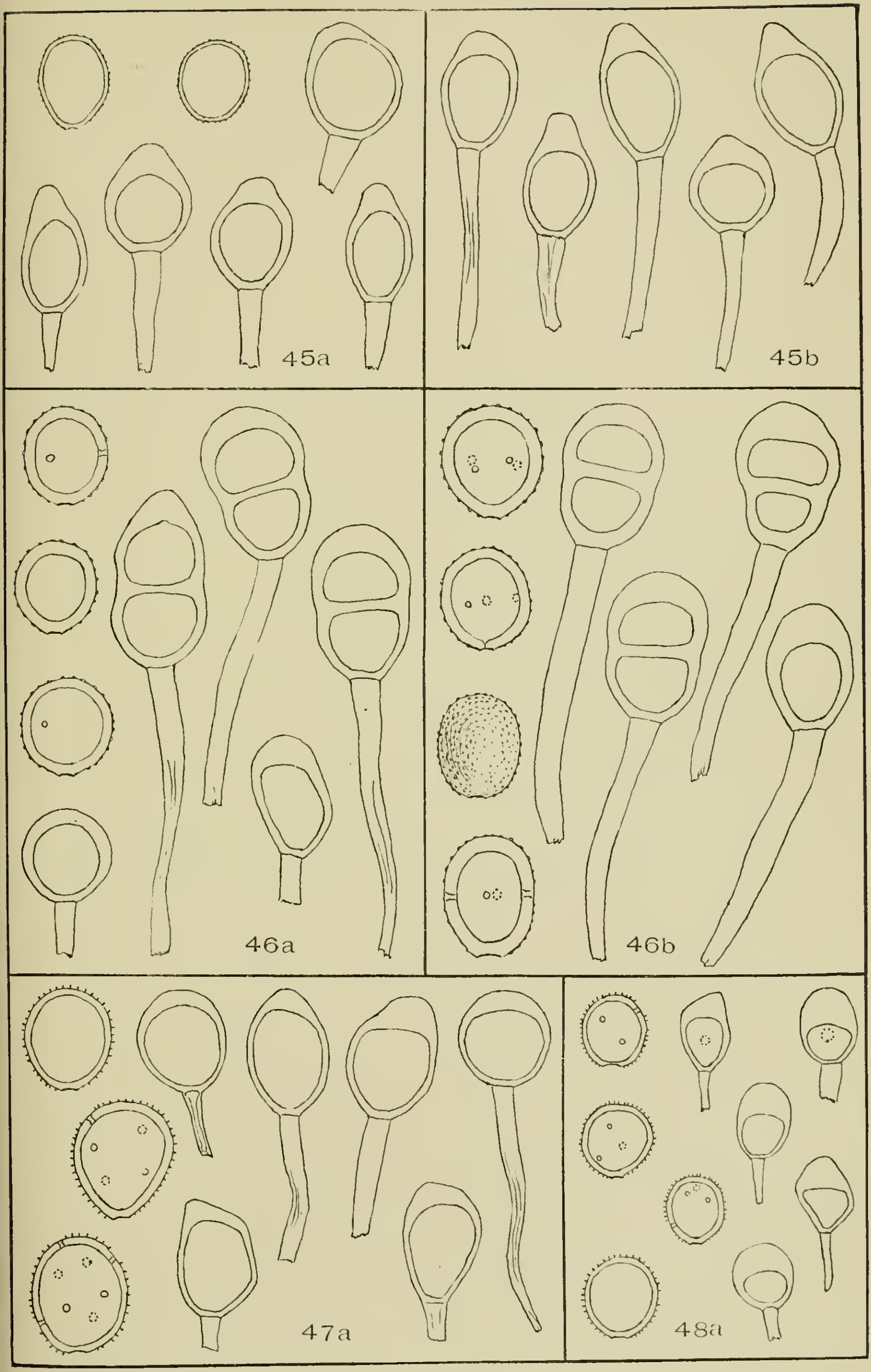
46*a*. Puccinia aristidicola *Henn.*
On *Aristida fasciculata* Torr., from Mexico.
Three uredospores and five teleutospores.

46*b*. Puccinia aristidicola *Henn.*
On *Aristida fasciculata* Torr., from Mexico.
Four uredospores, one drawn as if opaque, and four teleutospores.

47*a*. Uromyces epicampus *Diet. & Holw.*
On *Epicampus macroura* Benth., from Mexico.
Three uredospores and six teleutospores.

48*a*. Uromyces minimus *Davis.*
On *Muhlenbergia sylvatica* Torr., from Wisconsin.
Four uredospores and five teleutospores.

PLATE I.



Explanation of Plate II.

49*a*. Puccinia dochmia *Berk. & Curt.*
On *Muhlenbergia ciliata* Trin., from Mexico.
One uredospore and six teleutospores.

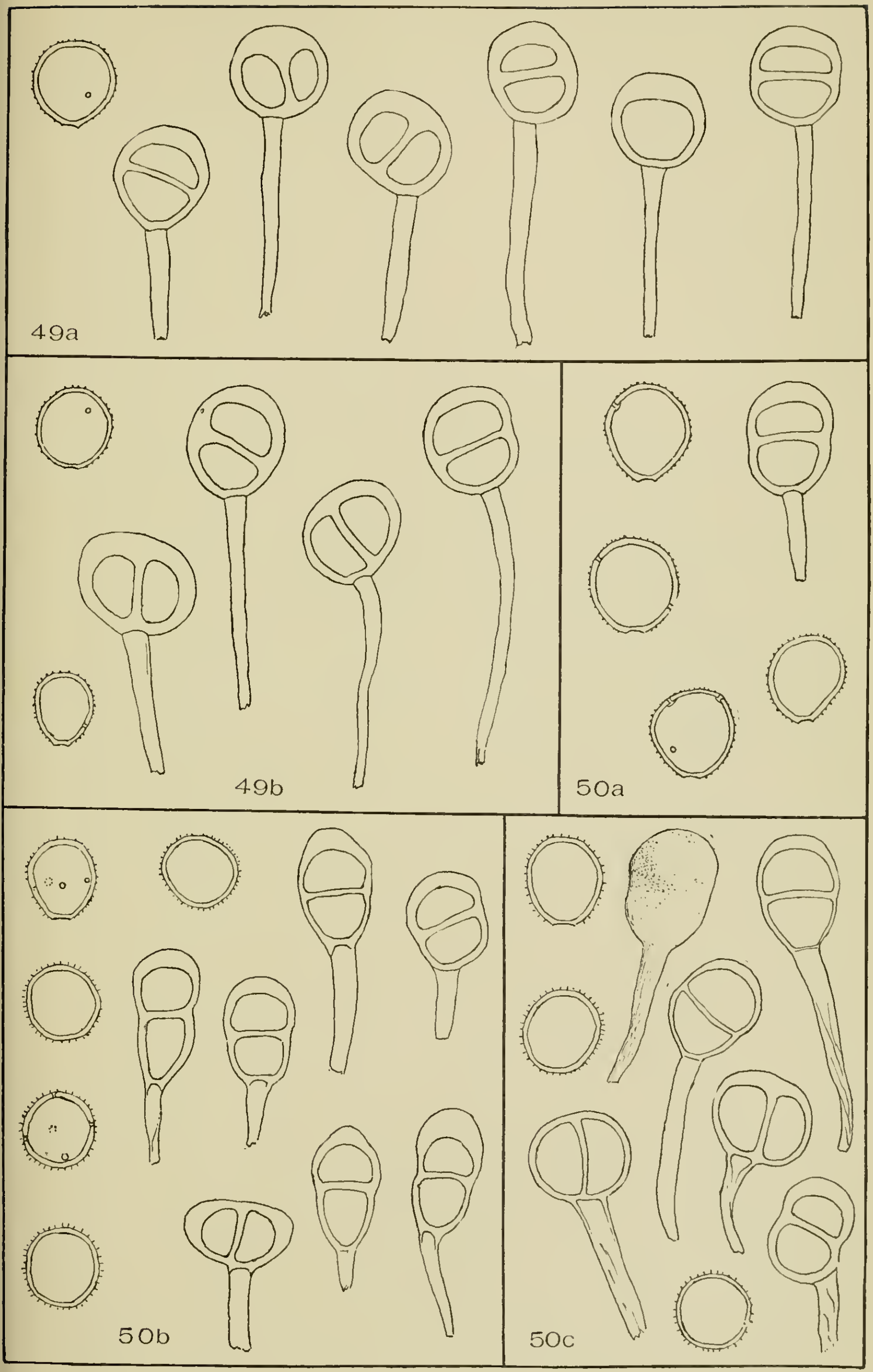
49*b*. Puccinia dochmia *Berk. & Curt.*
On *Perieilema crinitum* Presl., from Mexico.
Two uredospores and four teleutospores.

50*a*. Puccinia muhlenbergiæ *Arth. & Holw.*
On *Muhlenbergia diffusa* Willd., from Indiana.
Four uredospores and one teleutospore.

50*b*. Puccinia muhlenbergiæ *Arth. & Holw.*
On *Muhlenbergia mexicana* (L.) Trin., from Iowa.
Five uredospores and seven teleutospores.

50*c*. Puccinia muhlenbergiæ *Arth. & Holw.*
On *Muhlenbergia mexicana* (L.) Trin., from Kansas.
Three uredospores and six teleutospores, one drawn as if opaque.

PLATE II.



Explanation of Plate III.

50*d*. Puccinia muhlenbergiæ *Arth. & Holw.*
On *Muhlenbergia racemosa* (Michx.) B. S. P., from Nebraska.
One uredospore and five teleutospores.

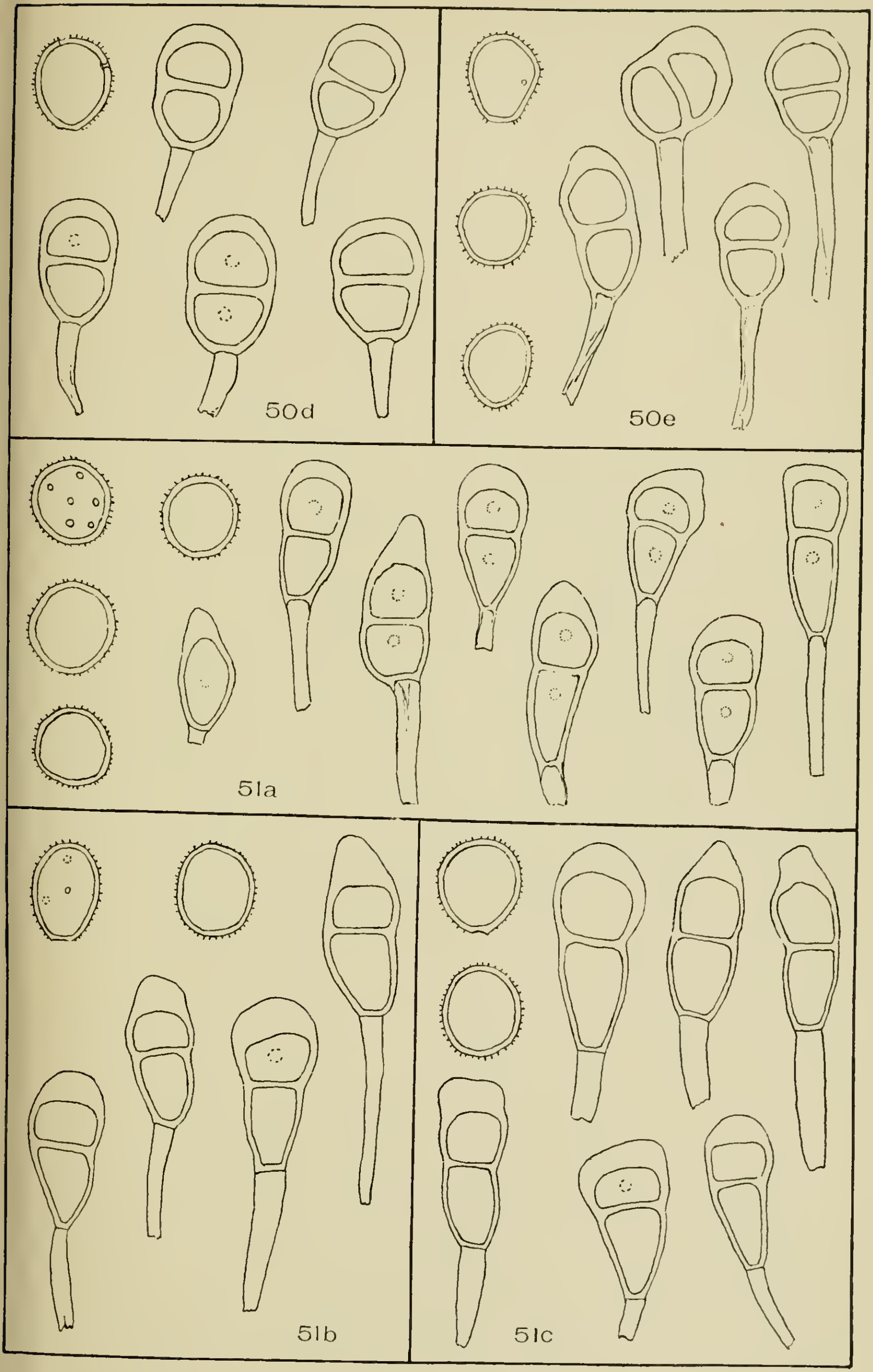
50*e*. Puccinia muhlenbergiæ *Arth. & Holw.*
On *Muhlenbergia racemosa* (Michx.) B. S. P., from Kansas.
Three uredospores and four teleutospores.

51*a*. Puccinia amphigena *Diet.*
On *Calamovilfa longifolia* (Hook.) Hack., from Illinois.
Four uredospores and eight teleutospores.

51*b*. Puccinia amphigena *Diet.*
On *Calamovilfa longifolia* (Hook.) Hack., from Illinois.
Two uredospores and four teleutospores.

51*c*. Puccinia amphigena *Diet.*
On *Calamovilfa longifolia* (Hook.) Hack., from Nebraska.
Two uredospores and six teleutospores.

PLATE III.



Explanation of Plate IV.

52*a*. Uromyces acuminatus *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Iowa.
Five uredospores and one teleutospore.

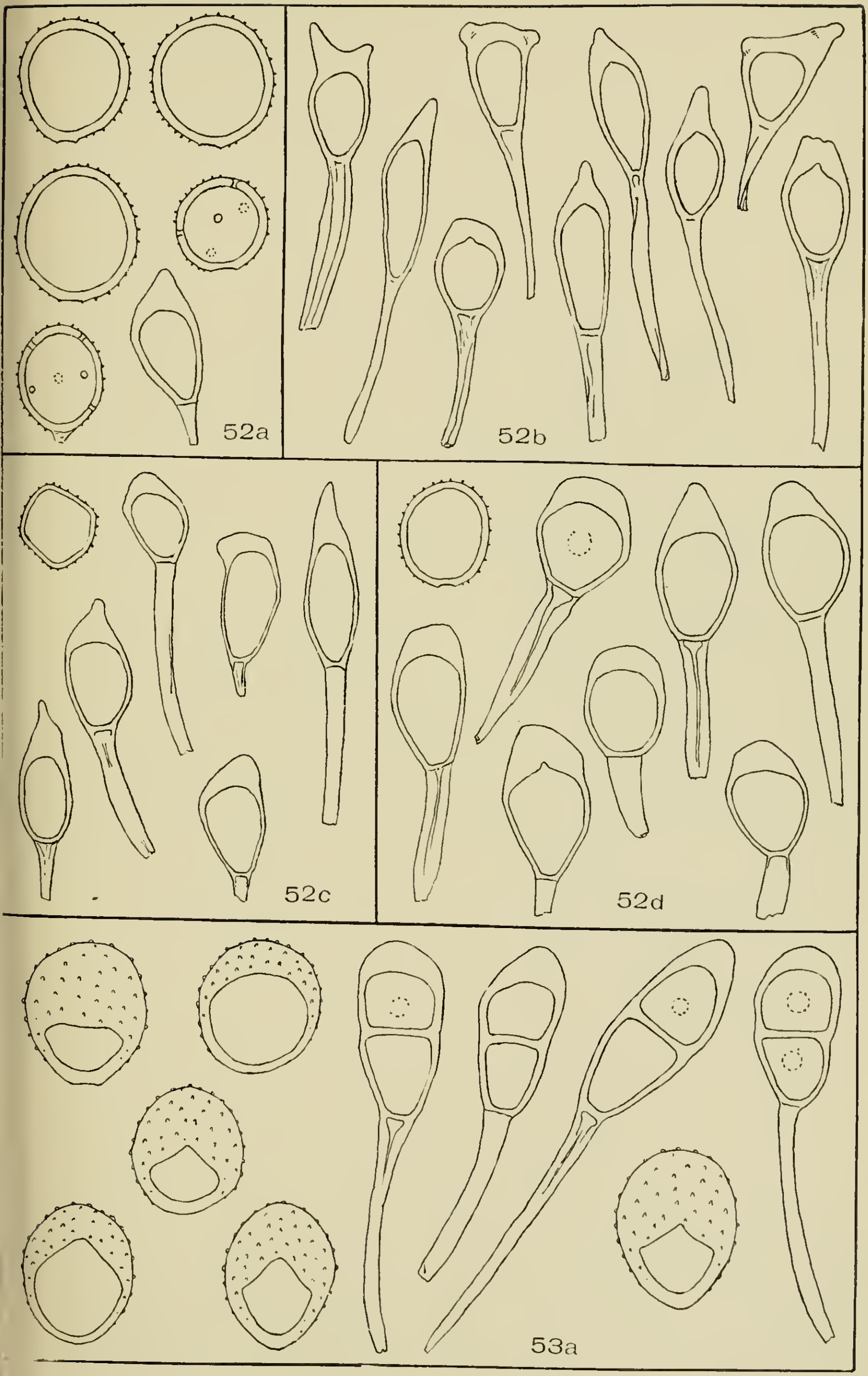
52*b*. Uromyces acuminatus, *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Iowa.
Nine teleutospores; a slender form.

52*c*. Uromyces acuminatus *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Iowa.
One uredospore and six teleutospores.

52*d*. Uromyces acuminatus *Arth.*
On *Spartina cynosuroides* (L.) Willd., from North Dakota.
One uredospore and seven teleutospores.

53*a*. Puccinia seymouriana *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Wisconsin.
Six uredospores and four teleutospores.

PLATE IV.



EXPLANATION OF PLATE V.

53*b*. PUCCINIA SEYMOURIANA *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Wisconsin.
Five teleutospores.

54*a*. PUCCINIA FRAXINATA (*Lk.*) *Arth.*
On *Fraxinus lanceolata* Borck., from Kansas.
Five æcidiospores.

54*b*. PUCCINIA FRAXINATA (*Lk.*) *Arth.*
On *Fraxinus lanceolata* Borck., from Iowa.
Four æcidiospores.

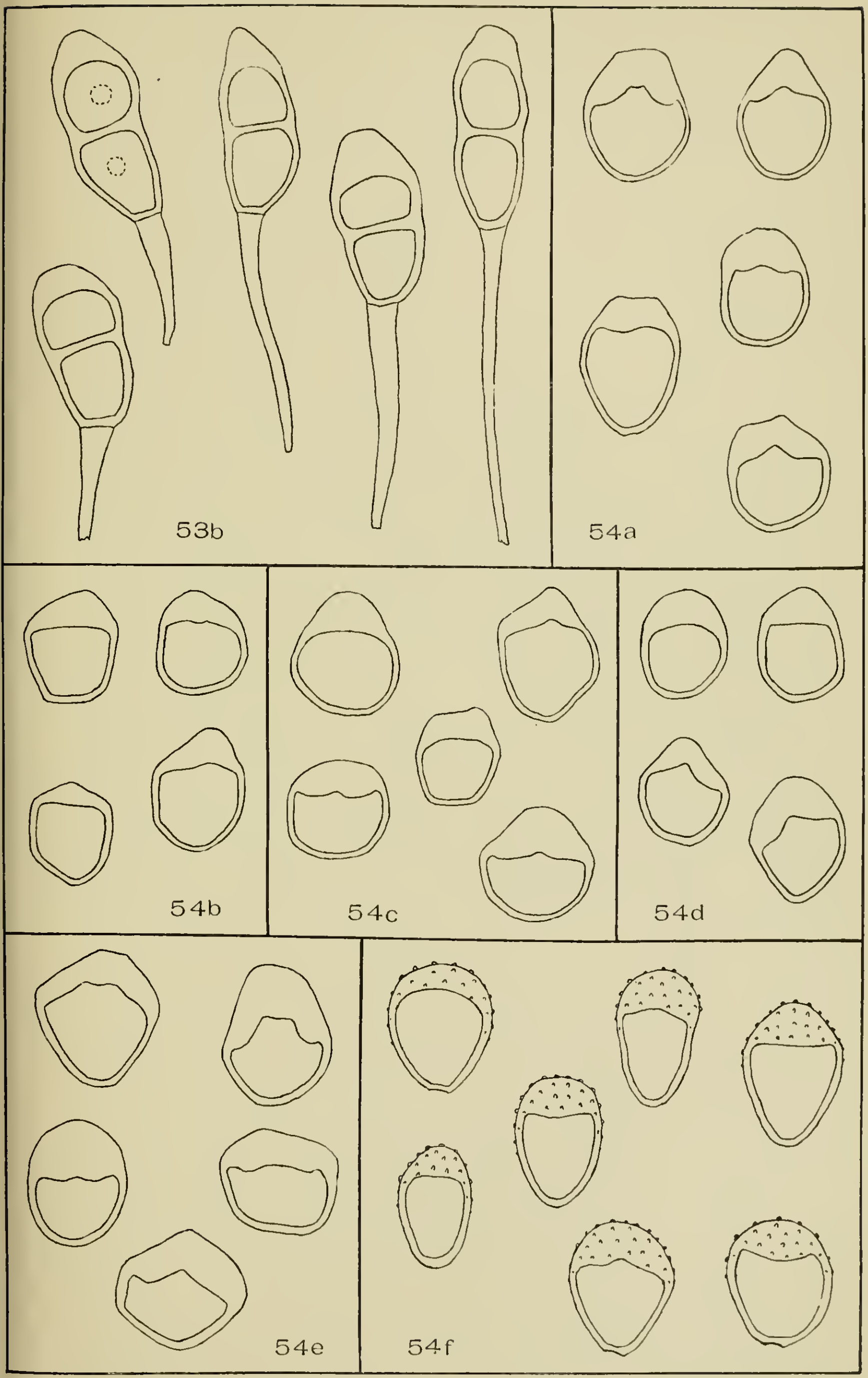
54*c*. PUCCINIA FRAXINATA (*Lk.*) *Arth.*
On *Fraxinus lanceolata* Borck., from Vermont.
Five æcidiospores.

54*d*. PUCCINIA FRAXINATA (*Lk.*) *Arth.*
On *Fraxinus pennsylvanica* Marsh., from Nebraska.
Four æcidiospores,

54*e*. PUCCINIA FRAXINATA (*Lk.*) *Arth.*
On *Fraxinus pennsylvanica* Marsh., from Vermont.
Five æcidiospores.

54*f*. PUCCINIA FRAXINATA (*Lk.*) *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Vermont.
Seven uredospores.

PLATE V.



Explanation of Plate VI.

54*g*. Puccinia fraxinata (*Lk.*) *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Iowa.
Six uredospores, two shown with pedicels, and one teleutospore.

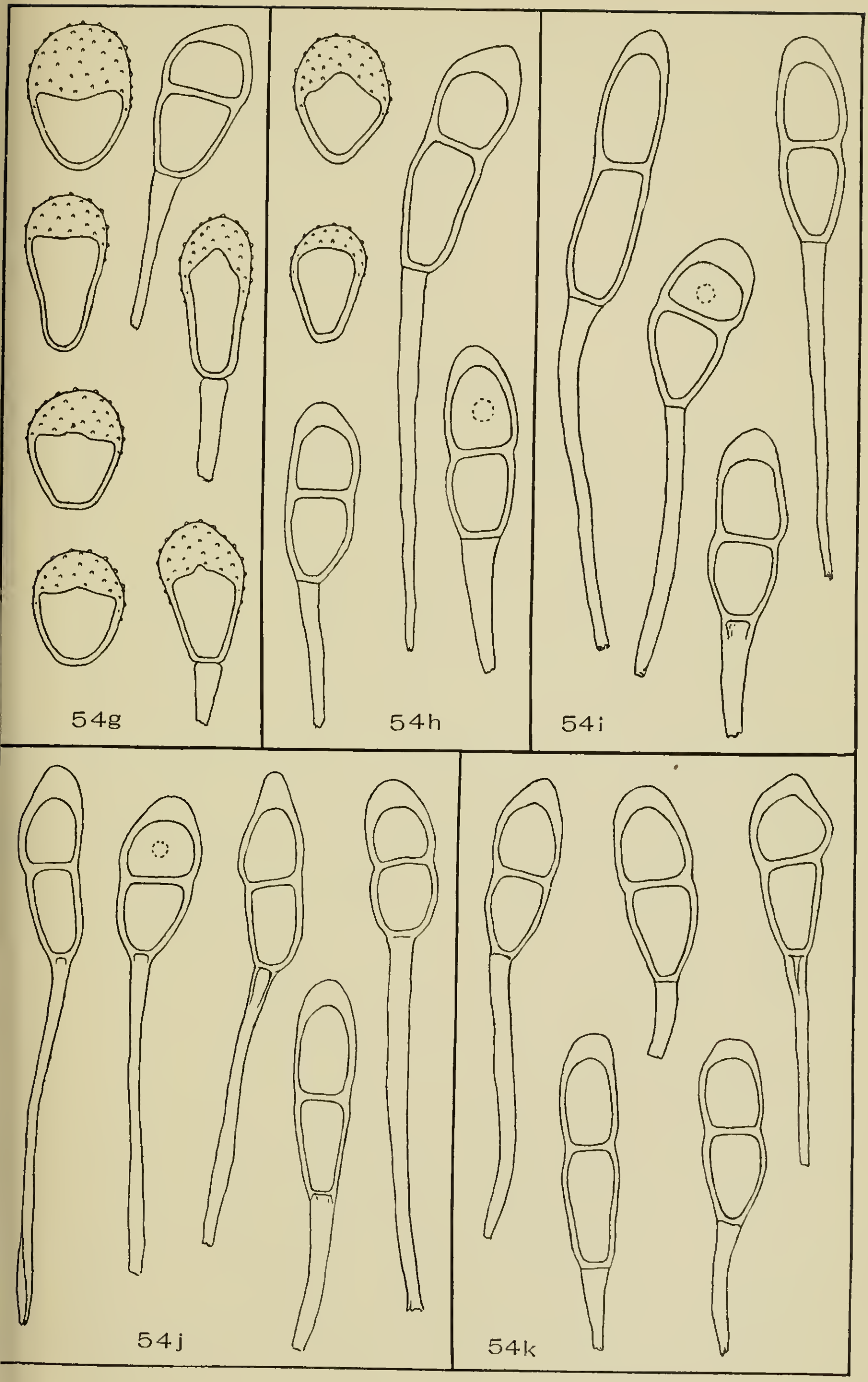
54*h*. Puccinia fraxinata (*Lk.*) *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Kansas.
Two uredospores and three teleutospores.

54*i*. Puccinia fraxinata (*Lk.*) *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Kansas.
Four teleutospores.

54*j*. Puccinia fraxinata (*Lk.*) *Arth.*
On *Spartina cynosuroides* (L.) Willd., from Iowa.
Five teleutospores.

54*k*. Puccinia fraxinata (*Lk.*) *Arth.*
On *Spartina fraxinata* (L.) Willd., from Iowa.
Five teleutospores.

PLATE VI.



Explanation of Plate VII.

55*a*. Puccinia distichlidis *E. & E.*
On *Spartina gracilis* Trin., from Montana.
Three uredospores, one drawn as if opaque, and four teleutospores

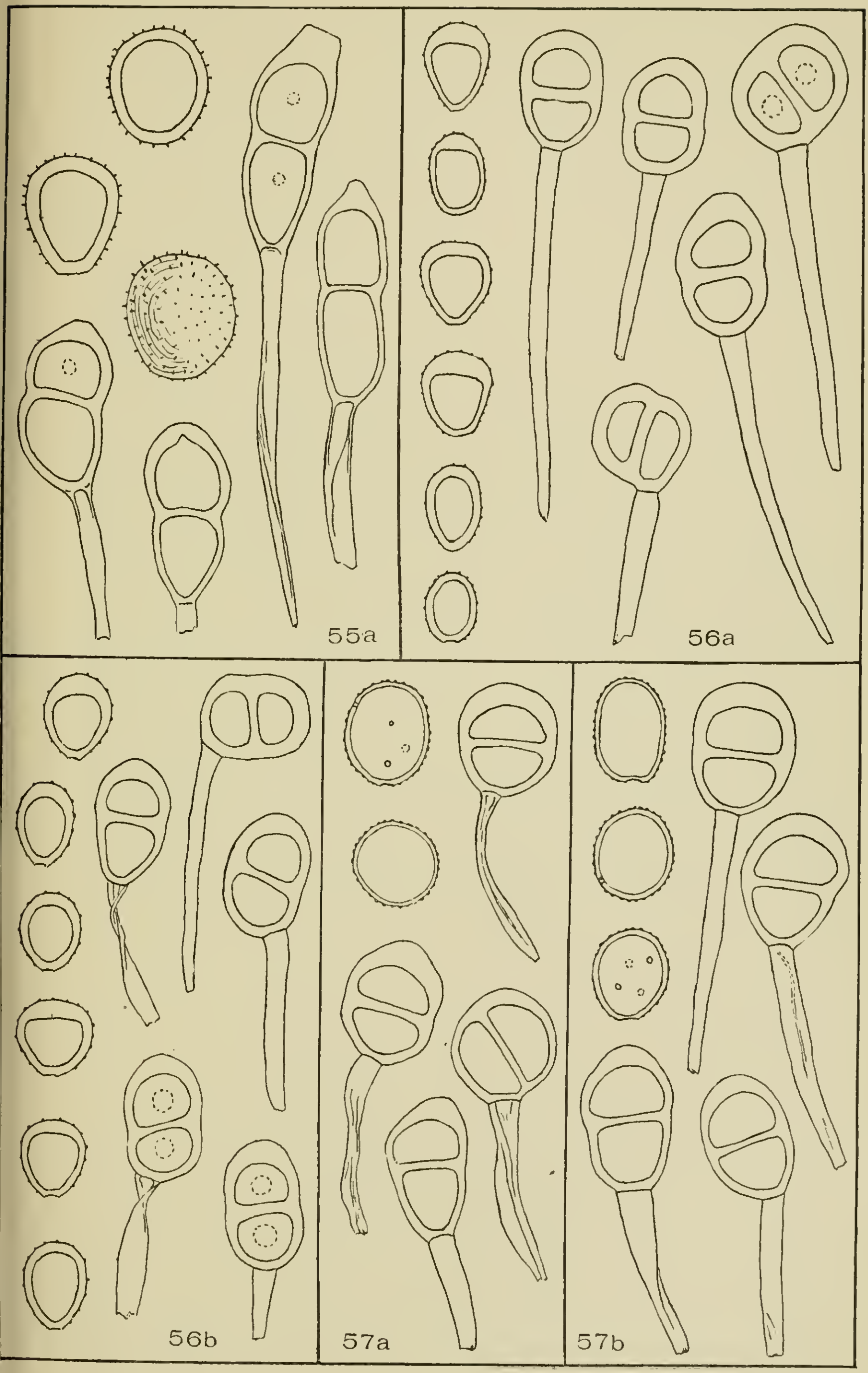
56*a*. Puccinia chloridis *Speg.*
On *Chloris elegans* H. B. K , from Mexico.
Six uredospores and five teleutospores.

56*b*. Puccinia chloridis *Speg.*
On *Chloris elegans* H. B. K., from Mexico.
Six uredospores and five teleutospores.

57*a*. Puccinia schedonnardi *Kell. & Sw.*
On *Schedonnardus paniculatus* (Nutt.) Trel., from Kansas.
Two uredospores and four teleutospores.

57*b*. Puccinia schedonnardi *Kell. & Sw.*
On *Schedonnardus paniculatus* (Nutt.) Trel., from Nebraska.
Three uredospores and four teleutospores.

PLATE VII.



Explanation of Plate VIII.

58*a*. Puccinia vexans *Farl.*
On *Atheropogon curtipendulus* (Michx.) Fourn., from Indiana.
Four uredospores, one amphispore and one teleutospore.

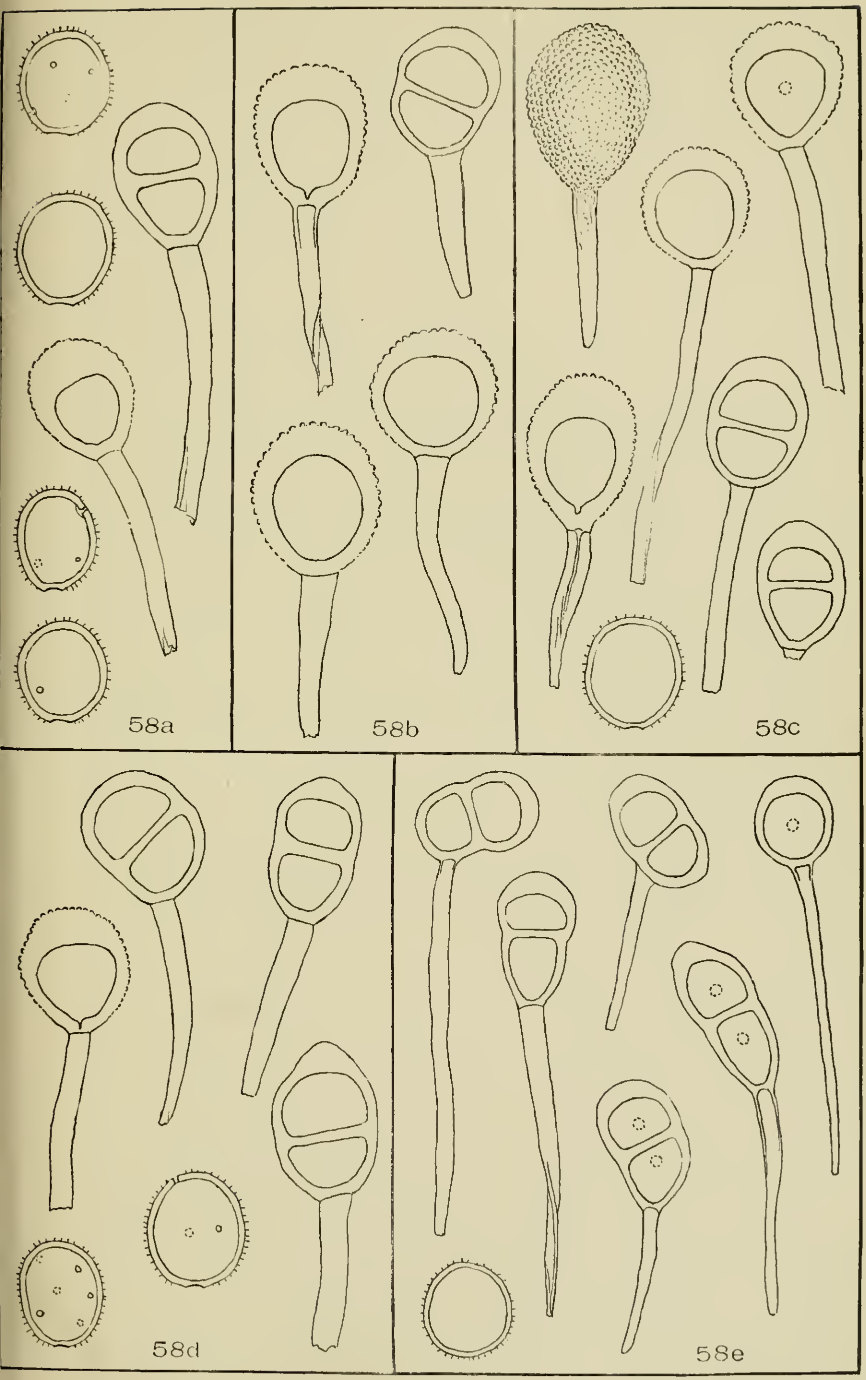
58*b*. Puccinia vexans *Farl.*
On *Atheropogon curtipendulus* (Michx.) Fourn., from Nebraska.
Three amphispores and one teleutospore.

58*c*. Puccinia vexans *Farl.*
On *Atheropogon curtipendulus* (Michx.) Fourn., from New Mexico.
One uredospore, four amphispores, one drawn as if opaque, and two teleutospores.

58*d*. Puccinia vexans *Farl.*
On *Atheropogon curtipendulus* (Michx.) Fourn., from Indiana.
Two uredospores, one amphispore, and three teleutospores.

58*e*. Puccinia vexans *Farl.*
On *Atheropogon curtipendulus* (Michx.) Fourn., from Iowa,
One uredospore and six teleutospores.

PLATE VIII



Explanation of Plate IX.

59*a*. Puccinia bartholomæi *Diet.*
On *Bouteloua oligostachya* (Nutt.) Torr., from Kansas.
Five uredospores and nine teleutospores.

59*b*. Puccinia bartholomæi *Diet.*
On *Bouteloua obligostachya* (Nutt.) Torr., from Nebraska.
One uredospore and five teleutospores.

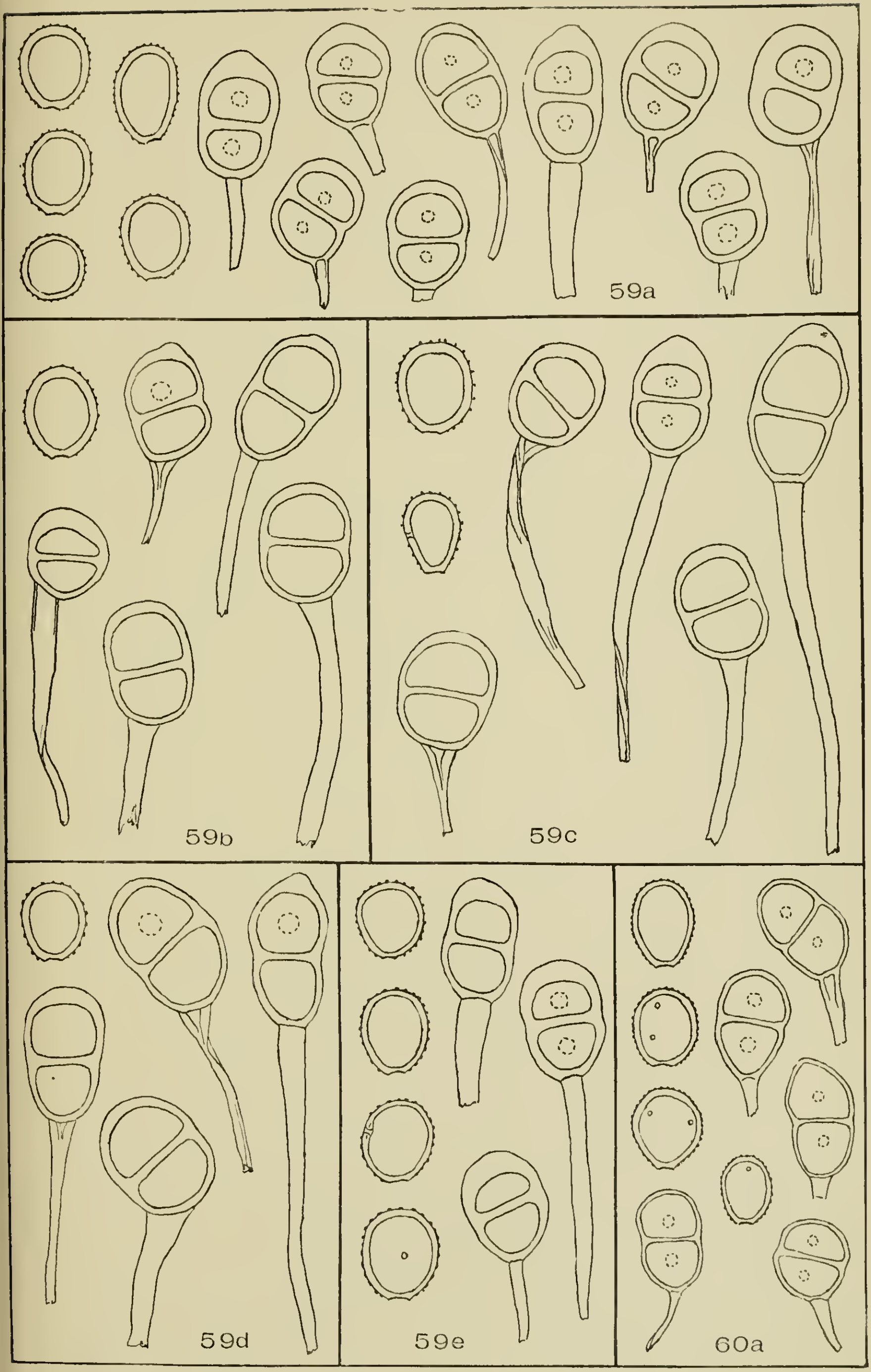
59*c*. Puccinia bartholomæi *Diet.*
On *Bouteloua hirsuta* Lag., from Nebraska.
Two uredospores and five teleutospores.

59*d*. Puccinia bartholomæi *Diet.*
On *Atheropogon curtipendulus* (Michx.) Fourn., from Texas.
One uredospore and four teleutospores.

59*e*. Puccinia bartholomæi *Diet.*
On *Leptochtoa dubia* Nees, from Mexico.
Four uredospores and three teleutospores.

60*a*. Puccinia kansensis *Ell & Barth.*
On *Bulbitis dactyloides* (Nutt.) Raf., from Kansas.
Four uredospores and five teleutospores.

PLATE IX.



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ACTINOMETRA IOWENSIS

A New Unstalked Crinoid from the Florida Reefs

By Frank Springer

Through the courtesy of Professor C. C. Nutting, I have recently had the opportunity to examine the magnificent collections made by the Bahama Expedition of the State University of Iowa in 1893, under his direction. The extent and variety of the material obtained, and the fine condition of the specimens, elicited my warmest admiration, and I cannot refrain from extending to Prof. Nutting and the ladies and gentlemen of his party, my sincere congratulatios upon the extremely valuable contribution to science made by them.

Among the Echinoderms there is a remarkable form of the Comatulid genus *Actinometra*, found in the shallowest water yet recorded for any crinoid. It seems to differ very decidedly from all other described species, and it was thought advisable to publish a preliminary notice of the occurrence in advance of the description now given. This was done in the American Geologist for August, 1902. With the permission of Prof. Nutting, I have proposed for it the name *Actinometra iowensis*, in commemoration of the extremely successful marine expedition sent out under the auspices of the University.

ACTINOMETRA IOWENSIS, n. sp.

Plate I—Figs 1–6.

A large species; with long, slender arms, having a spread of about 27 cm. Disk 20 mm. Color in alcohol, brown. Centrodorsal rather small, with basal star visible; bearing around the margin about 30 stout cirri, composed of 12 to 18 ossicles.

Radials barely visible at the outer part; facing outward. Rays spreading almost horizontal, connected by perisome extending down to the radials. First and second primibrachs united by articulation. Secundibrachs (distichals) 4, — the third and fourth united by syzygy. Rays dividing two or three times; in the latter case there are generally 3—exceptionally 2 or 1—tertibrachs (palmars) below the last bifurcation, the axillary and the next one below it constituting a syzygial pair. In the ultimate arm divisions there is a syzygial union between the second and third brachials; the next syzygy is at about the twelfth or thirteenth brachial; and beyond that they occur at intervals of about 4 or 5 brachials. Pinnules occur on the second secundibrach on the outer side of the ray, on the first brachial above the axillary secundibrach, and on the first brachial of the ultimate arm-division on the outer side; beyond this they occur on every brachial at alternate sides, not counting the hypozygal. Treating the form as primitively 10-armed, and counting the arm-branches as occupying the places of pinnules, the succession would be on secundibrachs 2, 4, 5, 7, 8. Proximal portion of first pinnules fixed by perisome. Arms 4, 5, or 6 to the ray,—giving 23 and 26 arms respectively in the two specimens found. They are about 13 cm. long, slender, and extremely brittle; the first six or seven brachials wider than long, quadrangular, with parallel transverse articulations; beyond that becoming strongly triangular with zig-zag articulations, and the relative length increasing. Oral pinnules about 22 mm. long; those at the middle of the arm 12 mm.; they are stout at the base, tapering rapidly, and slender, distally the lower ones have the combing characteristic of the genus. Ambulacral grooves lined with alternating covering plates on the arms and pinnules, and to some extent on the disk. Disk naked, without sign of other plates or spicules, and finely granular; mouth marginal and radial; anus central and protuberant, composed of longitudinal spicules.

Locality: Dry Tortugas, Florida. Depth, three feet.

This species is apparently quite distinct from any heretofore described. The presence of covering plates on the ambulacra differentiates it widely from all others of the genus. It belongs to the type which Dr. P. Herbert Carpenter, in his great work on the *Comatulae* of the Challenger Expedition, called "tridistichate",—that is, having three distichals, the axillary one with a syzygy,—by which he meant that it was divided into two parts with a syzygial union between them. Other species he called "bidistichate" which have "two distichals united by syzygy." (Chall. Rep. *Comatulæ*, p. 277). This shows the confusing manner in which Carpenter employed the term "syzygy",—for in these cases either the "two distichals united by "syzygy" should be called one, or the "three distichals, the axillary a "syzygy" ought to be called four. A syzygial pair should be uniformly treated, either as one plate or as two. The latter course is now adopted by Mr. Bather, but I think there is much force in the reasoning of Carpenter that the syzygial pair—at least in the arms—represents only one brachial, since the hypozygal loses its individuality, and bears no pinnule. The trouble is that in practice he did not follow out his reasoning. Which ever plan is adopted, it ought to be used consistently; and we should not call four plates, of which two are united by syzygy, "tridistichate," and in the same breath call two plates of the same order, also united by syzygy, "bidistichate". Following the plan of Bather, the form under consideration has four secundibrachs (distichals), the first two united by bifascial articulation, and the next two by syzygy.

Our species belongs to the anomalous group *Fimbriata*, comprising seven described species, which differ from all others in this genus, and from all but one in *Antedon*, in having the first syzygy in the arms between the second and third brachials; or, as Carpenter states it, "in the second brachial." In all others, with the exception alluded to, the first arm syzygy is either between the first and second, or the third and fourth, brachials; and the first arm pinnule is borne on the second brachial, instead of on the first, as in the *Fimbriata* group.

Only one species of this group has been described from Atlantic waters, viz, *Actinometra lineata* P. H. Carpenter, which has been dredged in the Caribbean Sea, and off the coast of Brazil, at depths of from 7 to 88 fathoms. It is a considerably smaller species than ours, which is one of the largest of the genus, and ours does not possess the dark medio-dorsal line of that species; the form of the brachials is also different. From *Actinometra fimbriata* and its allies of the Indian Ocean it differs in the number and size of the cirri, and in the form of the brachials.

From all it differs in the presence of plated ambulacra.

Carpenter mentions without description (Chall. Rep. *Comat.* p. 316), under the name *Actinometer discoidea*, another species of this group, dredged by the "Blake" at 88 to 118 fathoms. The only character of it which he specifies is that it has the "arm-joints quadrate," which is the case with our species for the first six or seven brachials, but above that they are very different.

The presence of alternating covering plates in the ambulacra is really the most remarkable feature of this peculiar form. This is very conspicuous, and may be readily seen at several places on the photographic figures 2 and 3 on the accompanying plate as well as in the drawings of portions of arms and pinnules, figs. 4 and 5. The absence of a plated ambulacral skeleton on arms and pinnules has hitherto been regarded as one of the most striking characters of *Actinometra*. In this structure it differs from *Antedon*, and all the stalked crinoids. No other crinoid, recent or fossil, was known to be thus constructed until it was found, as I have lately pointed out, in the remarkable Cretaceous genus *Uintacrinus* (Memoirs Museum Comparative Zoology, Harvard, Vol. XXV, No. 1.) Our species has the other characters of *Actinometra* in a marked degree. No one who has any acquaintance with these crinoids would hesitate to refer it to this genus, on the first glance at the exocyclic disk and combed pinnules, which are thoroughly characteristic.

Why this species, alone of all known, should have an ambulacral structure similar to that of *Antedon* and the *Pentacrinidae*, we cannot even conjecture. It is exceptional among *Actinometrae* for its very shallow habitat; but this does not seem to suggest any explanation, since there are plenty of Antedons and Actinometras living at equal depths in deep water, which preserve their distinct ambulacral structures. It is evidently to be treated as a transition or intermediate form and it seems to me that we can only accept this as another of those perplexing facts which are constantly coming to light to show us how little we really know of the exact limits of Nature's groups.

Explanation of Plate I.

Actinometra iowensis, n. sp.

Fig. 1. Dorsal view of specimen . . . . Natural size

Fig. 2. Ventral view of another specimen, from which one ray has been removed, so that the cirri show through at that side. This shows the disk-ambulacra, central anal tube, marginal mouth, and plated ambulacra in the arms; also in some places the combed pinnules . . . . Natural size

Fig. 3. Ventral view of lower part of an arm, showing the covering plates of the ambulacrum . . . . $\times 2.2$

The above three figures are from photographs direct from the specimens, and may be advantageously studied with a low power magnifier, such as an ordinary reading glass. The following figures, 4, 5, and 6, are from drawings.

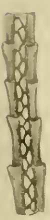
Fig. 4. Ventral side of arm at median part, showing the covering plates of the ambulacrum . . . . $\times 6$

Fig. 5. Ventral side of a pinnule from distal portion of arm, showing the covering plates , . , ... $\times 10$

Fig. 6. Terminal comb of proximal pinnule . . . . $\times 10$

2

3



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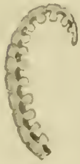

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Explanation of Plates I. and II.

Plate I. Exposure of St. Peter sandstone northeast of Hesper, Iowa, looking north. *Prunus pumila* grows on its summit. (See p. 226.)

Plate II. Same exposure, but looking east. The shrub on the left side of the ledge is *Aronia nigra*. (See p. 226).

PLATE I.

PLATE II.

Explanation of Plates III. and IV.

Plate III. Exposure of St. Peter sandstone northeast of Hesper, and a half mile west of that shown in Plates I. and II. Looking north. *Selaginella rupestris*, *Woodsia ilvensis*, *Cystopteris bulbifera*, and *Rubus baileyanus* grow on the east side of this exposure. The sandy talus produces *Polygonum tenue*, *P. douglasii*, *Potentilla tridentata*, and the following trees and shrubs: *Betula papyrifera* (the most common), *Quercus borealis*, *Q. macrocarpa*, *Prunus virginiana*, and *Amelanchier rotundifolia*. (See pp. 225–7).

Plate IV. Characteristic St. Peter standstone plants:

Fig. 1. *Polygonum douglasii* Greene.
Fig. 2. *Aronia nigra* (Willd.) Britt.
Fig. 3. *Potentilla tridentata* Sol.
Fig. 4. *Woodsia ilvensis* (L.) R. Br.
Fig. 5. *Selaginella rupestris* (L.) Spring.
(See pp. 226–7).

PLATE III.

PLATE IV.

THE FLORA OF THE ST. PETER SANDSTONE IN WINNESHIEK COUNTY, IOWA

By B. Shimek

Read before the A. A. A. S. at St. Louis, Mo., Dec. 29, 1903

The exposures of St. Peter sandstone in Iowa are limited to Winneshiek, Allamakee, Clayton and the extreme northeastern part of Dubuque counties. They are found in large part along the bluffs which border the deep, narrow valleys of the streams of this part of the state, but in some portions of the area they are remote from streams, being then found along the borders of depressions which were evidently formed by the erosion of large quantities of the sandstone.

In Winneshiek county this sandstone is exposed only in interrupted areas along the Oneota river below Decorah, and along Canoe creek, where it forms portions of the bordering bluffs, and in several localities in the extreme northeastern part of the county, notably near the state line, where the exposures are evidently remnants of formerly extensive deposits, or the visible margins of sandstone strata now buried under geest, or drift, or loess.

The St. Peter sandstone of Allamakee county, which lies east of Winneshiek, has been described as follows: *

"The formation is made up almost entirely of water-worn grains of quartz. * * * * * The Saint Peter sandstone is in some places practically as incoherent as when the beds were first laid down in the Ordovician sea. In portions exposed to the weather for some time the constituent sand

* Calvin, S., Iowa Geol. Sur., vol. IV, p. 69; 1895.

grains become more or less cemented at and near the surface. * * * At a large proportion of the localities * * * the sandstone is so far indurated as to admit of being taken out in blocks."

This description applies equally well to the exposures in Winneshiek county. The sandstone is usually so easily eroded that the bases of the exposures are buried in a broad talus of sand* upon which a scant sandy soil is held in place by the scattered vegetation. Upon this sandy talus, and upon the more or less projecting ledges of sandstone† and the thin sandy soil which here and there appears upon their upper surfaces, an interesting flora is established. It is noteworthy because it adds five species of flowering plants and one fern to the hitherto known flora of the state, but its chief interest lies in its relationship to peculiar local floras in remote portions of the state, and in the fact that it is made up in part of common plants belonging normally to other habitats but which have here established themselves in very much reduced sizes.

The new state records are the following:

Woodsia ilvensis (L.) R. Br. This widely distributed northerly species, long known from Minnesota and Wisconsin, was found in considerable numbers at two localities northeast from Hesper, in both cases on northerly exposures.

Polygonum douglasii Greene. Very common on sandy talus northeast from Hesper.

Polygonum camporum Meisn. Rare. The species also occurs westward in the state, but has heretofore been confused with *Polygonum ramosissimum* Mx.

Aronia nigra (Willd.) Britt. In crevices of rock at one point, only, northeast from Hesper. (See Plate II).

Prunus pumila L. This was associated with the preceding species. It has been reported from southwestern Wisconsin.*

Rubus baileyanus Britton. Rare. On ledges northeast from Hesper.

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*See Plate I.

†See Plates II and III.

*L. H. Pammel; Ia. Acad. Sci., vol. I, pt. II, p. 78; 1892.

It should also be noted that *Phragmidium fragariæ* (?) was found abundantly upon *Potentilla tridentata* Sol., a host-plant hitherto unrecorded from Iowa for this fungus.

The flora under discussion varies more or less with the texture of the rock or soil, and with exposure, and may, for convenience, be considered in several groups.

Upon the harder exposed rock surfaces the following species of lichens and mosses were found:

Lecanora rubina (Vill.) Ach.
Physcia cæsia (Hoffm.) Nyl.
Parmelia conspersa (Ehrh.) Ach.
Urceolaria scruposa (L.) Nyl.
Placodium aurantiacum (Light.) N. & H.
Buellia spuria (Schaer.) Arn.
Bryum intermedium Brid.
Ceratodon purpureus Brid.
Dicranella heteromalla Schimp.

Upon the upper portions of the ledges, in crevices, or on surfaces on which a little sandy soil had accumulated, but which are more or less exposed, the following species occurred:

Cladonia cornucopioides (L.) Fr.
Cladonia rangiferina (L.) Hoffm.
Grimaldia barbifrons Bisch.
Polytrichum piliferum Schreb.
Sellaginella rupestris (L.) Spring.
Sisyrinchium angustifolium Mill.
Linum sulcatum Rid.
Polygala viridescens L.
Potentilla tridentata Sol.
Prunus pumila L.
Aronia nigra (Willd.) Britt.
Scutellaria parvula Mx.

and upon mosses, etc., in similar situations, were:

Physcia pulverulenta (Schreb.) Nyl.
Omphalia, probably *umbratilis* Fr.
Humaria—sp. ?

Where the sandy soil on the rock ledges was somewhat better developed, the following species were found:

Muhlenbergia racemosa (Mx.) B. S. P.
Aristida basiramea Eng.
Bouteloua hirsuta Lag.
Eragrostis frankii Steud.
Amelanchier alnifolia Nutt.
Lespedeza capitata Mx.
Amorpha canescens Pursh.
Helianthemum canadense (L.) Mx.
Lechea tenuifolia Mx.
Polygonum camporum Meisn.
Gnaphalium obtusifolium L.
Euthamia caroliniana (L.) Greene.
Solidago rigidiuscula (T. & G.) Port.
Aster sericeus Vent.

and where somewhat better shaded or protected:

Woodsia ilvensis and *Rubus baileyanus*.

The sandy talus below the ledges yielded the following native plants:

Festuca octoflora Walt..
Sporobolus brevifolius (Nutt.) Nash.
Cyperus filiculmis Vahl.
Polygonum douglasii Greene
Polygonum tenue Mx.
Solidago nemoralis Ait.

and stunted forms of *Helianthemum canadense* (L) Mx. and *Lechea tenuifolia* Mx.

Also the following introduced weeds:

Chætochloa glauca (L.) Scrib.
Syntherisma linearis (Krock.) Nash.
Syntherisma sanguinale (L.) Dulac.
Poa pratensis L.
Polygonum aviculare L.
Polygonum convolvulus L.
Polygonum pennsylvanicum L.
Rumex acetosella L.
Lepidium virginicum L.
Oxalis stricta L.
Nepeta cataria L.
Ambrosia artemisiæfolia L.
Leptilon canadense (L.) Britt.

Both the talus and the sandy soil on the ledges gradually shade off into deeper and better soil, and trees and shrubs, such as *Betula papyrifera* Marsh., *Quercus macrocarpa* Mx., *Quercus velutina* Lam., *Amelanchier canadensis* (L.) Medic., *Amelanchier rotundifolia* (Mx.) Roem., *Prunus pennsylvanica* L., *Prunus virginiana* L., etc., and their accompanying mesophytic herbs, were found, but it is scarcely proper to refer these to the flora of the St. Peter sandstone.

In the same doubtful category should be placed *Marchantia polymorpha* L., *Porella platyphylla* Lindb., *Athyrium filix-fœmina* (L.) Roth, and *Cystopteris bulbifera* (L.) Bernh , which were found upon moist rocks in sheltered places.

It will be noticed that with these exceptions the flora of the St. Peter sandstone is almost wholly xerophytic. More permanent terrestrial xerophytic areas in Iowa are practically limited to the following:

Unsheltered rock exposures of comparatively limited extent.

Higher sands not subject to frequent overflows, including secondary sandy terraces and sand-dunes.

Dry ridges in wooded areas, usually rocky or gravelly, sometimes loess-covered.

Dry prairies.

Ordinary sand bars may also be included, but the fact that they are subject to frequent overflows renders the conditions which exist on them somewhat mixed, and subject to rapid change.

In its ecological characters the St. Peter sandstone combines more or less the qualities of all these areas. Its more indurated ledges furnish the exposed rock; its talus supplies all the conditions of the sand-area, and the gradually increasing sandy soil which extends back from the tops of the ledges, is equivalent in character to the dry ridge and prairie. Consequently we find a blending of the floras of these several areas. The lichens, bryophytes and pteridophytes point to a relationship with the flora of the Sioux Quartzite in the extreme northwestern part of the state; such forms as *Linum sulcatum*, *Scutellaria parvula*, *Helianthemum canadense*, *Lechea tenuifola*, *Aster sericeus*, *Sisyrinchium augustifolium*, *Polygala viridescens*, etc., recall the dry, often sandy-ridge flora; the grasses, sedges, Polygonums, etc., suggest the flora of the higher sand-bars and dunes of Muscatine county; while *Lespedeza capitata*, *Amorpha canescens*, *Solidago rigidiuscula*, etc., connect this flora with that of the dry prairies, which blend westward with the almost desert-like loess and drift ridges of the western part of the state.

By no means the least interesting part of the flora is that which has been comparatively recently introduced. At least thirteen species of common weeds have demonstrated their great adaptability to evironment by flourishing,—if that term is permissible under the circumstances,—upon the sandy talus of the areas under discussion. They are much reduced in size, but flower and fruit freely. These sandy areas are unlike ordinary sand-bars, because they are not subject to overflow, nor are they like the sand-dunes, on which the constantly shifting sands make the existence of many plants impossible. These sands are more permanent, and will remain in their present condition for a long time, since there is a constant gradual addition of sand from the ledges above. The interesting question arises,—will these more permanent conditions finally give rise to distinct races, or forms, or varieties, of the plants which have been introduced either from other native floras, or as weeds?

THE DISCOMYCETES OF EASTERN IOWA

By Fred Jay Seaver

PREFACE

In view of the fact that the Discomycetes have been very little studied in this State, the work presented in the following paper was taken up in the fall of 1902 at the suggestion of Professor T. H. Macbride, under whose direction the work has been conducted and to whom I wish to acknowledge my indebtedness for his untiring aid and attention. I am also indebted to Professor B. Shimek for valued suggestions and many collections of material.

Beginning with the fall of 1902 much material was collected in the woods surrounding Iowa City on account of the favorable season resulting from the unusually heavy rain-fall, which material was preserved for study. In the spring of 1903 several specimens were collected near the Agricultural Experiment Station, Lafayette, Indiana, all of which, with one or two exceptions, have been duplicated in this State. In June of the same season one very interesting specimen was collected in Washington Park, Chicago, which is here described and which has not been collected in the State so far as known. In the following summer one species was collected in Pocahontas county and at the same time several were collected by Professor B. Shimek in Winneshiek county, Iowa.

In all nearly one hundred species belonging to this group have been collected, the most of them in the vicinity of Iowa City. Fifty of these, including the one collected in Illinois, are described in this paper. The remaining specimens collected are retained for further study and it is hoped will appear in a later paper.

In making the determinations I wish to extend thanks to Dr. E. J. Durand of Cornell University for suggestions and exchange of material.

FRED J. SEAVER.

Iowa City, April, 1904.

INTRODUCTION

The Discomycetes include all those forms of ascomycetous fungi in which the fruiting surface, or hymenium, is well exposed at maturity. This character distinguishes them from the closely allied group, the Pyrenomycetes, in which the hymenium is entirely inclosed in the perithecium, or open to the exterior by a small aperture only. On account of the peculiar cup-like form assumed by many of the plants of this group in their fruiting phase, they are often called cup-fungi. Ranging, as they do, in size from cups three or four inches in diameter to those scarcely visible to the unaided eye, many of the smaller and often more beautiful forms are seldom, if ever, seen by the casual observer.

As all other fungi, the individuals of this group are either parasitic, or saprophytic; the parasitic forms being found for the most part, on the stems and leaves of living plants, while the saprophytic forms, which comprise by far the larger number, occur on almost every kind of decaying organic material, where the conditions of moisture are suitable. In damp shady woods, scarcely a decaying log may be found which does not bear on its surface some form of discomycetes, although the aid of the hand-lens is often necessary to bring their minute forms into view. But although small in size, they are no less perfect in structure and beautiful in appearance; their colors often rivaling those of the most brilliant flowers of our gardens and their microscopic sporidia being often beautifully colored and delicately sculptured.

The predominating colors to be found among the plants of this group are shades of red or yellow; the red ranging from brilliant scarlet to dull brownish black, and the yellow including almost every conceivable tint. In addition to these colors, some plants are black, some white, and a few a dull green. As to the function of the color in fungi, little is known. De Bary attributes it to the presence of minute globules which are the aggregations of fatty materials in the protoplasm of the cells of the fungus. But whether the color should be attributed to the fatty substances themselves or to other coloring matters which are only associated with them is not known. In this locality the most brilliant forms occur in the late fall or early spring and it may be that the bright colors are associated with low temperatures. The most brilliantly colored form to be found in this region is *Sarcoscypha coccinea* (Jacq.) Sacc. Pl. XXII Fig. 11. Plants of this species may be found attached to sticks which are buried under leaves and soil in the late fall. The same plants have been found in the spring while the ground was still frozen, apparently in a fresh and living condition. There seems to be no doubt that these plants live during the winter under snow and ice, and it may be that the brilliant scarlet colors are concerned in this fact.

The life-history of the discomycete, as well as that of all other fungi, exhibits two distinct phases, the vegetative or growing phase and the reproductive. The unit of structure of the fungus is the hypha, and in this group of fungi the vegetative phase consists of a net-work of delicate, thread-like hyphae, or of combinations of hyphae forming larger cord-like mycelial strands which branch and permeate through the substratum on which the fruiting discs or cups are found, and is consequenty generally hidden from view. But the reproductive phase generally appears above ground and is often elevated on a pedicel in order that the spores may be more widely distributed at maturity.

In many of the plants of this group two distinct methods of reproduction have been studied; the sexual and the asexual.

The asexual method of reproduction consists in the formation of spores which are called gonidia or conidio-spores. When present they may often be seen in the form of delicate chains, each of which is composed of a great number of minute globular, or slightly elongated bodies which are formed by a series of constrictions in a simple or branching aerial hypha. These minute reproductive bodies are broken apart at maturity and carried away by the wind or other agency to produce a new fungus. In addition to the ordinary method of asexual reproduction these plants may also be reproduced vegetatively. Portions of the mycelium may be kept in a dry condition for an indefinite length of time and finally made to revive and grow by placing them in a moist chamber with suitable material for nourishment.

The sexual method of reproduction is much more difficult to study, especially in its early stages, but in general takes place in the following manner as described by DeBary for *Ascobolus furfuraceus* Pers. Pl. XV Fig. 11. The method varies somewhat with different species.

A branch arises from the mycelium and becomes very much enlarged at its upper extremity and separated by transverse walls into a number of cells which are well provided with protoplasm. This hyphal branch is called the archicarp. Other branches arise from near its base which grow upward and apply themselves at its extremity. This contact is followed by the production of another mass of hyphæ which entirely surround the archicarp and become closely united forming a layer of tissue which is called pseudo-parenchyma. The outer layer of this tissue forms a rind, some of the cells of which send out rhizoid or root-like hyphæ into the substratum below and in many species, still other cells produce hairs, differing in form and structure, which cover the exterior of the cup. Sterile branches called paraphyses are given off at the apical region just beneath the rind, or perithecium. This constitutes the beginning of the hymenium or fruiting surface. As new branches are thrust up between the old ones, the surface becomes broader until it ruptures the perithecium and the hymenium is exposed in the form of a disc. At this time branches are sent out from one of the cells of the fertilized archicarp and are added to the subhymenial layer. These branches are called the ascogenous hyphæ. From the cells of this tissue arise the spore bearing hyphæ or asci, which are thrust up between the paraphyses and continue to grow until they reach the surface of the hymenium.

The spores are formed endogenously by successive division of the nucleus within the terminal cell of the ascus. The number of spores in each ascus is generally two or some multiple of two, increasing in the following ratio:—2-4-8-16-32-64-128. This complete series is represented among the species described in this paper, with the exception of the first and last. *Humaria tetraspora* (Fckl.) Sacc., Pl. XI Fig. 1, shows constantly four spores in each ascus. Any of the common forms will show eight. *Ryparobius sexdecimsporus* (Cr.) Sacc., Pl. XVIII Fig. 1, will show the next number in the series which is sixteen. Thirty-two are found in each ascus of *Ryparobius pelletieri* (Cr.) Sacc., Pl. XVII Fig. 1 and sixty-four in *Ryparobius crustaceus* (Fckl.) Rehm., Pl. XVII Fig. 11. One other representative has been studied in which there are more than sixty-four but the exact number could not be determined definitely. In adddition to this series some species which ordinarily have eight spores sometimes contain only four or six. This has been found to occur in plants of *Ascobolus immersus* Pers., Pl. XVI Fig. 1, which were grown in the laboratory. Several plants were examined in each of which asci were found containing eight spores, several in each plant also being found containing only four, and in one or two cases, six.

The arrangement of the spores in the ascus varies with different species and genera and depends to some extent upon their form.

As to form, the sporidia may be spherical, elliptical, fusiform or spindle-shaped, or linear with many gradations between all of these forms. The spherical spores are generally disposed in one row in the ascus, those of an elliptical form in one, two, or four rows, or they may be irregularly arranged as in many species of *Ascobolus*. The elliptical spores are generally parallel or oblique with reference to the ascus. The fusiform spores may be in one or two rows and are generally nearly parallel with the ascus and those of a linear form are side by side and also parallel or nearly so.

The spores may be free in the ascus or imbedded in a gelatinous substance. In several species each individual spore is imbedded in this way, and in one genus, *Saccobolus*, the eight spores are closely united and the whole number imbedded in a block of gelatine, in which they are ejected from the ascus, still remaining united after being ejected.

Externally the spores may be smooth or marked in various ways. The markings may be the form of minute spines which are sometimes long, and sometimes very short, or they may form larger wart-like structures when the spores are said to be verrucose. In still other cases the spores are marked by elevated ridges arranged so as to form various patterns. In this case the spore is said to be reticulate.

Internally the spores are colored, transparent or hyaline, or granular, and in many cases there are one or several transparent drops, the number being quite constant with the different species, and the spore is then said to be guttate or guttulate. In many cases, especially when the spores are long and slender, they are divided by cross walls into several cells, and are then septate.

One of the most interesting points in connection with the sexual fructification of the discomycetes is the manner in which the spores are ejected from the ascus at maturity. If fresh material of almost any of the common species, such as *Peziza aurantia* Pers., Pl. VIII, Fig. 1. be placed in a moist chamber and left for some time, on suddenly lifting the bell jar, a cloud of spores will be seen to issue from the hymenium in such numbers that the fungi are often said to smoke. This so-called smoking takes place at intervals and seems to be brought about by any slight disturbance in the atmosphere; the breath often being sufficient to cause the ejection of thousands of spores. This phenomenon is well known to all those who are familiar with the plants of this group, but the cause is not so well known. Since the puffing of the spores takes place after removing the bell jar, it is thought by some students of fungi that the ejection of the spores is due to the contraction of the ascus in drying. This is not the case for if uninjured asci from fresh plants be placed on a slide in water, thus preventing every possibility of drying, the ejection will take place and may be easily studied with the microscope. The addition of water does not hinder the processs and the activity of the apparatus is even stimulated in this way.

The ejection of the spores probably takes place continually while the plants are under cover but the ejection of the spores in large numbers at the moment of raising the bell jar is probably due to the sudden change in the atmospheric pressure. The bursting of the ascus is brought about by the internal pressure resulting from the process of endosmosis. The ejection of the spores does not take place if the asci are immersed in a solution of alcohol or glycerine, showing that those agencies which tend to promote the process of endomosis stimulate the spore-dispersal.

If asci immersed in water are carefully studied during the process of spore ejection, they will be seen not to contract, but to expand just before the ejection of the spores and then to assume their normal form except for the rupture at their free end, and to remain thus if unmolested. If several asci from fresh plants of *Lachnea scutellata* (Linn.) Sacc., Pl. VI, Fig. 1, in which the spores are arranged in a definite row in the ascus, be studied as described above, the spores will be seen to crowd toward its free end so that the row is broken up and the spores are crowded together, the ascus becoming very much expanded at that point. They remain in this position for some time as though under tension, when suddenly the ascus breaks at a certain point called the point of dehiscence and the spores are ejected in a mass.

The position and form of the rupture of the ascus for the exit of the spores varies in different species. In some species it is a simple slit-like opening across the end of the ascus, while in others it is in the form of a circle near its end so that the whole top is entirely removed or remains attached at one side in the form of a lid. That the operculum should remain attached at one side seems to be accidental. The spore pressure from within would be likely to be more on one side than the other, and the operculum, having broken loose on that side would naturally remain attached at the other, as it does in many species. Boudier has placed a great deal of importance upon the manner of dehiscence of the ascus and in one of his papers he suggests that this be used as a basis of classification for separating the discomycetes into two large groups, the operculate and the non-operculate forms.

In many of the species of this group the asci emerge beyond the surface of the hymenium at maturity, this being brought about, in part at least, by the elongation of the mature ascus. This is characteristic of the family *Ascobolaceæ*, in many of which the spores become purple at maturity. Measurements show that the asci which contain purple spores are much longer than those in which the spores are not yet mature. This may be in part due to the stretching of the ascus from the pressure within, as is indicated by the fact that the asci tend to retract after the spores have been ejected.

The emergence of the asci in this group led to the old idea that the asci themselves were ejected with their spores. This was commonly thought to be the case by early writers on account of the disappearance of the asci after the ejection of their dark colored contents. Prof. Underwood, of Columbia University, in his book entitled "Moulds, Mildews and Mushrooms," page 56, describes it in the following words: "The

Ascobolaceæ are peculiar in their habit of discharging their asci so as to more widely disseminate their spores." That this is a mistake may be shown by a simple experiment. If a small piece of glass be moistened on one side with glycerine or some other substance which will furnish a sticky surface, and suspended over the plants with the moist surface down until the asci have had time to eject their spores, the sticky film will be found upon examination to contain spores and no asci.

The most interesting form for this experiment is *Ascobolus immersus* Pers. Pl. XVI, Fig. 1. Plants of this species may be grown in the laboratory on suitable material. In spite of the small size of the plants they may be easily studied on account of the large size of the spores and asci. If grown under cover, after removing the cover the emergent asci can be seen with the naked eye and counted with the aid of the hand-lens. The asci do not all mature at one time but from three to five may be seen at one time in the same plant. At the time of the maturity of the spores, the asci, project to such an extent that the eight spores are borne in that part of the ascus above the surface of the hymenium. After leaving the plants uncovered for a short time the asci will be seen to suddenly disappear one at a time or several at once. DeBary says that in the *Ascobolaceæ* the spores are ejected from all the mature asci in each plant at one time and not in succession. In this case the mature asci do not always eject their spores at one time, but it may take place in succession. If a glass be suspended over these plants as described above it will soon be found to contain spores in clusters of eight each; the spores having been ejected with such force that all of the spores from each individual ascus remain attached to the glass. In this case the spores are in clusters but not in close contact as they were in the ascus but scattered as shot would scatter when fired from a gun. In other species of *Ascobolus*, in which the asci are more numerous the spores are not in clusters but cover the entire surface of the glass, but in no case are asci found to be present.

The process of spore-dispersal may also be studied with the low power of the microscope in almost any of the members of this family. In *Ryparobius crustaceus* (Fckl.) Rehm., Pl. XVII, Fig. 11, the asci have been seen to protrude very much until the spores have been ejected and then to gradually retract toward their original position.

DeBary in his Morphology and Biology of Fungi, p. 92, describes this process in the following words: "When the asci are ready to eject their spores they are very much extended and their broad club-shaped apex rises considerably above the surface of the hymenium; this led to the erroneous idea which was reproduced by Boudier, that the asci became detached from their point of insertion and wandered up among the paraphyses; they really remain firmly attached as in all the rest of the Discomycetes. The projecting asci are moreover distinctly visible to the naked eye in the larger species as dark points, by reason of the dark violet-colored spores in their apices. These points disappear at the moment of dusting, because the spores fly off and the empty tubes are drawn back beneath the surface of the hymenium. Older observers were led by these appearances to the mistaken notion that the entire asci were ejected from the hymenium and hence the name *Ascobolus*."

The habitat of the discomycetes varies with the different species and seems to be quite constant in each individual case. Only one of the species described in this paper is parasitic, *Mollisia dehnii* (Rabenh.) Karst., Pl. XXIII, Fig. 1. This plant occurs on living plants of *Potentilla norvegica* and grows in such numbers as to almost completely cover the stems and leaves, those on the leaves being found on or near the veins.

The remaining forms are saphrophytic and occur on nearly every kind of organic matter, such as decaying wood, leaves and stems of herbaceous plants, damp soil which is mixed with organic material, charcoal, ashes, old cloth, paper, etc.

Ascophanus testaceus (Moug.) Phill. Pl. XIII, Fig. 1, is commonly found on old sacking, probably on account of the material of which the sacking is made. This species has been described by many authors as occurring on this kind of habitat; and for this reason, during the spring of 1903 an old sack found in a damp place among weeds at Lafayette, Indiana, was examined for the purpose of finding this particular species. It was found to be covered in places with the beautiful, pale red plants. Specimens of this material after being kept dry for several months were placed in a moist chamber and resumed growth. Other pieces of sacking were inoculated from this and produced mature plants in a few weeks. Specimens of the same plant have been found in smaller quantities in this state growing on old rag carpet.

Several genera, including the one just mentioned, are usually found on the dung of different animals. These genera belong to the family *Ascobolaceæ*. Nearly all of the plants described here belonging to this family have been grown on such materials in the laboratory. Fresh material may be used but in most cases the material used was that obtained outside and which had stood in the open field for some time. This material would be crowded with spores and spawn of various kinds.

Several different species were grown on the same substratum but generally appear at different times. In several cases the same specimen has been grown on different kinds of dung but in many cases the plants seem best adapted or restricted to one particular habitat, so that knowing this, we may predict the species likely to appear.

One species *Ascobolus atro-fuscus* (P. & P.) Pl. XV, Fig. 1, is commonly found on burnt ground and charcoal, but as a group the *Ascobolaceæ* are dung-inhabiting plants.

Those specimens which were grown in the laboratory and the kind of material on which they were grown is indicated in the descriptions and need not be repeated here.

The history of the study of the discomycetes extends back over several centuries. The first available reference to the name *Peziza* used as a botanical term, under which most of those forms now included in the *Pezizineæ* were at first studied, is in "Plinie's Naturall Historie," Vol. 2, p. 7, Chap. 3, a translation published in 1601 from the original written about 70 A. D., and reads as follows: "Within the province of Cyrenaica in Affrick, there is found the like excresence called Missy, passing sweet and pleasant, as well in regard of the smell as the taste, more pulpous also and fuller of carnositie than the rest: likewise, another of that nature in Thracia, called Ceraunium. As touching all the forts of Mushromes, Toad-stools, Puffes, Fusbals or Fusses, these particulars following are observed, First it is known for certain, That if the autumn be much disposed to raine, and withall the aire bee troubled and disquieted with many thunders, during that season: there will be good store of such Mushromes, &c., especially (I say) if it thunder much. * * * * * * * * * As touching the Truffles or Mushromes of Afia, the most excelent of all others be neare unto Lampsacum and Alopeconnesus: but the best that Greece yieldeth are in the territorie about the citie Elis. In this Toad-stoole or Mushroome kind are those flat Fusses and Puffes to be reckoned, which the Greeks name *Pezitæ* (Pezici): as they have no root at all, so they bee altogether without either stele or taile."

Whether the plants referred to in this article are the same as those now included under that name is not known.

In 1719, Dillenius in "Catalogus Plantarum" p. 194-196 describes several species of *Peziza*.

In 1769, Linnæus in Systema Natura Vol. 3, p. 725 describes several species of fungi under the same name.

In 1791, Bulliard in Historie des Champignons described and illustrated many species belonging to both the *Pezizineæ* and the *Helvellineæ*. Other authors who have described much material belonging to this group are Persoon, who published Synopsis Methodica Fungorum in the year 1801, Fries in Systema Mycologicum published in 1823, and Cooke in Handbook of British Fungi, in 1871.

Phillips in his book entitled British Discomycetes, published in 1887 describes more than six hundred species of plants belonging to this group, which occur in England.

In 1889 Saccardo published Sylloge Fungorum in which all the known species up to that date are described, and in 1897 Engler and Prantl published that part of the Naturlichen Pflanzen Familien in which the principal groups are described and illustrated.

The classification of the group varies at different times and with different authors. Most of the forms now belonging to the *Pezizineæ* were at first included under the genus *Peziza* and it was represented by only a small number of described species The *Pezizineæ* are now represented by about three thousand known species which are distributed among many different genera, the exact number of genera depending upon the author. The Discomycetes represent one of the largest groups of fungi and are world-wide in their distribution.

The external characters were used by the early authors as the only basis for classification, but since the microscope has come into use, in addition to the external characters, much attention is given by recent writers on the subject to the internal characters such as the size of the asci, spores and paraphyses, also to the form, markings and coloration of the spores.

By most of the recent authors the *Pezizineae* are divided into nine families, the distinction between the families being made on the internal and external characters as given above.

Dr. E. J. Durand of Cornell University suggests a new basis of classification for separating the *Pezizineæ* into families. He divides the *Pezizineæ* into four families, the distinction being made upon the structural characters of the sterile part of the fruiting phase. Since the aim in modern classification is to show as far as possible the natural relationship, a classification based upon structural characters is that by which this may best be done.

The classification used here with few exceptions is that presented by Schrœter and Lindau in Engler-Prantl, Naturlichen Pflanzen Familien. The complete key to the genera of the two orders *Helvellineæ* and *Pezizineæ* is given here as presented in that work.

Since the determinations have been made for the most part without material for comparison, any corrections by those interested will be gratefully received.

KEY TO THE GENERA

A—Hymenium exposed from the first . . *Helvellineæ*
A—Hymenium at first closed.
  b—Hymenium open at an early stage, without firm covering . . . . . *Pezizineæ*
  b—Hymenium inclosed in firm covering, opening at maturity.
    c—Opening with a star-like aperture . *Phacidiineæ*
    c—Elongate opening with a slit-like aperture *Hysteriineæ*

HELVELLINEÆ

A—Receptacle borne on a stem.
  b—Pileus clavate or knob-like; asci non-operculate . . . . *Geoglossaceæ*
  b—Pileus capitate or pileate; asci operculate *Helvellaceæ*
A—Receptacle sessile . . . . . *Rhizinaceæ*

GEOGLOSSACEÆ

A—Receptacle sessile on the stem or adnate with it.
  b—Receptacle clavate, sessile on the stem.
    c—Spores colorless, 1-celled.
      d—Pileus sharply distinguished from the stem, bright colored . . . *Mitrula*
      d—Pileus not sharply distinguished, bright or dark colored . . . . *Microglossum*
    c—Spores several-celled.
      d—Spores colorless . . . . *Leptoglossum*
      d—Spores brown . . . . *Geoglossum*

b—Receptacle spoon-shaped, adnate with the stem.
c—Receptacle adnate on one side only . *Hemiglossum*
c—Receptacle adnate on both sides of stem.
d—Spores spherical . . . . *Neolecta*
d—Spores linear . . . . *Spathularia*
A—Receptacle knob-like, pileate, sharply distinguished from the stem, with a definite rind.
b—Spores elongate-elliptic, fusiform or needle-shaped.
c—Spores elongate-elliptic.
d—Receptacle gelatinous . . . *Leotia*
d—Receptacle waxy . . . . *Cudoniella*
c—Spores linear.
d—Receptacle fleshy; pileus pileate, with rind . . . . . . *Cudonia*
d—Receptacle waxy; pileus cup-shaped *Vibrissea*
b—Spores spherical . . . . *Ræsleria*

HELVELLACEÆ

A—Pileus hollow entirely or in the upper part only. The cavity of the pileus is a continuation of that of the stem.
b—Upper surfare of the pileus marked by deep pits . . . . *Morchella*
b—Upper surface of the pileus marked by spiral folds . . . . *Gyromitra*
A—Pileus membranous, bell-shaped or ragged, attached to the stem at the central point only.
b—Pileus bell-shaped . . . . *Verpa*
b—Pileus flat, inverted almost pileate . . *Cidaris*
b—Pileus lobed, wrapped around the stem . *Helvella*

RHIZINACEÆ

A—Spores elliptical or fusiform.
b—Receptacle flat, fleshy-membranous, spread out or inverted.
c—Under side smooth . . . . *Psilopeziza*
c—Under side with root-like processes . *Rhizina*
b—Receptacle fleshy upright columnar . *Underwoodia*
A—Spores spherical; receptacle roundish . *Sphærosoma*

PEZIZINEÆ

A—Receptacle free. Stroma entirely wanting or consisting of a felt-like layer or a thin black crust.
b—Receptacle fleshy or waxy, rarely gelatinous; ends of paraphyses free.

c—Peridium and hypothecium of nearly the same structure.

d—Receptacle open from the first, convex; peridium wanting or poorly developed *Pyronemaceæ*

d—Receptacle at first concave; peridium developed; fleshy.

e—Asci at maturity forming an even layer, not emergent . . . *Pezizaceæ*

e—Asci at maturity emergent . . *Ascobolaceæ*

c—Peridium forming a more or less well differentiated layer.

d—Peridium composed of elongate, thin, bright-walled cells parallel with each other forming the pseudo-parenchyma . *Helotiaceæ*

d—Peridium composed of roundish or angular, thin, dark-walled cells forming the psudo-parenchyma . . . . *Mollisiaceæ*

b—Receptacle leathery or cartilaginous; ends of paraphyses united to form an epithecium.

c—Peridium wanting or poorly developed *Celidiaceæ*

c—Peridium well developed, mostly leathery.

d—Receptacle free from the first, never inclosed in a membrane . . . *Patellariaceæ*

d—Receptacle at first submerged, later breaking through the epidermis, cup- or beaker-shaped often at first inclosed in a membrane . . . . . *Cenangiaceæ*

A—Receptacle seated on a well developed stroma consisting of strands or knob-like structures.

b—Stroma consisting of strands; receptacle on ends of strands . . . . . *Cordieritidaceæ*

b—Stroma consisting of knob-like structures; receptacles imbedded . . . . *Cyttariaceæ*

Pyronemaceæ

A—Receptacle seated on loose hyphæ; hypothecium very poorly developed; peridium wanting; asci free on the receptacle.

b—Epispore colored . . . . . *Ascodesmis*

b—Epispore colorless . . . . *Ascocalathium*

A—Receptacle seated on a spider-web-like, or felt-like mass of hyphæ; hypothecium well developed, fleshy; peridium poorly developed.

b—Spores elliptical . . . . . *Pyronema*

b—Spores spherical . . . . . *Pyronemella*

Pezizaceæ

A—Spores spherical.	
b—Receptacle externally clothed with hairs.	
c—Receptacle bright colored; hairs long, sharp	*Sphærospora*
c—Receptacle dark colored; hair fine short	*Pseudoplectania*
b—Receptacle externally smooth . . .	*Pliicariella*
A—Spores elliptic, blunt, rarely pointed.	
b—Receptacle externally hairy.	
c—Margin regular	*Lachnea*
c—At first buried or partly buried in ground, margin irregularly splitting . . .	*Sarcosphæra*
b—Receptacle externally smooth.	
c—Regular, cup-shaped, margin smooth .	*Peziza*
Sub-genera	
d—Juice colorless.	
e—Asci blue with iodine	
f—Receptacle sessile . . .	*Plicaria*
f—Receptacle stipitate . . .	*Tazzetta*
e—Asci not blue with iodine.	
f—Spores smooth or rough.	
g—Entirely sessile . . .	*Humaria*
g—More or less sessile.	
h—Stem short thick.	
i—Stem smooth.	
j—Receptacle goblet- or beaker-shaped . . .	*Geopyxis*
j—Receptacle at last entirely flat	*Discina*
i—Stem uneven, grooved .	*Acetabula*
h—Stem long thin; receptacle outside rough . . .	*Macropodia*
f—Spores at last reticulate . .	*Aleuria*
d—Juice milky, colored . . .	*Galactinia*
c—Cup irregular, split or elongated on one side	*Otidea*

Ascobolaceæ

A—Spores colorless.	
b—Spores spherical	*Cubonia*
b—Spores elliptical.	
c—Peridium developed.	
d—Asci 8-spored.	
e—Receptacle hairy . . .	*Lasiobolus*
e—Receptacle smooth . . .	*Ascophanus*
d—Asci 16- to many-spored.	
e—Asci without ring at summit .	*Ryparobius*
e—Asci with ring at summit . .	*Streptotheca*
c—Peridium wanting.	

d—Cup not surrounded with gelatinous layer *Zukalina*
d—Cup with gelatinous layer . . *Glœopeziza*
A—Spores colored, at last violet or brown.
b—Spores spherical . . . . . *Boudiera*
b—Spores elliptical, or fusiform.
c—Spores united in a ball in the ascus . *Saccobolus*
c—Spores free in the ascus . . . *Ascobolus*

HELOTIACEÆ

A—Receptacle between fleshy and waxy or waxy, thick or membranous.
b—Receptacle fleshy waxy, bright fragile or dull leathery; not coherent.
c—Externally hairy.
d—Externally tomentose . . . *Sarcoscypha*
d—Externally bristly . . . . *Pilocratera*
c—Externally smooth.
d—Receptacle not springing from sclerotium.
e—Spores at length not stalked.
f—Substratum green . . . *Chlorosplenium*
f—Substratum not colored . . *Ciboria*
e—Spores, at length, stalked . . *Rutstrœmia*
d—Receptacle arising from a sclerotium *Sclerotinia*
b—Receptacle waxy, thick, tough or membranous.
c—Receptacle externally hairy.
d—Receptacle seated on a web of hyphæ.
e—Spores 1-celled . . . . *Eriopeziza*
e—Spores at last more than 1-celled . *Arachnopeziza*
d—Receptacle without web of hyphæ.
e—Spores spherical . . . *Lachnellula*
e—Spores elliptical or elongate.
f—Hymenium clothed with dark hairs *Desmazierella*
f—Hymenium smooth.
g—Paraphyses blunt at the apices.
h—Apothecium delicate; spores 1-celled or 2-celled . . *Dasyscypha*
h—Apothecium thick; spores at last 2-celled . . . *Lachnella*
g—Paraphyses sharp at the apices.
h—Spores at last 1-celled . *Lachnum*
h—Spores at last more than 1-celled *Erinella*
c—Receptacle externally smooth.
d—Spores spherical . . . . *Pilya*
d—Spores elliptical or fusiform.
e—Spores at last 1-celled.
f—Apothecium smooth . . . *Hymenoscypha*
f—Apothecium notched . . *Cyathicula*

e—Spores at last 2-4-celled.
f—Receptacle sessile; rarely crowded, on ground . . . . *Belonium*
f—Receptacle stipitate; stems united.
g—Apothecium waxy; stem short delicate . . . . *Belonioscypha*
g—Apothecium waxy thick; stem thick . . . . . *Helolium*
d—Spores linear.
e—Receptacle sessile . . . *Gorgoniceps*
e—Receptacle stipitate . . . *Pocillum*
A—Receptacle cartilaginous or gelatinous.
b—Spores at last 1-celled.
c—Receptacle at first spherical, sessile, at last stipitate, small . . . . . *Stamnaria*
c—Receptacle stipitate from first, spherical, then cup-shaped, larger . . . *Ombrophila*
b—Spores at last several-celled . . . *Coryne*

MOLLISIACEÆ

A—Receptacle fleshy-waxy or rarely membranous.
b—Receptacle from the first free on the substratum.
c—Seated on a conspicuous web of hyphæ.
d—Spores at length 1-celled . . *Tapesia*
d—Spores many-celled, linear . . *Trichobelonium*
c—Not seated on a web of hypha.
d—Spores at length 1-celled.
e—Spores spherical . . . . *Mollisiella*
e—Spores elongate . . . . *Mollisia*
d—Spores at last 2-celled . . . *Niptera*
d—Spores fusiform, 4- to many-celled . *Belonidium*
d—Spores linear many-celled . . *Belonopsis*
b—Receptacle at first immersed in the substratum, then erumpent.
b—Bright colored, only slightly erumpent.
d—Spores at last only 1-celled . . *Pseudopeziza*
d—Spores at last many-celled . . *Fabræa*
c—Dark colored and strongly erumpent.
d—Spores at last 1-celled.
e—Externally beset with spines . *Pirottæa*
e—Externally smooth-margined, at most,
d—Spores many-celled . . . *Beloniella*
A—Receptacle cartilaginous, horny when dry.
b—Spores at last 1-celled . . . . *Orbilia*
b—Spores at last 2-4-celled . . . *Calloria*

CELIDIACEÆ

A—Spores 1-celled.
  b—On wood or bark . . . . *Agyrium*
  b—On lichens . . . . . . *Phacopsis*
A—Spores 2-celled.
  b—On wood or bark . . . . . *Lecideopsis*
  b—On lichens . . . . . . *Conida*
A—Spores 4-6-celled; on lichens . . . *Celidium*

PATELLARIACEÆ

A—Apothecium thin; hypothecium poorly developed.
  b—Spores hyaline.
    c—Spores 1- often at last 2-celled . . *Patellea*
    c—Spores septate, 4-6-celled . . . *Durella*
  b—Spores brown, 2-celled . . . . *Caldesia*
A—Apothecium thick; hypothecium well developed.
  b—Asci 8-spored.
    c—Spores 1- or 2-celled.
      d—Spores at last 1-celled.
        e—Paraphyses not thickened above . *Starbæckia*
        e—Paraphyses club-shaped at their apices.
          f—Receptacle from the first on the surface; saprophytic . . . *Patinella*
          f—Receptacle at first immersed, erumpent; parasitic . . . *Nesolechia*
      d—Spores 2-celled.
        e—Receptacle smooth.
          f—Spores hyaline . . . *Scutula*
          f—Spores hyaline then brown, seldom brownish.
            g—Receptacle free, sessile, rarely slightly immersed; saprophytic.
              h—Receptacle round . . *Karschia*
              h—Receptacle elongate or irregular *Melaspilea*
              h—Receptacle linear or stellately branched . . . . *Hysteropatella*
            g—Receptacle at first immersed then erumpent; parasitic . . *Abrothallus*
        e—Receptacle hairy; on living leaves *Johansonia*
    c—Spores needle-shaped or thread-like, 4 to many celled.
      d—Spores not breaking into single cells in the ascus.
        e—Spores fusiform or elongate.
          f—Spores elliptic, mostly 4- (6 or 8) celled hyaline then brown; mostly parasitic . . . . . *Leciographa*

f—Spores fusiform, 4- or more celled, hyaline; saprophytic . . *Patellaria*
e—Spores long, thread-like.
f—Receptacle sessile.
g—Spores rod-like, 4-6 celled. . *Pragmorpora*
g—Spores thread-like, many celled *Scutularia*
f—Receptacle top-shaped, stipitate *Lahmia*
d—Spores thread-like, many celled, breaking into single cells in the ascus . *Bactrospora*
b—Asci many spored.
c—Spores spherical, 1-celled . . . *Biatorella*
c—Tpores elongate, 4-celled . . . *Baggea*

CENANGIACEÆ

A—Receptacles when fresh leathery, horny, or waxy.
b—At first immersed, stroma not present.
c—Spores 1-celled.
d—Receptacles bright-colored outside, downy *Velutaria*
d—Receptacles dark-colored outside.
e—Spores hyaline; receptacle smooth outside . . . . . . *Cenangium*
e—Spores colored; receptacle externally downy . . . . . *Schweinitzia*
c—Spores elongate 2-4-celled.
d—Spores hyaline.
e—Spores always 2-celled; receptacle externally smooth . . . . *Cenangella*
e—Spores 2 or 4-celled; receptacle externally downy . . . . *Crumenula*
d—Spores when mature brown to brownish-black.
e—Receptacle elongate, with thick rind. *Tryblidiella*
e—Receptacle roundish.
f—Spores 2-celled; margin thin . *Pseudotryblidium*
f—Spores 4-celled; margin of receptacle involute . . . . . *Rhytidopeziza*
c—Spores thread-like, many celled . . *Godronia*
b—Receptacle seated on a more or less well developed stroma; at first under the bark.
c—Spores 8 in the ascus, not germinating in ascus . . . . . . *Dermatea*
c—Spores sprouting in the ascus, ascus filled with conidia . . . . . *Tympanis*
A—Receptacle in fresh condition gelatinous.
b—Receptacle sessile or stipitate, smooth and cup-shaped.
c—Spores 1-celled.

d—Spores spherical . . . . *Pulparia*
d—Spores elongate.
e—Receptacle within gelatinous, soft.
f—Receptacle sessile thin . . *Bulgariella*
f—Receptacle stipitate thick . . *Bulgaria*
e—Receptacle within watery-gelatinous *Sarcosoma*
c—Spores 2-celled.
d—Spores unequally 2-celled, rounded, parasitic on algæ . . . . *Paryphedria*
d—Spores elongate pointed, 2-celled, on wood . . . . . . *Sorokina*
c—Spores thread-like . . . . *Holwaya*
c—Spores muriform . . . . *Sarcomyces*
b—Receptacle with disc folded, brain-like.
c—Spores 1-celled, hyaline . . . *Hæmatomyces*
c—Spores septate muriform, dark colored . *Hæmatomyxa*

Order I—HELVELLINEÆ *Schrœter.*

Receptacle vertical, stipitate, mitrate, pileate, or clavate; hymenium superior, exposed from the first; substance between fleshy and waxy, rarely gelatinous.

Family I—**GEOGLOSSACEÆ**

Receptacle fleshy, waxy, or gelatinous; fructification separated into a sterile stem and a fertile receptacle. Hymenium on the outside of the receptacle, always exposed. Asci clavate, non-operculate.

Genus I—SPATHULARIA *Persoon.*

Receptacle fleshy, stipitate, vertical, compressed laterally, extending down two opposite sides of the stem; sporidia 8, filiform, hyaline, paraphyses filiform.

One species has been collected in the northeast part of the state which is distinguished by its yellow color. It is common in that part of the state on naked soil in woods.

SPATHULARIA CLAVATA (*Schaeff.*) *Sacc.*

PLATE I, fig. I.

1800 *Elvella clavata* Schæffer, t. CXLIX.
1801 *Spathularia flavida* Persoon, Syn. Fung., II, p. 610.
1818 *Spathularia flavida* Martius, Flora Crpt. Erlang., p. 400.
1860 *Spathularia flavida* Berkeley, Outl. of Brit. Fung., p. 360.
1871 *Spathularia flavida* Cooke, Handbk. of Brit. Fung., II, p. 661.
1884 *Spathularia flovida* Ellis and Everhart, N. A. Fung. No. 1268.
1887 *Spathularia flavida* Phillips, Brit. Disc., p. 30.
1889 *Spathularia clavata* Saccardo, Sylloge Fung., VIII, p. 48.
1896 *Spathularia clavata* Underwood, Minn. Bot. Studies, reprint, p. 498.

Receptacle spatulate, compressed, nearly even, yellow; margin often crisped or undulated, 1 to 3 inches high; stem light colored, whitish; asci clavate; sporidia 8, filiform, 50 to 60 by 2 to 3 microns, guttulate or granular within; paraphyses filiform, branched, numerous.

Habitat—On the ground in woods, summer; collected by B. Shimek, Winneshiek county, Iowa.

Plants distinguished by their yellow color. The pileus is flattened laterally so as to be spoon-shaped or spatulate and is often much contorted and twisted. The plants are found among leaves and sticks on damp soil in woods.

Genus II—L E O T I A *Hill.*

Receptacle stipitate, gelatinous, pileate, roundish or spreading, revolute at the margin; hymenium covering the upper surface and the margin of pileus, under surface sterile; hymenium undulated or even. Stem cylindrical or laterally compressed. Asci clavate, 8-spored; sporidia fusiform or linear, colorless.

LEOTIA STIPITATA (*Bosc.*) *Schrœter.*

PLATE I, fig. II.

1823 *Leotia chlorocephala* Fries, Syst. Myc., II, p. 30.
1874 *Leotia chlorocephala* Berkeley, Grev., III, p. 149.
1887 *Leotia chlorocephala* Phillips, Brit. Disc., p. 23.
1889 *Leotia chlorocephala* Saccardo Sylloge Fung. VIII, p. 609.
1896 *Leotia chlorocephala* Underwood, Minn. Bot. Studies, reprint, p. 498.
1897 *Leotia stipiata* Engler-Prantl, Pflan. Famil., II, p. 166.

Plants stipitate, 1 to 3 inches high by 1 inch broad; pileus globose or spreading, smooth, dark æruginous green; stem long, flattened or twisted, light colored, yellowish, covered with minute hair-like structures; asci clavate; sporidia 8, guttulate and granular within, 20 by 5 microns; paraphyses filiform.

Habitat—On soil in woods among leaves, summer and fall, Iowa City.

This species is recognized by its dark green pileus and light colored stem. The light yellowish stem distinguishes it from the very closely related species, *Leotia lubrica* Pers. in which the stem and pileus are both green.

Several plants were examined by Dr. E. J. Durand of Cornell University and reported to be the species named above.

Family II—**HELVELLACEÆ.**

Plants fleshy, saparated into stem and pileus. Stem sharply distinguished from the receptacle, for the most part hollow, fragile. Receptacle pileate covered outside with the hymenium, which is always exposed, composed of asci and well developed paraphyses. Asci operculate. Spores elliptical, colorless or light yellowish.

Genus I—M O R C H E L L A *Dillenius.*

Fleshy, stipitate, fragile, with pileate receptacle. Stem cylindrical, hollow. Receptacle sharply distinguished from the stem and pitted. Hymenium covering the outer surface of the receptacle. Asci 8-spored cylindrical, operculate. Sporidia elliptic, 1-celled. Paraphyses cylindrical or clavate.

Two species have been collected in this part of the state. Plants of the same species vary greatly in external form but these differences do not seem to be definite enough to mark distinct species.

KEY TO THE SPECIES.

a—Receptacle adnate at the base with stem . .	*M. conica.*
a—Receptacle free at the base	*M. hybrida.*

MORCHELLA CONICA *Pers.*

PLATE II, fig I.

1823 *Morchella conica* Fries, Syst. Myc., II, p. 7.
1887 *Morchella conica* Phillips, Brit. Disc., p. 4.
1889 *Morchella conica* Saccardo, Sylloge Fung., VIII, p. 9.
1896 *Morchella conica* Underwood, Minn. Bot. Studies, reprint, p. 493.
1897 *Morchella conica* Engler-Prantl, Pflan. Famil., I, i, p. 169, fig. 141.
1900 *Morchella conica* Atkinson, Mush., p. 218, fig. 206.

Pileus conical, or terete, oblong' adnate at the base, yellowish; primary ribs longitudinal, secondary forming transverse folds; pits elongated, narrow; stem cylindrical or tapering toward the top, whitish; asci cylindrical, 8-spored; sporidia elliptic, 15 to 20 by 10 to 12 microns, granular within paraphyses a little enlarged at their apices.

Habitat—On the ground in spring; Iowa City.

The principle distinction between this species and *Morchella esculenta* Linn. seems to be in the form and external appearance of the plants. In the species described here the primary ribs tend to be longitudinal with the pileus forming oblong pits which are more or less rectangular. In *Morchella esculenta* Linn. the pileus is more nearly rounded and the pits are irregular and show no definite arrangement.

MORCHELLA HYBRIDA (*Sow.*) *Pers.*

PLATE II, fig. II.

1801 *Morchella hybrida* Persoon, Syn, Fung., II, p. 620.
1823 *Morchella semilibera* Fries, Syst. Myc., II, p. 10.
1828 *Morchella semilibera* Fries, Elench. Fung., 1, p. 2.
1860 *Morchella semilibera* D.C., Berkeley, Outl. of Brit. Fung., p. 358.
1871 *Morchella semilibera* D.C., Cooke, Handbk. of Brit. Fung., II, p. 656.
1887 *Morchella semilibera* D.C., Phillips, Brit. Disc., p. 7.
1889 *Moachella hybrida* Saccardo, Sylloge Fung., VIII, p. 13.
1897 *Morchella hybrida* Engler-Prantl, Pflan. Famil., I, i, p. 169.
1899 *Morchella hybrida* Underwood, M. M. & M., p. 66.
1900 *Morchella semilibera* D.C., Atkinson, Mush., p. 219.

Pileus free half way up; ribs longitudinal, forming oblong pits which are veined within; stem cylindrical, even, often very long and enlarged at the base; asci cylindrical; sporidia 8, elliptic, yellowish, 20 to 25 by 12 to 14 microns; paraphyses filiform, slightly enlarged at their apices.

Habitat—On the ground; spring; Iowa.

The stem is long and generally even and the pileus is a small cap-shaped body often of a dark brownish or yellowish color. The plants often grow to a height of from 5 to 6 inches. The stem is covered with minute hair-like structures, which are very irregular, consisting of loosely united roundish or elongated cells.

Genus II—HELVELLA *Fries.*

Receptacle pileate, supported by the center, deflected, concave and sterile beneath. Upper surface of pileus covered by the hymenium which is even. Stem always present, united by the center to the pileus, hollow or filled with cavities. In mature plants pileus compressed, lobate, substance waxy-membranaceous; asci cylindrical; sporidia 8, elliptic, smooth; paraphyses linear.

Several species have been collected in this part of the state, two of which are described. The plants described are found in woods in the spring or fall.

KEY TO THE SPECIES.

a—Stem grooved, large; pileus free at the margin . *H. crispa.*
a—Stem even, slender; pileus free . . . . *H. elastica.*

HELVELLA CRISPA (*Scop.*) *Fries.*
PLATE III, fig. 1.

1823 *Helvella crispa* Fries, Syst. Myc., II, p. 14.
1860 *Helvella crispa* Berkeley, Outl. of Brit. Fung., p. 350.
1871 *Helvella crispa* Cooke, Handbk. of Brit. Fung., II, p. 658.
1887 *Helvella crispa* Phillips Brit. Disc., p. 10.
1889 *Helvella crispa* Saccardo, Sylloge Fung., VIII, p. 18.
1896 *Helvella crispa* Underwood, Minn. Bot. Studies, reprint, p. 489.
1897 *Helvella crispa* Engler-Prantl, Pflan. Famil., I, i, p. 170, fig. 141.
1900 *Helvella crispa* Atkinson, Mush., p. 219.

Pileus deflected, lobed, free, crisped, pallid; stem hollow with deep grooves; asci cylindrical; sporidia 8, elliptical, 15 to 18 by 10 to 12, paraphyses filiform, slender.

Habitat—On the ground in woods; Iowa City.

Plants are from 2 to 3 inches in height and the pileus from 1 to 2 inches in diameter. Margin of pileus is entirely free from the stem and the whole plant is of a very light color being almost white. The color and the pileus which is entirely free and expanded distinguishes this species from *Helvella lacunosa*. Plants are found in the spring in woods near Iowa City.

HELVELLA ELASTICA *Bull.*

PLATE III, fig. 11.

1793 *Helvella elastica* Bulliard, Champ., p. 262.
1823 *Helvella elastica* Fries, Syst. Myc., II, p. 21.
1860 *Helvella elastica* Berkeley, Outl. of Brit. Fung., p. 359.
1871 *Helvella elastica* Cooke, Handbk. of Brit. Fung., p. 659.
1887 *Helvella elastica* Phillips, Brit. Disc., p. 15.
1889 *Helvella elastica* Saccardo, Sylloge Fung., VIII, p. 24.
1896 *Helvella elastica* Underwood, Minn. Bot. Studies, p. 490.
1897 *Helvella elastica* Engler-Prantl, Pflan. Famil., I, i, p. 171, fig. 114.

Pileus free, even, inflated, at length acutely lobed; stem elongated, slender attenuated upwards, pruinose; asci cylindrical; sporidia 8, elliptic, 18 to 20 by 10 to 12 microns; paraphyses filiform, slightly enlarged above.

Habitat—On the ground in woods; spring; Iowa City.

Distinguished by the long slender stem and free pileus which is lobed often being very regular in outline, but sometimes more or less irregular. Margin of pileus is often slightly incurved. Plants are of a very light yellowish color and from 1 to 2 inches in height and .5 to 1 inch broad.

Order II—PEZIZINEÆ.

Receptacle well developed, fleshy or more or less leathery generally regular. At first closed spherical (except *Pyronemaceæ*) gradually opening becoming shallow cup-shaped or beaker-shaped. Hymenium forming a covering on the upper, inner surface, composed of asci and paraphyses arranged in the form of a palisade.

Family I—**PYRONEMACEÆ**.

Receptacle seated on a mass of thread-like hyphæ. Hymenium at length plane or subconvex. Peridium wanting or poorly developed.

Genus I—P Y R O N E M A *Carus.*

Receptacle seated on a mass of hyphæ, fleshy, at first spherical, then expanded. Peridium very poorly developed or wanting. Sporidia elliptical, hyaline.

KEY TO THE SPECIES.

a—Plants very minute, crowded, on charcoal .	*P. aurantio-rubrum.*
b—Plants larger, scattered, on burnt ground .	*P. melaloma.*

PYRONEMA AURANTIO-RUBRUM (*Fckl.*) *Sacc.*
PLATE IV, fig. 1.

1823 *Peziza omphalodes*
a. *aurantio-rubrum* Fries, Syst. Myc., II, p. 73.
1889 *Pyronema aurantio-rubrum* Saccardo, Sylloge Fung., VIII, p. 73.

Receptacle fleshy, distinct, gregarious or crowded, 1 mm in diameter, sessile, brick red or paler; hymenium plane; asci cylindrical, 8-spored; sporidia elliptical, 8 to 9 by 5 to 6, microns, 2 to 3 guttulate, granular within, paraphyses enlarged upwards and filled with colored granules.

Habitat—On charcoal and ashes where fire has been in the fall; Iowa City.

These plants grow closely crowded together on charcoal and surrounding soil forming large reddish masses in such places in the fall of the year during very wet weather. This species is distinguished from *Pyronema omphalodes* (Bull) Fckl., as described in Saccardo by the much smaller sporidia. A plant collected at Lafayette, Indiana, by a student of Purdue University, seems to conform to the description of *P. omphalodes* Bull. These plants were collected on clay which was mixed with charcoal, and in this case the cups had run together so as to form an irregular mass about 1 to 2 inches in diameter, the individual cups near the center having been fused into one mass, the sporidia also being much larger. The color of the plants in both specimens is nearly the same.

PYRONEMA MELALOMA (*Fr.*) *Fckl.*
PLATE IV, fig. II.

1823 *Peziza melaloma* Fries, Syst. Myc., II, p. 68.
1889 *Pyronema melaloma* Saccardo, Sylloge Fung., VIII, p. 197.

Cups at first hemispherical then expanded, nearly plane, hymenium dull orange-red, 3 to 5 mm in diameter, externally clothed with dark brown, indistinct, hair-like processes; asci cylindrical; sporidia elliptic, 1- to 2-guttulate 7 to 10 by 15 to 18 microns, smooth, hyaline; paraphyses filiform, septate, somewhat enlarged upwards.

Habitat—On the ground in a burnt place in the fall; Iowa City.

Similar to *Lachnea melaloma* (A. & S.) Sacc. but cups smaller and orange-red instead of brown and the hair-like processes not so well developed. In this species these hair-like structures consist of dark brownish lines near the margin of the cup which in some cases seem to be hairs but are not very well developed. The plants were numerous in the fall where wood had been burned.

Family II—PEZIZACEÆ.

Receptacle, for the most part, borne on the surface, not immersed in the substratum, sessile or stipitate, externally smooth or clothed with hairs, fleshy. At first closed then opening by a small aperture at the top and gradually expanding. Peridium and hypothecium composed of loose roundish cells. Asci not protruding at maturity, often operculate, or opening by a flap-like structure. Spores hyaline.

Genus I—SPHÆROSPORA *Saccardo.*

Receptacle sessile, at first hemispherical, then expanded, externally clothed with simple, sharp pointed, septate hairs. Asci 8-spored; spores spherical with one large guttula, smooth or beset with spines, arranged in one row in the ascus. Paraphyses thickened above and filled with colored granules.

One species common in woods near Iowa City. In external appearance the plants resemble those of the genus *Lachnea* from which they are distinguished by their spherical spores.

SPHAEROSPORA CONFUSA (*Cooke*) *Sacc.*
PLATE V, fig. 1.

1889 *Sphaerospora confusa* Saccardo, Sylloge Fung., VIII, p. 479.
1897 *Sphaerospora confusa* Engler-Prantl, Pflan Famil., I, i, p. 179.
1900 *Sphaerospora confusa* Durand, Bull. Torrey Bot. Club, 27, p. 479.

Cups gregarious or scattered, hemispherical, then depressed, 5 to 10 mm in diameter, dark reddish brown, clothed externally with numerous, short, septate brown hairs, which are often enlarged near the base; asci cylindrical, 14 by 150 to 160 microns; sporidia spherical, 1-guttulate, 13 to 15 microns in diameter; paraphysis filiform, enlarged at their apices.

Habitat—On soil in woods; Iowa City.

These plants are common on shady banks in the woods, all summer, on naked soil or among moss. The plants are dull brown and very hairy on the outside. They are easily distinguished from the different species of *Lachnea* which they resemble in external appearance, by their spherical spores.

Genus II—LACHNEA *Fries.*

Receptacle sessile or stipitate, externally more or less haired, at first hemispherical, then expanded. When mature more or less cup-shaped or expanded. Asci 8-spored; sporidia elliptical, rarely fusiform, hyaline, smooth or rough, with one or two guttulæ, or eguttulate. On wood, soil, or other decaying organic materials. Receptacle fleshy, varying in color.

The plants of this genus are very common and readily distinguished by their external covering of hairs. Three species are described here of the eight or ten collected near Iowa City, the rest to appear later.

KEY TO THE SPECIES.

a—Receptacle cup-shaped, hymenium white or bluish white . . . . *L. hemispherica.*
a—Receptacle expanded, hymenium nearly plane.
  b—Hairs on the exterior sharp pointed, hymenium scarlet . . . . *L. scutellata.*
  b—Hairs on the exterior flexuose, hymenium, reddish brown . . . . . *L. melaloma.*

LACHNEA HEMISPHERICA (*Wigg.*) *Gill.*
PLATE VII, fig. 1.

1791 *Peziza labellum* Bulliard, Champ., t. III, p. 204
1801 *Peziza hemispherica* Persoon, Fung., II, p. 204.
1824 *Peziza hemispherica* Fries, Syst. Myc., p. 82.
1839 *Peziza hemispherica* Link, Handbk., III, p. 323.
1960 *Peziza hemispherica* Berkeley, Brit. Fung., p. 367.
1871 *Peziza hemispherica* Cooke, Handbk. of Brit. Fung., II, p. 680.
1874 *Peziza hemispherica* Cooke, Grev. III, p. 73, pl. 23, fig. 95.
1882 *Peziza hemispherica* Ellis, N. A. Fungi. No. 837.
1887 *Lachnea hemisphêrica* Phillips, Brit. Disc., p. 211.
1889 *Lachnea hemispherica* Saccardo, Sulloge Fung., VIII, p. 166.
1897 *Lachnea hemispherica* Engler-Prantl, Pflan. Famil. I, i, p. 180.
1900 *Lachnea hemispherica* Durand, Bull. Tor. Bot. Club, 27, p. 478.
1902 *Sepultaria albida* Morgan, Jour. of Myc. 64, p. 188.

Cups scattered, sessile, hemispherical, entire, .5 to 1 inch in diameter, margin at first incurved; externally brown, covered with brown, rigid, septate hairs, more numerous near the margin; hymenium bluish white; asci cylindrical or slightly enlarged upwards; sporidia 8, elliptic, 2-guttulate, asperate, 20 to 22 by 10 to 13 microns; paraphyses septate, clavate at the apices.

Habitat—On the ground in damp shady woods; Iowa City.

A very common species on naked soil in woods about Iowa City. The plants are at first almost spherical, gradually opening until they become hemispherical, as the name implies.

The hairs, with which the exterior is covered, are more numerous and much longer near the margin, forming a fringe which especially in the young specimens projects inward. The cups are often 1 inch in diameter but generally smaller.

LACHNEA SCUTELLATA (*Linn.*) *Sacc.*
PLATE VI, fig. I.

1767 *Peziza scutellata* Linnæus, Syst. Nat., III, p. 725.
1801 *Peziza scutellata* Persoon, Syn. Fung., II, p. 650.
1823 *Peziza scutellata* Fries, Syst. Myc,, II, p. 85.
1833 *Peziza scutellata* Link, Handbk., III, p.323.
1860 *Peziza scutellata* Berkeley, Outl. of Brit. Fung., p. 368.
1871 *Peziza scutellata* Cooke, Handbk. of Brit. Fung., II, p. 682.
1885 *Peziza scutellata* Ellis and Everhart, N. A. Fung., No. 1310.
1887 *Lachnea scutellata* Phillips, Brit. Disc., p. 222.
1889 *Lachnea scutellata* Saccardo, Sylloge Fung. VIII, p. 173.
1897 *Lachnea scutellata* Engler-Prantl, Pflan. Famil.,I, i, p. 180, fig. 147.

Cups scattered or gregarious, fleshy, sessile; externally as well as the elevated margin, brown, clothed with rather long, septate, brown, sharp pointed hairs; hymenium at first concave then plane, bright red; asci cylindrical; sporidia 8 elliptic, smooth, when fresh, often fitted with numerous guttulæ and granules, generally with 2 or 3 large guttulæ, 20 to 22 by 12 to 14 microus; paraphyses simple or branched, enlarged at their apices, often spirally marked, filled with orange granules.

Habitat—On decaying wood in the fall; Iowa City.

The plants of this species are very closely related to one or two other common species which are not described in this paper, but may be easily distinguished by the bright red disc and the smooth spores which are filled with numerous granules. The hairs on the exterior are long and dark colored. The planis are common in the late fall on much decayed wood in wet places.

LACHNEA MELALOMA (*A. & S.*) *Sacc.*
PLATE VI, fig. II.

1860 *Peziza melaloma* Berkeley, Outl. of Brit. Fung., p. 366.
1871 *Peziza melaloma* Cooke, Handbk. of Brit. Fung., II, p. 674.
1887 *Peziza metaloma* Phillips, Brit. Disc., p. 109.
1889 *Lachnea melaloma* Saccardo, Sylloge Fung., VIII, p. 107.

Sessile crowded, yellowish, slightly concave, then nearly plane, becoming dingy orange brown, 3 to 8 mm. in diameter, externally clothed with delicate flexuose, septate, black or brown hairs; asci cylindrical; long; sporidia eight, elliptic, 1- to 2-guttulate, 17 to 20 by 7 to 8 microns; paraphyses slender, slightly enlarged at their apices.

Habitat—On and surrounding an old burnt stump, in open woods; fall Iowa City.

The plants are very abundant on burnt wood and the surrounding soil. When mature they are of a dark brownish color and clothed on the outside of the cup with dark, reddish brown hairs which are not errect but adpressed, forming dark lines which extend from near the base toward the margin of the cup. Fresh plants grown in the laboratory are at first yellowish, becoming brown with age. At maturity the margin is generally elevated leaving the hymenium slightly concave.

Genus III—N E O T I E L L A *Cooke.*

Receptacle sessile or stipitate, externally clothed with hyaline hairs. Asci 8-spored; spores ellipitial or fusiform, hyaline, smooth, or verrucose, with or without guttulæ. Plants found on earth or wood.

One species has been collected near Iowa City on damp soil.

NEOTIELLA LUTEO-PALLENS (*Nyl.*) *Sacc.*
PLATE V, fig. 11.

1889 *Neotiella luteo-palens* Saccardo, Sylloge Fung. VIII, p. 191.

Cups sessile, at first hemispherical, then expanded, pale orange yellow, 4 to 5 mm. in diameter, externally clothed with light colored septate, rather rigid hairs; asci cylindrical, operculate; sporidia elliptic, 15 to 17 by 9 to 10 microns granular within; paraphyses stout thickened at their apices, filled with large pale yellow granules, 5 to 7 microns in diameter.

Habitat—On naked soil in woods; also grown in laboratory from same soil.

The light colored hairs with which the exterior of these plants is clothed distinguish this genus from the genus *Lachnea* in which the hairs are dark colored. They are distinguished from the genus *Sacroscypha* which also has light colored hairs, by the small sessile plants. Two plants were grown in the laboratory from soil on which the plants were found in the field. The hymenium is almost plane but generally surrounded by a delicate fringe. The asci often show only four or six spores. Spores are often surrounded by a gelatinous substance.

Genus III—S A R C O S P H Æ R A *Auersw.*

Receptacle at first closed, immersed in the ground, opening at the summit and gradually spreading, often splitting at the margin, when mature only partly immersed. Externally clothed with soft, flexuose, septate, brown hair, longer near the base, or nearly smooth. Asci 8-spored; sporidia elliptical, hyaline, smooth, 1-guttulate. Paraphyses colorless clavate.

The one species described here was collected in the summer on sandy soil on the bank of a small lake in Washington park, Chicago. The plants were partly immersed in the sand and constricted at the mouth. Mature specimens were only slightly split at the margin.

SARCOSPHAERA ANENICOLA (*Lev.*) *Lindau.*
PLATE VII, fig. 11.

1887 *Lachnea arenicola* Phillips, Brit. Disc., p. 210.
1889 *Lachnea arenicola* Saccardo, Sylloge Fung., VIII, p. 172.
1897 *Sarcosphaera arenicola* Engler Prantl, Pflan. Famil., I, i, p. 181, fig. 147.

Cups sessile, subterranean, subglobose, then cup-shaped, depressed, waxy, about one inch in diameter, clothed, especially near the base with long, brown, flexuose hairs encrusted with sand; mouth constricted, becoming split; hymenium white or brownish; asci cylindrical; sporidia 8, broadly elliptic, 1-guttulate, smooth 20 to 25 by 12 to 14 microns; paraphyses clavate at the apices.

Habitat—In sandy soil on the bank of a small lake in Washington park, Chicago.

This specimen has not been collected in Iowa, but is described here as a representative of this genus which is distinguished from *Lachnea* by the fact that the cups are buried or partly buried in the ground. The margin of the cup is at first even but splits irregularly as the plant matures. The cups are about one inch broad and when removed from the soil are found to be flattened.

Genus V—P E Z I Z A *Dillenius.*

Receptacle at first closed, spherical, then opening becoming more or less cup-shaped, stipitate or sessile, externally smooth, furfuraceus, or covered with flexuose, soft hairs, never clothed with sharp pointed ones, fleshy, brittle. Asci 8-spored; sporida elliptical fusiform, smooth, asperate, or reticulate. Paraphyses slender, clavate, or curved at their apices. Plants varying in color, growing on earth, wood, or other decaying materials.

The genus *Peziza* is separated into several groups which are treated as subgenera by Lindau and the most of these groups are included here as separate genera as they are treated by Saccardo in Sylloge Fungorum.

A large number of specimens have been collected several of which are described here, distributed through the different genera.

Subgenus I—A L E U R I A *Fckl.*

Receptacle borne on a short stem or stem-like base and colored by the red granules contained by the paraphyses. The spores are marked on the outside by net-like reticulations.

Two species have been collected which show very distinctly the net-like markings on the surface of the spores which are given as a characteristic of this subgenus.

KEY TO THE SPECIES.

a—Plants large more than 1 inch in diameter, spores 2-guttulate . . . . *P. aurantia.*
a—Plants much smaller, stipitate, spores reticulate, 1-guttulate . . . . *P. rutilans.*

PEZIZA AURANTIA *Pers.*

PLATE VIII, fig. 1.

1783 *Peziza cochleata* Batsch, Elench. Fung., p. 223.
1791 *Peziza coccinea* Bulliard, Champ., t. IV, p. 474
1800 *Peziza aurantia* Persoon, Fung., I, p. 58.
1823 *Peziza aurantia* Fries, Syst. Myc., p. 49.
1833 *Peziza aurantia* Link, Handbk., III, p. 318.
1860 *Peziza aurantia* Berkeley, Outl. of Brit. Fung., p. 363.
1871 *Peziza aurantia* Cooke, Handbk. of Brit. Fung., II, p. 668.
1877 *Peziza aurantia* DeBary, Morph. of Fungi, p. 7.
1887 *Peziza aurantia* Phillips, Brit. Disc., p. 56, pl. 3, fig. 14.
1889 *Peziza aurantia* Saccardo, Sylloge Fung., VIII, p. 74.
1897 *Peziza aurantia* Engler-Prantl, Pflan. Famil. I, i, p. 187, fig. 150.
1898 *Peziza aurantia* Strasburger, Text, p. 358.
1902 *Otidea aurantia* Morgan, Jour. of Myc., 64, p. 191.

Cups subsessile, irregular, 1 to 2 inches in diameter; hymenium bright orange, externally whitish; asci cylindrical; sporidia 8, elliptic, 2-guttulate, rough with the projections of the net-like reticulations, 15 to 17 by 8 microns; paraphyses slender, enlarged upwards, filled with orange granules.

Habitat—In a grassy place at the base of a large oak stump, also in damp places in woods, among leaves and moss, in the fall; Iowa City.

The finest specimens were found at the base of a large stump in open woods near Iowa City. When growing alone the plants are quite regular but when crowded, become irregular in form. Those forms found in damp shady woods were more regular in outline but much smaller in size. They are recognized at once on account of their large size and bright orange color.

PEZIZA RUTILANS *Fries.*

PLATE VIII, fig. 11.

1823 *Peziza rutilans* Fries, Syst. Myc., II, p. 68.
1871 *Peziza rutilans* Cooke, Handbk. of Brit. Fung., II, p. 674.
1374 *Peziza rutilans* Cooke, Grevillea, III, fig. 74.
1887 *Peziza rutilans* Phillips, Brit. Disc., p. 89, pl. IV, fig. 20.
1889 *Humaria rutilans* Saccardo, Sylloge Fung., VIII, p. 133.
1897 *Peziza rutilans* Engler-Prantl, Pflan. Famil., I, i, p. 185.

Gregarious, sessile or with a short stem, about 1 cm. in diameter; hymenium orange colored, externally covered with very minute white hairs; asci cylindrical, 8-spored; sporidia, elliptical, 1-guttulate, externally covered with net-like reticulations, giving the spore a roughened appearance, 22 to 25 by 12 microns; paraphyses slender, enlarged upwards, filled with orange granules.

Habitat—In sandy soil in woods with plants of *Polytrichum*. Iowa City.

Cups about 1 cm. in diameter generally with a short stem, which tapers toward the base, generally found among plants of *Polytrichum*. Mature spores show distinct reticulations on the surface which are very regular and resemble those found on the spores of *Peziza aurantia* Mull. except that they may be finer and a little more numerous. In no available description is there any reference to the reticulate spores in this species although they are always described as being rough. In all other respects these plants seem to be identical with those described as *Peziza rutilans* Fr. Among the characters given in Engler-Prantl for the subgenus *Aleuria* are the net-like reticulations of the spores. The reticulations in this species are very distinct in mature specimens.

PEZIZA CEREA *Sow.*

PLATE IX, fig. 1.

1791 *Peziza cerea* Bulliard, Champ., t. II, pl. 44.
1801 *Peziza cerea* Persoon, Syn. Fung. I–II, p. 643.
1823 *Peziza cerea* Fries, Syst. Myc., II, p. 49.
1860 *Peziza cerea* Berkeley, Brit. Fung., p. 363.
1871 *Peziza cerea* Cooke, Handbk. of Brit. Fung., II, p. 670.
1875 *Peziza cerea* Cooke, Grev., III, p. 127, pl. 38, fig. 132.
1887 *Peziza cerea* Phillips, Brit. Disc., p. 74.
1889 *Peziza cerea* Saccardo, Sylloge Fung., VIII, p. 74.
1900 *Peziza cerea* McIlvaine, Amer. Fung., p. 558.

Cups large, gregarious, hemispherical, or infundibuliform when young, becoming repand with age, 1 to 3 inches in diameter, fleshy, very fragile, furfuraceus, whitish, or sometimes reddish brown near the margin and slightly cleft, often with a stem-like base below; asci cylindrical operculate; sporidia 8 elliptic, smooth, 20 to 22 by 10 microns, granular within; paraphyses slender, enlarged upwards, filled with granules.

Habitat—On rich ground and dung heaps in the fall, Iowa City.

This species has been found but once in a large mass growing on a dung pile which was mixed with straw. The plants were at first hemispherical but in older species the margin becomes wavy. The flesh is very brittle and resembles wax as is indicated by its specific name. Especially when young, the plants have a mealy appearance on the outside, and cups are sometimes produced into a short stem below.

Genus VI—G A L A C T I N I A *Cooke.*

Receptacle sessile, cup-shaped, entire, fleshy, when wounded exuding a milky colored juice. Asci cylindrical; sporidia 8, elliptic, hyaline.

One species has been collected near Iowa City.

GALACTINIA SUCCOSA *Berk.*
PLATE IX, fig. 11.

1860 *Peziza succosa* Berkeley, Brit. Fung., p. 363.
1871 *Peziza succosa* Cooke, Handbk. of Brit. Fung., II, p. 667.
1887 *Peziza succosa* Phillips, Brit. Disc. p. 70, pl. 4, fig. 16.
1889 *Galactinia succosa* Saccardo, Sylloge Fung., VIII, p. 106.
1897 *Peziza succosa* Engler-Prantl, Pflan. Famil., I. i, p. 187.
1902 *Peziza succosa* Morgan, Jour. of Myc., 64, p. 190.

Cups large or medium sized, 1 to 2 inches in diameter, sessile, hemispherical, then expanded, pale wax-brown, externally paler, whitish, pruinose; margin slightly inflexed; juice from broken flesh, thick, milky, golden yellow; asci cylindrical; sporidia 8, elliptic, asperate, 1 to 2 guttulate, 18 to 20 by 12 microns; paraphyses clavate, filled with brown granules.

Habitat—On the ground in damp, shady woods in summer, Iowa City.

The plants of this species were found on naked soil in dense woods near Iowa City. They are not striking in their external appearance, but are easily distinguished by the thick milky juice which is golden yellow. The margin of the cup is irregular and sometimes slightly wavy.

Genus VII—H U M A R I A *Fries.*

Plants small, entirely sessile, for the most part red, or yellow. Hymenium plane or subconvex. Asci generally 8-spored, sporidia elliptical or fusiform. Growing generally on damp soil, often among moss.

Two species are described both of which have fusiform spores and are common among moss in shady places.

KEY TO THE SPECIES.

a—Asci 4-spored, spores fusiform . . . *H. tetraspora.*
a—Asci 8-spored, spores fusiform . . . *H. muralis.*

HUMARIA TETRASPORA (*Fckl.*) *Sacc.*
PLATE XI, fig. 1.

1874 *Peziza tetraspora* Cooke, Grev. III, p. 121.
1889 *Humaria tetraspora* Saccardo, Sylloge Fung., VIII, p. 121.

Cups sessile, gregarious or scattered, hymenium slightly concave or plane, bright orange red, whitish near the margin, 2 to 3 mm. in diameter; asci clavate 4-spored; 20 to 22 by 10 microns; parphyses clavate at the apices, filled with orange granules.

Habitat—On shady mossy banks by the roadside, fall, Iowa City.

Plants scattered, on mossy banks in the late fall, small but easily distinguished on account of their bright orange color. The margin of the cup is bordered by a delicate white fringe. The cups are similar in external appearance to those of *Humaria muralis* Quel. but are smaller in size. The spores are also similar in form and appearance to those of *Humaria muralis* but are somewhat smaller in size and generally contain one large central guttula and two or three smaller ones. Spores are fusiform and attenuate at the ends. This species is easily distinguished on account of the number of spores in the ascus which is constantly four as is indicated by its specific name.

HUMARIA MURALIS *Quel.*
PLATE XI, fig. 11.

1879 *Peziza (Humaria) muralis* Quellet, Grev., VIII, p. 116.
1889 *Humaria muralis* Saccardo, Sylloge Fung., VIII, p. 127.

Cups minute, sessile, gregarious or scattered, hemispherical, then expanded, orange yellow, 2 to 5 mm. in diameter; hymenium plane or nearly so; asci clavate; sporidia 8, fusiform, 2 to 3-guttulate, smooth, 25 to 30 by 7 to 9 microns, in one or two rows in the ascus or irregularly arranged; paraphyses much enlarged at their apices and filled with orange granules, 6 to 10 microns in diameter.

Habitat—On sandy soil among moss, Indiana and Iowa.

Plants collected only in small numbers but very conspicuous on account of their large elongated spores which are generally very irregularly arranged in the ascus. The spores generally have one large guttula near the center and one or more smaller ones on each side. Similar to *H. tetraspora* except as to the number of spores in the ascus and a slight variation in the size of the spores.

Genus VIII—G E O P Y X I S *Persoon.*

Receptacle funnel-shaped or spreading. For the most part, large fungi with a distinct stem which is generally short and thick.

One species collected which is common on decaying wood in woods; Iowa City.

GEOPYXIS NEBULOSA (*Cke.*) *Sacc.*
PLATE XXI, fig. 11.

1879 *Peziza nebulosa* Ellis and Everhart, A. N. Fung., No. 281.
1889 *Geopyxis nebulosa* Saccardo, Sylloge Fung., VIII, p. 70.
1897 *Geopyxis nebulosa* Engler-Prantl, Pflan. Famil., I, i, p. 185.

Gregarious, stipitate, globose, then expanded, becoming funnel-shaped, yellowish brown, 1 to 2 cm. in diameter: margin incurved; hymenium concave, same color as exterior; stem 1 to 10 mm. in length, tapering toward the base; asci cylindrical, sporidia fusiform, 25 to 35 by 6 microns, granular within; paraphyses filiform, abundant.

Habitat—In woods on rotten logs, summer; Iowa City.

Plants found on wood which is generally very much decayed. They are generally found in groups and may be quite easily distinguished in the field by their short stems and uniform dull, smoky, brown color. Upon microscopic examination, they may be distinguished by their long slender spores.

Genus IX—MACROPODIA *Fuckel.*

Receptacle borne on a stem which is generally long and slender, externally rough or clothed with minute hairs; hymenium dark colored, spores elliptical or fusiform.

One species common in woods on naked soil near Iowa City.

MACROPODIA PUBIDA (*B. & C.*) *Sacc.*
PLATE XX, fig. 1.

1874 *Peziza pubida* Berkeley and Cooke, Grev. III, p. 153.
1884 *Peziza pubida* Ellis and Everhart, N. A. Fung., No. 1269.
1889 *Macropodia pubida* Saccardo, Sylloge Fung., VIII, p. 159.
1902 *Peziza pubida* Masse, Morgan, Jour. of Myc. Vol. 8, No. 64, p. 190.

Cups gregarious or scattered, hemispherical, shortly stipitate below, .5 to 1 inch in diameter; hymenium dark brown, often purplish when dry: externally covered with short, brown, septate hairs, giving the plants a mealy appearance, hair longer near the base; asci cylindrical; sporidia 8, fusiform, rough, 2 guttulate, granular within, 38 to 42 by 10; paraphyses slender enlarged upward, brown.

Habitat—On the ground in woods all summer, Iowa City.

The stem is short and generally covered with long, brown hairs, and immersed in the ground so that the cups seem to be sessile. In the field, the plants resemble those of Lachnea hemisphærica but are distinguished by the dark colored hymenium and by the soft hairs instead of the sharp bristly ones on the exterior.

These specimens have been compared with those of *Peziza pubida* in Ellis and Everhart's N. A. Fungi and found to be the same.

Peziza morgani Masse is referred to here for the reason that the description given for this species in the "Journal of Mycology" seems to conform in every particular to the material described is *Peziza pubida* B. & C. in Ellis and Everhart's N. A. Fungi, and to the same material collected here. The fusiform, warted, biguttulate spores given as a distinguishing character for *Peziza morgani* Masse are found in *Macropodia pubida* (B. & C.) Sacc., and it seems possible that the two species may be identical.

Genus X—OTIDEA *Persoon.*

Receptable large, elongated on one side or split on one side to the base. Cups more or less stipitate, scattered or crowded. Asci 8-spored; spores elliptical, smooth, hyaline, with one or more guttulae. Paraphyses clavate, or bent in the form of a hook at the apex.

Two species have been collected in the northeast part of the state.

KEY TO THE SPECIES.

a—Plants large, hymenium brown, paraphyses hooked — *O. leporina*
a—Plants smaller, yellowish, paraphyses not hooked — *O. ocharcea*

OTIDEA LEPORINA (*Batsch*) *Fckl.*

PLATE X, fig. 11.

1783 *Peziza leporina* Batsch, Elench. Fung., p. 118.
1801 *Peziza leporina* Persoon, Syn. Fung., II, p. 637.
1823 *Peziza leporina* Fries, Syst. Myc., II, p. 47.
1833 *Peziza leporina* Link, Handbk., III, p. 317.
1860 *Peziza leporina* Berkeley, Brit. Fung., p. 363.
1871 *Peziza leporina* Cooke, Handbk. of Brit. Fung., II, p. 668.
1887 *Peziza leporina* Phillips, Brit. Disc., p. 53.

1889 *Otidea leporina* Saccardo. Sylloge Fung., VIII, p. 94.
1897 *Otidea leporina* Engler-Prantl, Pflan. Famel., I, p. 187.

Cups substipitate, elongated on one side, split on the short side near the base, cleft margin ircurved, margin inclined to be scalloped, 1 to 3 inches in diameter; hymenium dark brown, externally lighter; asci cylindrical; sporidia 8, elliptic, smooth, 2-guttulate, 12 to 14 by 7 to 8 microns; paraphyses filiform, curved at their apices.

Habitat—On the ground in the woods; collected by B. Shimek in Winneshiek County, Iowa.

Plants distinguished from those of *Otidea ochracea* Fr. externally by their larger size and darker color. Upon microscopic examination they are distinguished by their paraphyses which are always curved in the form of a hook at the apex. These characters also distinguish this species from *Otidea onotica* which is similar to *Otidea ochracea* Fr. but much larger in size and more stipitate in form.

OTIDEA OCHRACEA (*Fries.*) *Sacc.*
PLATE X, fig. 1.

Peziza onotica
B—*ochracea* Fries, Syst. M.c., II, p. 48.
Otidea ochracea Saccardo, Sulloge Fung., VIII, p. 95.

Cups small, 2 to 3 cm. in diameter, caespitose or solitary, continued into a short thick stem-like base below, base corrugated; cups split on one side to the base and margin incurved; asci cylindrical, 8-spored, 110 to 130 by 10 microns; paraphyses not enlarged at their apices, septate, granular, branched often several times.

Habitat—On soil among leaves in woods, Winneshiek County, Iowa. Collected by B. Shimek.

This form is distinguished from *Otidea onotica* (Pers.) Fckl. by its smaller size and yellowish color. The spore measurements also seem to be somewhat less. The cups are not much elongated on side, if any, but are split to the base. Plants distinguished from *O. leporina* (Batsch) Fckl. by their smaller size size, yellow collor, and straight paraphyses.

Family III—**ASCOBOLACEÆ.**

Receptacle generally sessile on the surface, at first closed, later more or less expanded, nearly always found on dung. Peridium thin or wanting. Hypothecium for the most part well developed, consisting of roundish cells. Asci at maturity protruding beyond the surface of the hymenium, generally operculate.

Genus I—L A S I O B O L U S *Saccardo.*

Receptacle similar to Ascophanus but externally clothed with sharp pointed hairs. Two species have been collected one of which is very common on the dung of horses and cows in wet places.

KEY TO THE SPECIES.

a—Plants minute, hairs abundant, simple . . *L. equinus.*
a—Plants larger, hairs few, septate . . . *L. raripilus.*

LASIOBOLUS EQUINUS (*Mull.*) *Karst.*
PLATE XII, fig. I.

1801 *P.z'za papillata* Persoon, Syn. Fung., II, p. 652.
1823 *Peziza papillata* Fries, Syst. Myc., 11, p. 88.
1889 *Lasiobolus equinus* Sacardo, Sylloge Fung., VIII, p. 536.
1879 *Lasiobolus equinus* Engler-Prantl, Pflan. Famil., I, i, p. 189, fig. 152.
1900 *Lasiobolus equinus* Durand, Bull. Torrey Bot. Blub, 27, p. 480.
1902 *Lasiobolus equinus* Morgan, Jour. Myc., 64, p. 182.

Gregarious, crowded or scattered, minute, sessile, .5 to 1 mm. in diameter, yellowish, externally clothed with numerous, straight, non-septate, colorless spines; asci 8-spored, clavate operculate; sporida elliptical, hyaline, smooth, 20 to 22 by 10 to 12 microns, paraphyses slender, septate, granular, simple or branched.

Habitat—On dung of cows and horses in wet places in summer and fall; also grown in the laboratory.

This material has been compared with Rehm's Ascom. No. 1036 which was received by the kindness of Dr. E. J. Durand and seems to be the same. These plants have been collected in large quantities on cow dung in the spring and summer and on horse dung in the late fall. In some cases they grow crowded together so as to entirely cover the substratum. The paraphyses are filled with granules which are often orange colored but seem to vary under different conditions. The paraphyses are simple or branched. In some specimens grown in the laboratory, they are branched many times but in other respects the material seems to be the same as that described by Saccardo as *Lasiobolus equinus.*

LASIOBOLUS RARIPILUS (*Phill.*) *Sacc.*
PLATE XII, fig. II.

1878 *Ascobolus raripilus* Phillips, Grev. VII, p. 23.
1889 *Lasiobolus raripilus* Saccardo, Sylloge Fung., VIII, p. 537.
1897 *Lasiobolus raripilus* Engler-Prantl, I, i, p. 189.

Gregarious or crowded, minute, sessile, glabrous, at first globose then expanded, 1 to 3 mm. in diameter, disc convex, pale, lemon yellow, very scantily clothed externally, with a few, pale, septate, straight hairs; asci broadly clavate; sporidia 8 elliptical or ovate 30 by 10 microns; paraphyses simple, clavate at the apices.

Habitat—On cow dung and the surrounding soil in ravine, Iowa City.

This species seems to agree with the description given by Phillips in Grevillea. The plants grow crowded together in dense pale yellow masses sometimes covering a considerable area in a wet place in a ravine near Iowa City. It is very scantily clothed with hairs, several specimens having been examined before any of the hairs were seen. The hairs differ from those of *Lasiobolus equinus* by being much more slender and septate.

Genus II—ASCOPHANUS *Boudier.*

Receptacle at first closed, then expanded, fleshy or fleshy-gelatinous, externally smooth, hymenium at maturity plane or convex. Asci cylindrical or clavate, operculate, 8-spored, protruding beyond the surface of the hymenium. Spores elliptical, hyaline, smooth or sometimes rough. In one or two rows in the ascus. Plants generally occur on dung.

Several species have been collected or grown in the laboratory.

KEY TO THE SPECIES.

a—Plants minute, paraphyses with globose apices, yellow . . . . *A. microsporus*
a—Plants larger, paraphyses not globose.
  b—Receptacle red, paraphyses clavate, on sacking *A. testaceus.*
  b—Receptacle blackish, paraphyses filiform, on dung . . . . *A. cinereus.*

ASCOPHANUS MICROSPORUS (*B. and Br.*) *Phill.*
PLATE XIII, fig. 11.

1871 *Ascobolus microsporus* Cooke, Handbk. of Brit. Fung. II, p. 730.
1887 *Ascophanus microsporus* Phillips, Brit. Disc., p. 307.
1889 *Ascophanus microsporus* Saccardo, Sylloge Fung., VIII, p. 528.

Very minute, sessile, light yellowish red, sometimes almost white, depressed, about .5 to 1 mm. in diameter; asci broadly clavate, often furnished at the base with a little narrow, oblique stem, 85 to 90 by 12 microns; sporidia 8, elliptical, hyaline, 7 to 8 by 4 microns; paraphyses slender septate, with large, globose apices, filled with a greenish yellow endochrome.

Habitat—On old cow dung in a culture in the laboratory.

Numerous plants of this species were found growing, either gregarious or scattered, on old cow dung which was kept moist under glass in the laboratory for several weeks. The plants are very small in size and of a transparent reddish brown color. They are easily distinguished on account of the small size of the plants, their minute spores, which are generally arranged in two rows in the ascus and the paraphyses with their large globose apices, the apices alone being filled with yellow coloring matter, making them very conspicuous. Phillips in his "British Discomycetes" (page 307) describes the spores as being at length violet. In no case were the spores seen to be violet in the specimens studied in this laboratory, and the plants were kept growing for more than four weeks, and examined often. Saccardo in Sylloge Fungorum, (page 528) describes the spores as being hyaline.

ASCOPHANUS CINEREUS (*Crouan*) *Boud.*
PLATE XIV, fig. 1.

1871 *Ascobolus cinereus* Cooke, Handbk. of Brit. Fung., II, p. 731.
1887 *Ascophanus cinereus* Phillips, Brit. Disc., p. 308.
1889 *Ascophanus cinereus* Saccardo, Sylloge Fung., VIII, p. 531.

Scattered or gregarious, sessile or slightly stipitate, at first globose then expanded; hymenium plane or convex, 1 to 2 mm. in diameter; externally pruinose, cinereus, or blackish brown; asci cylindrical or slightly clavate; sporidia 8, elliptical or slightly attenuate at the ends, granular within, 20 to 22 by 10 microns; paraphyses filiform, slender.

Habitat—Grown on horse dung in culture in laboratory.

This species is distinguished from the other species of *Ascophanus* described here by the color of the plants, the habitat also being different. The plants are similar in size to those of *Ascophanus testaceus* but are different in color and general appearance. The spores are somewhat larger and inclined to be narrow at the ends. The paraphyses are much more slender and not enlarged at their apices nor colored.

ASCOPHANUS TESTACEUS (*Moug.*) *Phill.*
PLATE XIII, fig. 1.

1860 *Helotium testaceum* Berkeley, Outl. of Brit. Fung., p. 372.
1871 *Ascobolus testaceus* Cooke, Handbk. of Brit. Fung., II, p. 732.
1887 *Ascophanus testaceus* Phillips, Brit. Disc., p. 310.
1889 *Ascophanus testaceus* Saccardo, Sylloge Fung., VIII, p. 535.
1807 *Ascophanus testaceus* Engler-prantl, Pflan. Famil. I, i, p. 190.

Gregarious, waxy, sessile, smooth, depressed, convex, brick red, 1 to 2 mm. in diameter; asci broadly clavate; sporidia 8, elliptical, often granular, 18 to 20 by 9 to 10 microns; paraphyses stout, septate, simple or branched at the base, clavate at the apices, filled with numerous reddish granules.

Habitat—Abundant on old sacking in wet places, also on heavy paper, Indiana and on old rag carpet, Pocahontas, Iowa.

The color of these plants varies according to conditions; they are generally dark red but often lighter. A piece of old sacking found near the experiment station at Lafayette, Indiana, was almost entirely covered with the plants of this species. This species seems to be best adapted to old cloth, especially sacking. It has also been found on heavy building paper in wet places. It is easily recognized on account of its red color and its habitat. The spores are arranged in two rows in the ascus and are generally hyaline or sometimes slightly granular.

Genus III—RYPAROBIUS *Boudier.*

Receptacle minute, fleshy, spherical or conical, then expanded or depressed, white or whitish, externally smooth or downy. Asci cylindrical or very broad and elliptical, present in small numbers generally operculate, 16 to many spored. Spores elliptical or fusiform, hyaline, smooth. Paraphyses slender, colorless.

Several species have been grown in the laboratory.

KEY TO THE SPECIES.

a—Receptacle at first conical, then cylindrical, asci 32-spored . . . . *R. pelletieri.*
a—Receptacle minute, depressed.
  b—Plants scarcely visible with lens, asci few many spored . . . . . *R. pachyascus.*
  b—Plants larger, whitish. asci 16 to 64-spored.
    c—Asci 16-spored . . . . *R. sexdecimsporus.*
    c—Asci 64-spored . . . . *R. crustaceus.*

RYPAROBIUS PELLETIERI (*Cr.*) *Sacc.*
PLATE XVII fig.

1881 *Ascobolus pelletieri* Phillips and Plowright, Grev., X, p. 69.
1887 *Thecotheus pelletieri* Phillips, Brit. Disc.' p. 297.
1889 *Ryparobius pelletieri* Saccardo, Sylloge Fung., VIII, p. 542.
1897 *Ryparobius pelletieri* Engler-Prantl, Pflan. Famil., I, i, p. 190.

Gregarious or scattered, conical, then cylindrical, grey or dull whitish; externally pruinose; hymenium at first slightly concave, then plane or convex; asci few, large, cylindrical, operculate, stipitate, 300 to 320 by 50 to 60 microns; sporidia

32 in each ascus, large, attenuate at the ends, often filled with large guttulae, or granular, 23 to 24 by 35 to 38; paraphyses slender, branched.

Habitat—Grown on cow dung in the laboratory, Iowa City.

The plants of this species have been grown several times under glass in the laboratory. They are at first white or nearly so, and taper to a point at the top which gradually spreads until the plant becomes cylindrical with the hymenium convex. When mature the whole plant is from 2 to 3 mm. in diameter and about the same in height. The spores are often surrounded by a hyaline gelatinous substance.

RYPAROBIUS SEXDECIMSPORUS (*Cr.*) *Sacc.*
PLATE XVIII, fig. I.

1871 *Ascobolus sexdecimsporus* Cooke, Hanbk. of Brit. Fung., II, p. 730.
1887 *Ascophanus sexdecimsporus* Phillips, Brit. Disc., p. 311.
1889 *Ryparobius sexdecimsporus* Saccardo, Sylloge Fung., VIII, p. 541.
1897 *Ryparobius sexdecimsporus* Engler-Prantl, Pflan Famil., I, i, p. 190.

Scattered, very minute, sessile, yellowish white, just visible to the naked eye, hymenium papillate with the emergent asci; asci broad, curved or straight, 75 to 80 by 16 to 18 microns, terminated by a short, curved stem below; sporidia 16 in each ascus, elliptical, guttulate, smooth, 10 to 12 by 6 microns; paraphyses numerous, filiform, simple or branched.

Habitat—Grown on old cow dung in the laboratory, winter, Iowa City.

These plants resemble in external appearance and size the plants of *Ryparobius crustaceus* but are distinguished by the number of spores in each ascus which is 16. The asci in this case are not quite as broad as in the other, as would naturally follow from the smaller number of spores contained. The plants were found scattered but in considerable numbers.

RYPAROBIUS PACHYASCUS *Rehm.*
PLATE XVIII, fig. II.

1889 *Ryparobius pachyascus* Saccardo, Sylloge Fung., VIII, p. 541.

Gregarious or scattered, very minute, scarcely visible with the lens, 70 to 90 mm. in diameter, partly immersed, yellowish brown; asci few in each plant, 3 to 5, broad, acute at the base, not stipitate, 70 to 76 by 32 to 35, many spored; sporidia minute, elliptical, 5 to 7 by 3 microns; paraphyses not distinct.

Habitat—Grown on old cow dung in the laboratory, winter, Iowa City.

Plants are very small and could not be distinguished except as they were collected accidently with other specimens. The number of asci in each plant is small and varies in different cases but is generally from 3 to 5. The entire ascus is filled with the spores which seem to be arranged radially around the outside of the ascus. The exact number of the spores in the ascus could not be determined but there are more than 64. The paraphyses if present were indistinct.

RYPAROBIUS CRUSTACEUS (*Fckl.*) *Rehm.*
PLATE XVII, fig. 11.

1888 *Ryparobius crustaceus* Saccardo, Sylloge Fung., VIII, p. 539.
1897 *Ryparobius crustaceus* Engler-Prantl, Pflan. Famil., I, i, p. 190.

Gregarious or scattered, sessile, hemispherical then depressed, very small, not more than .5 mm. in diameter, generally less, dirty white or slightly yellowish, hymenium convex, papillate with emergent asci; asci very broad, curved, stipitate, from 10 to 15 in each plant, or sometimes more, 100 by 30 microns, stem 12 to 14 by 4 microns; sporidia elliptical, when mature 1-guttulate, 64 in each ascus, 10 by 6 microns; paraphyses numerous, filiform, branched.

Habitat—Grown on old cow dung in culture, winter, Iowa City.

Plants are very small and difficult to see but may be easily seen with the aid of the lens. The asci are very large and not very numerous in each plant. The spores being borne in a mass are not very easily counted. If one ascus be separated from the rest on a slide, and crushed under a cover until the spores are all in one plane they can be easily counted.

In this way the spores were found to be 64 in each ascus, although the number may vary as it does in some other cases.

Genus IV—ASCOBOLUS *Persoon.*

Receptacle fleshy-gelatinous, at first closed, spherical, later more or less cup-shaped, externally smooth, furfuraceus, or clothed with hairs. Asci cylindrical or clavate, operculate, protruding at maturity. Spores elliptical, smooth reticulate, or verrucose, at first hyaline, then purple and at last brown. Paraphyses scarcely enlarged upwards. Plants generally found on dung but often found on decaying plant material. The ends of the asci with their dark colored spores appear as black dots on the hymenium.

KEY TO THE SPECIES.

a—Plants minute, externally smooth . . *A. glaber.*
a—Plants externally furfuraceus or pilose.
  b—Plants minute, partly immersed, pilose with soft hair . . . . . . *A. immersus.*
  b—Plants larger, furfuraceus.
    c—Plants light colored, yellowish, spores reticulate . . . . . . *A. furfuraceus.*
    c—Plants brownish-black, spores verrucose, on charcoal . . . . . . *A. atro-fuscus.*

ASCOBOLUS GLABER *Pers.*
PLATE XVI, fig. 11.

1801 *Ascobolus glaber* Persoon, Syn. Fung., II, p. 677.
1817 *Ascobolus glaber* Martius, Flora Crypt. Erlang., p. 472.
1823 *Ascobolus glaber* Fries, Syst. Myc., p. 164.
1833 *Ascobolus glaber* Link, Handbk, III, p. 333.
1869 *Ascobolus glaber* Berkeley, Outl. of Brit. Fung., p. 374.
1871 *Ascobolus glaber* Cooke, Handbk. of Brit. Fung., p. 728.
1887 *Ascobolus glaber* Phillips, Brit. Disc., p. 288.
1889 *Ascobolus glaber* Saccardo, Sylloge Fung., VIII, p. 517.
1897 *Ascobolus glaber* Engler-Prantl, Pflan. Famil., I, p. 193.

Plants sessile, minute, often gregarious, smooth and shining, obconical, base immersed, appearing hemispherical, generally convex, brown or reddish brown, hymenium papillate with its projecting asci filled with dark colored spores; asci clavate; sporidia elliptical, violet then brown, reticulate, 10 to 12 by 22 to 25 microns; paraphyses very slender, often branched.

Habitat—Found growing on horse dung on which *Lasiobolus* was abundant in a culture in the laboratory.

These plants which are from 1 to 2 mm. in diameter were found growing sparingly on the material described above. When growing they appear as small, spherical, shining dots but removed from the substratum, they are found to be pyriform, the lower part of the plant being immersed. The sporidia of this species are similar in size to those of *Ascobolus furfuraceus* Pers. but are easily distinguished by their surface markings. The sporidia of *Ascobolus furfuracens* are marked by a few branching reticulations which are for the most part longitudinal while in *Ascobolus glaber* they may extend in any direction and are very much more numerous, giving the entire surface of the sporidia a roughened appearance.

ASCOBOLUS IMMERSUS *Pers.*

PLATE PVI, fig. 1.

1801 *Ascobolus immersus* Persoon, Syn. Fung., II, p. 677.
1823 *Ascobolus immersus* Fries, Syst. Myc., p. 164.
1833 *Ascobolus immersus* Link, Handbk., III, p. 164.
1871 *Ascobolus immersus* Cooke, Handbk. of Brit. Fung., II, p. 728.
1887 *Ascobolus immersus* Phillips, Brit. Disc., p. 292.
1889 *Ascobolus immersus* Saccardo, Sylloge Fung., VIII, p. 523.
1897 *Ascobolus immersus* Engler-Prantl, Pflan. Famil., I, p. 193.

Immersed or partly immersed, very small, about 1 to 2 mm. in diameter, appearing hemispherical or pyriform, yellowish brown, coated externally with numerous hyaline, septate, flexuose hairs; hymenium shining; asci very large broad, and clavate, when mature, much elongated and exserted; sporidia very large, elliptical, or oblong-elliptic, violet, then brown, each inclosed in a hyaline membrane, nucleus visible when young, when mature marked with longitudinal, branching, reticulations, 50 to 60 by 20 to 32 microns;paraphyses filiform, simple or branched.

Habitat—Grown on cow dung, in culture, in the laboratory.

The material on which these specimens were grown, had been kept dry in the laboratory for several weeks. It was then moistened and placed under a bell jar. In a few days abundant growth was seen. The first discomycetes to be found being those of *Ascobolus furfuraceus*, which were mature in about one week from the time the material was placed in culture. About the same time, the much smaller plants of *Ascobolus immersus* made their appearance. On removing the bell jar, the minute plants with their emergent asci filled with dark colored spores presented a very beautiful appearance under the hand lens. In a few minutes, the asci disappeared, having ejected their spores. The asci are protruded half their own length or more but only the spores are ejected.

ASCOBOLUS FURFURACEUS *Pers.*

PLATE XV, fig. 11.

1791 *Peziza slercoraria* Bulliard, Champ., t. III, p. 376.
1801 *Ascobolus furfuraceus* Persoon, Syn. Fung. II, p. 676.
1817 *Ascobolus furfuraceus* Martius, Flora Crypt., p. 472.
1823 *Ascobolus furfuraceus* Fries, Syst. Myc. II, p. 163.
1828 *Ascobolus furfuraceus* Fries, Elench, Fung. I, p. 16.
1833 *Ascobolus furfuraceus* Link, Handbk., III, p. 332.
1860 *Ascobolus furfuraceus* Berkeley, Outl. of Brit. Fung., p. 374.
1871 *Ascobolus furfuraceus* Cooke, Handbk. of Brit. Fung., II, p. 727.
1887 *Ascobolus furfuraceus* DeBary, Morph. of Fung., p. 296, 186, 92.
1887 *Ascobolus furfuraceus* Phillips, Brit. Disc., p. 290.
1887 *Ascobolus furfuraceus* Goebel, Class. and Sp. Morph., p. 110.
1889 *Ascobolus furfuraceus* Saccardo, Sylloge Fung., VIII, p. 516.
1900 *Ascobolus furfuraceus* Durand, Bull. Tor. Bot. Club, 27, p. 481.
1902 *Ascobolus furfuraceus* Morgan, Jour. of Myc., 64, p. 182.

Sessile, gregarious, globose, then expanded, 1 to 5 mm. in diameter, externally pale yellow, covered with bran-like particles, especially near the margin; hymenium concave, sometimes plane or slightly convex, same color when young, becoming dark with age on account of the dark colored spores; flesh very brittle; asci clavate, emergent; sporidia elliptical, reticulate, violet, then brown, 20 to 25 by 10 to 12;

microns; paraphyses filiform, septate, imbedded in sulphur yellow gelatine.

Habitat—On old cow dung in pastures and woods, also easily grown in culture.

This is a very common species in this locality. The plants are very pale in color, but when mature, the hymenium is covered with small, black dots, the dots being the ends of the emergent asci filled with dark colored spores. They may be found growing scattered or densely crowded.

ASCOBOLUS ATRO-FUSCUS *Phil. and Plow.*
PLATE XV, fig. 1.

1873 *Ascobolus atro-fuscus* Phillips and Plowright, Grev., II, p. 186, pl. 24, 1.
1887 *Ascobolus atro-fuscus* Phillips, Brit. Disc., p. 291.
1897 *Ascobolus atro-fuscus* Engler-Prantl, Pflan. Famil., I, p. 193.
1900 *Ascobolus atro-fuscus* Durand, Bull. Tor. Bot. Club, 29, p. 458.

Sessile, crowded or scattered, brownish-black, concave or plane, 2 to 8 mm. in diameter, margin crenulate, externally rough; sporidia 8, elliptical, violet, then brown, externally very rough with minute spicules, appearing granular 20 by 12 microns; paraphyses linear, surrounded by a greenish yellow mucus, brown near the surface of the hymenium.

Habitat—On burnt ground which is mixed with charcoal in October; Iowa City.

Plants found growing on hard clay soil on the bank of the Iowa river, near Iowa City, where a brush-pile had been burned. The plants grow scattered also densely crowded on and surrounding the pieces of charcoal with which the soil is mixed. They are dark brown in color and very granular on the outside. The asci are slightly clavate, 8-spored, the spores being rather irregularly arranged in the ascus, at first violet, then brown. The paraphyses are often branched.

This material, by the kindness of Dr. E. J. Durand, has been compared with his material collected in New York and reported to be the same.

Genus V—SACCOBOLUS *Boudier.*

Receptacle similar to *Ascobolus*, externally smooth. Asci emergent, operculate, clavate, often stipitate, 8-spored. Spores elliptical or fusiform, at first hyaline, then purple, at last brown, smooth, united into one globular mass in the ascus. Generally found on dung.

One species has been grown in the laboratory.

SACCOBOLUS KERVERNI (*Crouan*) *Boud.*
PLATE XIV, fig. 11.

1871 *Ascobolus kerverni* Cooke, Handbk. of Brit. Fung., II, p. 729.
1886 *Saccobolus kerverni* Phillips, Brit. Disc., p. 294.
1889 *Saccobolus kerverni* Saccardo, Sylloge Fung., VIII, p. 524.
1897 *Saccobolus kerverni* Engler-Prantl, Pflan. Famil., I, p. 192,

Plants very small, scattered or crowded, golden yellow, about .5 mm. in diameter, smooth, shining, sessile, hemispherical then expanded, depressed, hymenium convex, asci broad, clavate, operculate; sporidia 8, elliptical, at first hyaline becoming violet, then brown, smooth inclosed in a hyaline gelatinous material, with which they are discharged from the ascus, 18 to 20 by 9 microns; paraphyses branched enlarged at their apices, filled with golden yellow coloring matter.

Habitat—Grown on old cow dung in culture in the laboratory; Feb. 20; Iowa City.

Plants of this species have been found growing either scattered or crowded on cow dung in the laboratory. They are very small and difficult to see with the naked eye. With the lens they are easily seen. The plants are light colored and when mature are covered with dark colored dots, the ends of the asci filled with purple spores which contrast very strongly with the light colored hymenium. Before maturity the spores are transparent and fill almost the entire ascus, but at maturity they become purple, are much more closely compact, and imbedded in a mass of gelatine. The asci at this time are also much larger so that the spores occupy only a small part of the ascus. The asci open by a lid and the spores are ejected, still imbedded in the block of gelatine. The spores at maturity are arranged in four rows in the ascus.

Family IV—**HELOTIACEÆ.**

Receptacle generally on the surface, seldom beneath the epidermis, sessile or stipitate, smooth or clothed externally with hairs, waxy membranaceous or thick. Apothecium composed of thin walled, bright colored cells. At first closed then expanded. Asci 8-spored; spores spherical, elliptical, or linear, 1 to 8-celled. Paraphyses slender.

Genus I—SARCOSCYPHA *Fries.*

Plants generally gregarious or tufted, more or less long-stocked. Receptacle generally cup-shaped, externally hairy. Asci cylindrical, 8-spored; spores elliptical, seldom rough, hyaline, with 1 to many guttulæ. Paraphyses slender, branched, enlarged above. Plants large, generally bright colored, growing on decaying wood.

Three species are common in woods near Iowa City.

KEY TO THE SPECIES.

a—Externally clothed with numerous long, rather rigid hairs . . . . *S. floccosa.*
a—Externally clothed with few, soft, flexuose hairs .
b—Cups large, stem short, thick . . . *S. coccinea.*
b—Cups small, stem long, slender . . . *S. occidentalis.*

SARCOSCYPHA FLOCCOSA (*Schw*) *Sacc.*
PLATE XIX, fig. 1.

1783 *Peziza floccosa* Batsch, Elench. Fung., p. 223.
1875 *Peziza floccosa* Cooke, Grev., III, p. 73, fig. 87.
1880 *Peziza floccosa* Ellis and Everhart, N. A. Fung., I, No. 435.
1889 *Sarcoscypha floccosa* Saccardo, Sylloge Fung., VIII, p. 156.
1899 *Sarcoscypha floccosa* Underwood, M. M. & M., p. 57.
1900 *Sarcoscypha floccosa* Durand, Bull. Torrey Bot. Club, 27, p. 477.
1900 *Sarcoscypha floccosa* Atkinson, Mush., p. 222.

Stipitate, infundibuliform when mature, 1 to 2 cm. in diameter, stem .5 to 1 inch in length, margin at first incurved;

hymenium bright scarlet, whitish externally and clothed with a dense covering of straight or somewhat flexuose, hyaline hairs, erect and longer near the margin; asci cylindrical; sporidia 8, elliptical granular within, 20 to 25 by 11 to 12 microns; paraphyses filiform, slender.

Habitat—On sticks half buried in the ground in spring; Iowa City.

The cups are stipitate, the length of the stem varying according to the depth at which the sticks from which they grow are buried. This is a common species in the woods in spring, and recognized on account of the bright colored hymenium and the dense covering of white hairs on the exterior.

SARCOSCYPHA COCCINEA (*Jacq.*) *Cke.*
PLATE XX, fig. II.

1791 *Peziza epidendra* Bulliard, Champ., t. 4, pl. 467.
1801 *Peziza coccinea* Persoon, Syn. Fung., II, p. 652.
1823 *Peziza coccinea* Fries, Syst. Myc., II, p. 79.
1833 *Peziza coccinea* Link., Handbk., III, p. 328.
1860 *Peziza coccinea* Berkeley, Brit. Fung. p. 363.
1871 *Peziza coccinea* Cooke, Handbk., of Brit. Fung., II, p. 679.
1874 *Peziza coccinea* Cook, Grev. III, p. 73, fig. 87.
1887 *Peziza coccinea* Phillips, Brit. Disc. p. 202.
1897 *Sarcoscypha coccinea* Engler-Prantl, Pflan Famil., I, p. 195, fig, A-B.
1899 *Sarcoscypha coccinea* Underwood, M. M. and M., p. 57.
1900 *Sarcoscypha coccinea* Atkinson, Mush., p. 222.
1900 *Sarcoscypha coccinea* Durand, Bull. Tor. Bot. Club, 27, p. 477.
1902 *Geopyxis coccinea* Morgan, Jour. of Myc., 64, p. 188.

Cups large, stipitate, infundibuliform; externally whitish, clothed with a dense covering of delicate, flexuose, septate hairs; hymenium brilliant scarlet; margin, especially when young, inflexed; cup often flattened laterally; asci long, cylindrical; sporidia 8, oblong, elliptical, 26 to 27 by 8 to 10 microns; paraphyses linear.

Habitat—On buried or half buried sticks in the woods spring and fall; Iowa City.

This is one of the most common but most beautiful specimens found in this locality. On account of its brilliant scarlet hymenium, it is made very attractive and easy to collect. The plants always grow attached to sticks, which are generally buried under leaves and soil.

SARCOSCYPHA OCCIDENTALIS (*Schw*) *Cke.*
PLATE XIX, fig. II.

1875 *Peziza occidentalis* (Sarcoscypha) Berkeley, Grev. III, p. 153.
1880 *Peziza occidentalis* Ellis and Everhart, N. A. Fung., No. 436.
1889 *Sarcoscypha occidentalis* Saccardo, Sylloge Fung., VIII, p. 154.
1897 *Sarcoscypha occidentalis* Engler-Prantl, Pflan. Famil., I, p. 194.
1900 *Sarcoscypha occidentalis* Durand, Bull. Torrey Bot. Club, 27, p. 476.

Stipitate, cupulate, subinfundibuliform, 1 to 2 cm. hymenium dull scarlet, externally lighter, clothed with a few short, flexuose, septate hairs; stem .2 to 1 inch in length; asci cylindrical; sporidia 8, elliptical 18 to 20 by 10 to 12 microns, 2-guttulate; paraphyses filiform, slightly enlarged at their apices, filled with orange granules.

Habitat—On decaying sticks in woods, spring; Iowa City.

This species is found under the same conditions, as *S. floccosa*, from which it is distinguished by the more shallow cups and the exterior which is almost smooth, the hairs being small and inconspicuous. The length of the stem varies greatly, sometimes being as much as 2 inches, at other times the plants are almost sessile. The length of the stem depends upon the depth at which the sticks are buried under leaves and soil.

Genus II—H E L O T I U M *Fries.*

Plants generally gregarious, stipitate or sessile, externally generally smooth, bright colored, waxy; hymenium concave, plane or convex. Asci 8-spored; spores elliptical or fusiform, blunt or sharp-pointed, at maturity 2 to 4-celled, guttulate. Paraphyses slender. For the most part small plants growing on wood and stems.

One species is very common on decaying wood distinguished by its bright yellow color.

HELOTIUM CITRINUM (*Hedw.*) *Fr.*
PLATE XXI, fig. I.

1801 *Peziza citrina* Persoon, Syn. Fung., II, p. 663.
1823 *Peziza citrina* Fries, Syst. Myc., II, p. 131.
1860 *Helotium citrinum* Berkeley, Brit. Fung., p. 372.
1871 *Helotium critrinum* Cooke, Handbk., of Brit. Fung. II, p. 711.
1881 *Helotium citrinum* Phillips, Brit. Disc., p. 157.
1889 *Helotium citrinum* Saccardo, Sylloge Fung., VIII, p. 224.
1897 *Helotium citrinum* Engler-Prantl, Pflan. Famil., I, p. 207, fig. 162.
1899 *Helotium citrinum* Underwood, M. M. and M., p. 57.
1900 *Helotium citrinum* Durand, Bull. Torrey Bot. Club, 27, p. 483.

Cups sessile or shortly stipitate, plane, slightly concave or convex, hymenium lemon yellow, often whitish outside, firm, smooth, 1 to 8 mm. in diameter; asci cylindrical or clavate; sporidia 8, fusiform or oblong elliptical, 2 to 3-guttulate, often pseudo-septate, 10 by 3 microns; paraphyses filiform, very slender.

Habitat—On decaying wood in moist places; summer and fall; Iowa City.

The plants of this species are very common on wood and easily recognized on account of their bright yellow color. They are generally produced into a short stem below, but are often sessile and more or less irregular in outline. The substance of the plant is firm as is shown by the fact that they do not shrink much in drying.

Genus III—C O R Y N E *Tulasne.*

Plants tufted, with a short, thick stem, externally smooth gelatinous, hard when dry. Hymenium at first concave becoming nearly plane, generally dark colored. Asci cylindrical, 8-spored; spores fusiform, at last 2 to 8-celled, generally in 2 rows. Paraphyses slender, enlarged upwards. Found on decaying wood.

One species is found in woods near Iowa City.

CORYNE SARCOIDES (*Jacq.*) *Tul.*

PLATE XXII, fig. 1.

1801 *Peziza sarcoides* Persoon, Syn. Fung., II, p. 633.
1817 *Ascobolus inquinans* Martius, Flora Crypt. Erlang., p. 471.
1823 *Bulgaria sarcoides* Fries, Syst. Myc., II, p. 168.
1833 *Bulgaria sarcoides* Link, Handbk. p. 334.
1860 *Bulgaria sarcoides* Berkeley, Brit. Fung., p. 375.
1871 *Bulgaria sarcoides* Cooke, Handbk. of Brit. Fung. II, p. 733.
1887 *Ombrophila sarcoides* Phillips, Brit. Disc., p. 323.
1889 *Coryne sarcoides* Saccardo, Sylloge Fung., VIII, p. 642.

Caespitose, sessile or substipitate, firm, subgelatinous, flesh-red, or dark purple, 5 to 10 mm. in diameter; hymenium plane or concave and repand; asci cylindrical or slightly enlarged upwards; sporidia 8, fusiform, straight or unequal sided, granular within, guttulate 15 to 25 by 4 microns; paraphyses filiform, slender, enlarged at their apices, abundant.

Habitat—In woods on the decaying trunks of trees; often growing crowded together in thick masses from the crevices of the wood.

These plants may be found in large numbers in damp shady woods on decaying logs in the summer and fall. They are often crowded together so as to become very irregular in outline. The color of the older specimens is dark purple, but in younger plants it is of a reddish purple or flesh color. The plants are often nearly sessile, spreading in irregular masses over the surface of the wood, but they are often shortly stipitate. When young the hymenium is concave, becoming plane, sometimes with a little depression in the center.

Family V—MOLLISIACEÆ.

Receptacle either free from the first or at first immersed then breaking through the epidermis. Apothecium consisting of roundish cells. At first spherical, then more or less expanded. Asci 8-spored; spores hyaline, 1 to many celled.

Genus I—MOLLISIA *Fries.*

Receptacle entirely sessile, waxy, at last plane light colored, externally smooth. Asci clavate, 8-spored; spores elongate, curved, 1-celled, often in 2 rows. Found on the stems of plants.

Two species have been collected, one of which is sometimes included in another genus.

KEY TO THE SPECIES.

a—On living plants of Potentilla . . . *M. dehnii*
a—On decaying plants of Polygonum . . . *M. polygoni*

MOLLISIA POLYGONI (*Lash*) *Gill.*
PLATE XXIII, fig. II.

1888 *Peziza polygoni* Farlow and Seymour, Fung. of U. S., II, p. 92.
1889 *Mollisia polygoni* Saccardo, Sylloge Fung., VIII, p. 322.
1897 *Mollisia polygoni* Engler-Prantl, Pflan. Famil., I, p. 212.

Gregarious, sessile, at first hemispherical, then expanded, about 1 mm. in diameter, dark greyish, often lighter when dry; hymenium slightly concave or plane; asci clavate, 7 to 9 by 2 microns; sporidia fusiform, elongated on one side, often guttulate; paraphyses filiform, slender.

Habitat—On stems of *Polygonum* in wet places among weeds; Lafayette, Indiana and Iowa City, Iowa.

These plants have been found almost completely covering decaying stems of *Polygonum* in woods near Iowa City. The plants are very small and generally dark colored but sometimes yellowish. These plants seem to be especially adapted to the stems of this host plant as they have not been found on plants of any other species.

MOLLISIA DEHNII (*Rabenh.*) *Karst.*
PLATE XXIII, fig. I.

1888 *Peziza dehnii* Farlow and Seymour, Fung. of U. S., 8, p. 35.
1889 *Mollisia dehnii* Saccardo, Sylloge Fung., VIII, p. 325.

Gregarious or crowded, sessile or with a very short stem, about 1 mm. in diameter, dull lead color; hymenium at first concave then plane; asci clavate; sporidia elongate, straight or curved, often guttulate, 10 by 3 microns; paraphyses filiform slender.

Habitat—On growing stems and leaves of *Potentilla norvegica;* Pocahontas, Iowa.

The individuals of this species were found growing on a living plant of *Potentilla norvegica* in a yard at Pocahontas, Iowa, in the summer. The plants are dark colored and were found in such numbers as to cover the stems in places. They grow on the leaves, especially on the under side and generally near the veins. In external appearance these plants are similar to those of *Mollisia polygoni* but may be distinguished from their habitat, as well as from the size of the spores.

Family VI—**PATELLARIACEÆ.**

Receptacle either always on the surface or at first immersed, breaking through the substratum, generally leathery or hard, for the most part dark colored, hemispherical or elongated. At first closed, not protected by a covering membrane, then opening. Hypothecium generally well developed, dark colored. Asci thick-walled especially at the apex, 8-spored. Spores spherical, elongated, or filiform, 1 to many celled. Paraphyses forming a well developed epithecium. Plants saprophytic.

Genus I—PATELLARIA *Fries.*

Receptacle for the most part always on the surface, black or blackish, coriaceous. Plants spherical or elongated; hymenium concave or plane. Asci clavate, 8-spored; spores fusiform, often clavate and curved, or straight, 4 or more celled, hyaline, in 2 rows. Paraphyses forming a brown epithecium. Found on decaying wood.

Several species have been collected recently.

PATELLARIA MELAXANTHA (*Fries*) *Phillips.*
PLATE XXII, fig. 11.

1823 *Peziza melaxantha* Fries, Syst. Myc., II, p. 150.
1871 *Peziza melanotheja* Cooke, Handbk. of Brit. Fung., II, p. 706.
1887 *Patellaria melazantha* Phillips, Brit. Disc., p. 370.
1889 *Blytrydium melaxanthum* Saccardo, Sylloge Fung., VIII, p. 806.

Plants minute, not more than 1 mm. in diameter, generally less gregarious, or often confluent, depressed, yellowish brown, darker externally near the base; hymenium concave, plane or slightly convex, more or less papillate or rough; asci clavate 12 to 14 by 100 to 110 microns, very slender at the base, apex rounded, attenuated; spores 8, fusiform, generally curved, 5 to 7 septate, hyaline, 35 to 40 by 3 to 4 microns, obliquely arranged in the ascus, more or less twisted around each other; paraphyses filiform, branched.

Habitat—On decaying wood, Iowa City.

There is doubt as to the specific name given above on account of the incomplete description given for that species. The plants described here have been collected several times in the summer and fall. They are minute in size but always gregarious, and often forming a confluent yellowish mass. The internal characters are quite distinct. Spores are fusiform, generally curved or double curved, becoming very slightly S-shaped, from 5 to 7 septate (generally 7), and often apparently constricted at the septa. Paraphyses are less distinct, but filliform and branched.

Family VII—**CENANGIACEÆ.**

Receptacle at first immersed then breaking through the substratum, leathery or gelatinous, generally dark colored, at first closed then expanded, becoming cup-shaped, when young covered with a tough membranous covering which disappears with age. Asci generally 8-spored; spores 1 to many celled, often muriform, hyaline to black. Paraphyses often enlarged upwards, forming a well developed epithecium.

Genus I—C E N A N G I U M *Fries.*

Cups scattered or tufted at first immersed, then breaking through the substratum, sessile, leathery or waxy, brown or blackish. Receptacle, cup-shaped. Asci clavate, 8-spored, elongated, cylindrical or fusiform, straight or curved, spores 1-celled, hyaline, in 2 rows. Paraphyses enlarged at their apices, forming an epithecium.

One species collected in the northeast part of the state, on limbs of *Populus tremuloides.*

CENANGIUM POPULNEUM (*Pers.*) *Rehm.*

PLATE XXV., fig. 1.

1891 *Peziza populnea* Persoon, Syn. Fung., II, p. 671.
1889 *Cenangium populneum* Saccardo, Sylloge Fung., VIII, p. 565.
1897 *Cenangium populneum* Engler-Prantl, Pflan. Famil., p. 232.

Cups sessile, caespitose, 3 to 7 mm. in diameter, often very irregular, forming dense rosettes springing from beneath the epidermis, or solitary, dark brownish black; hymenium concave; margin irregularly lobed, often splitting; asci clavate; sporidia oblong, or fusiform, elongate, 12 to 14 by 3 to 4 microns, each containing 1 small central guttula; paraphyses filiform, slender, slightly enlarged upwards, often branched.

Habitat—On dead branches of *Populus tremuloides.* Collected by B. Shimek, Howard Co., Iowa; early spring.

Plants spring from beneath the epidermis of the host and often form rosettes nearly an inch in diameter, or a ring which extends nearly around the branch. The plants are crowded together so as to become very irregular, sometimes compressed and twisted in various shapes. They are quite easily recognized by these characters. The spores are often much curved with a very small guttula in the center.

Genus II—B U L G A R I A *Fries.*

Cups gregarious with a short thick stem. Growing at first under the bark then breaking through. Externally dark colored, rough, often with short hairs, gelatinous, shrinking when dry. Asci cylindrical, generally 8-spored; spores elliptical, or unequal sided, 1-celled, hyaline, then brown. Paraphyses forming a colored epithecium. Plants large growing on wood.

Two species have been collected near Iowa City.

KEY TO THE SPECIES.

a—Hymenium dark colored, spores unequal-sided . *B. inquinans*
a—Hymenium light colored, reddish, spores elliptical *B. rufa.*

BULGARIA RUFA *Schw.*

PLATE XXIV, fig. I.

1881 *Bulgaria rufa* Ellis and Everhart, N. A. Fung., No. 449.
1889 *Bulgaria rufa* Saccardo, Sylloge Fung., VIII, p. 638.

Subturbinate, caespitose, at first closed, then expanding, concave, gelatinous, 1 to 2 inches in diameter, margin in older specimens repand; hymenium light colored reddish; externally dark brown or black, covered with minute, flexuose, black, septate hairs, rugose near the base; asci cylindrical, sporidia 8, elliptical 10 by 20 microns; paraphyses filiform, slender.

Habitat—On decaying sticks in woods; Iowa City.

These specimens have been found in large numbers on decaying branches in woods near Iowa City. The plants are large and attractive and may be found in clusters of several each, growing from beneath the bark of decaying wood. The light colored hymenium contrasts strongly with the very dark exterior. The hymenium has a reddish tint which suggests its specific name. This species is easily distinguished from *Bulgaria inquinans* by its light colored, concave hymenium. The spores in this species are equal-sided.

BULGARIA INQUINANS *Fries.*

PLATE XXIV, fig. II.

1791 *Peziza nigra* Bulliard, Champ., t. 4, p. 460.
1801 *Peziza inquinans* Persoon, Syn. Fung., p. 631.
1823 *Bulgaria inquinans* Fries, Syst. Myc. II, p. 167.
1861 *Bulgaria inquinans* Berkeley, Outl. Brit. Fung., p. 375, pl. 22, fig. 7.
1871 *Bulgaria inquinans* Cooke, Handbk. of Brit. Fung. II, p. 732, fig. 239,
1887 *Bulgaria inquinans* Phillips, Brit. Disc., p. 314.

1889 *Bulgaria inquinans* Saccardo Sylloge Fung., VIII, p. 636.
1897 *Bulgaria inquinans* Engler Prantl. Pflan. Famil., I, p. 239.

Caespitose, turbinate, firm, gelatinous, externally rough, umber; hymenium at first concave, becoming plane, black or very dark purple; asci clavate; sporidia 8, elliptic, unequal-sided, often nearly pointed at one end, 10 to 14 by 5 to 6 microns; paraphyses filiform slender.

Habitat—On oak logs growing from crevices in the bark; Iowa City.

Plants common forming very dark colored gelatinous masses when wet, hard when dry. The cups are continued into a short stem below and are at first concave opening until the hymenium becomes plane, then margin becomes reflexed until the hymenium at maturity, is convex often with a little depression in the center. The cups are more or less irregular at maturity. The spores are of a dark brownish color and arranged in one or two rows in the ascus. The asci are very long so that the spores occupy only a small portion near its end.

Genus URNULA *Fries.*

Cups stipitate, urn-shaped, at first closed, then opening by a circular or stellate aperture, externally dark colored, furfuraceus or clothed with minute, dark colored hairs. Asci cylindrical, 8-spored; sporidia oblong-elliptical.

One species is common in woods in the early spring. This species is included, by Engler-Prantl with the subgenus *Geopyxis.*

URNULA CRATERIUM (*Schw.*) *Fr.*

PLATE XXV, fig. 11.

1823 *Peziza craterium* Fries, Syst. Myc., II, p. 74.
1883 *Peziza craterium* Ellis and Everhart, N. A. Fung., No. 982.
1889 *Urnula craterium* Saccardo, Sylloge Fung., VIII, p. 549.
1897 *Peziza craterium* (Geopyxis) Engler-Prantl. Pflan. Fam. I, p. 185.
1902 *Urnula craterium* Kupfer, Bull. Torrey Bot. Club, 29, p. 137.

Large, long-stipitate, subcæspitose, dark brownish black, at first closed, hollow within, opening at the top by an irregular rupture, leaving the margin notched, involute, clothed externally with minute black hairs; asci very long, cylindrical, 8-spored; sporidia oblong hyaline, granular within, 25 to 30 by 10 microns, paraphyses slender septate.

Habitat—On half-buried branches and sticks in woods; spring; Iowa City.

A large species common on decaying sticks in woods in the spring. A number of plants may often be found attached to a small stick. They are at first club-shaped, black structures, hollow in the center, finally opening by a star-shaped rupture at the apex, when mature, leaving the margin notched. In Engler-Prantl, this species is included with the subgenus *Geopyxis*. There is some difference of opinion as to whether this plant should be included with that genus or allowed to remain where it is (Bull. Torrey Bot. Club, 29, p. 137.)

Explanation of Plate I.

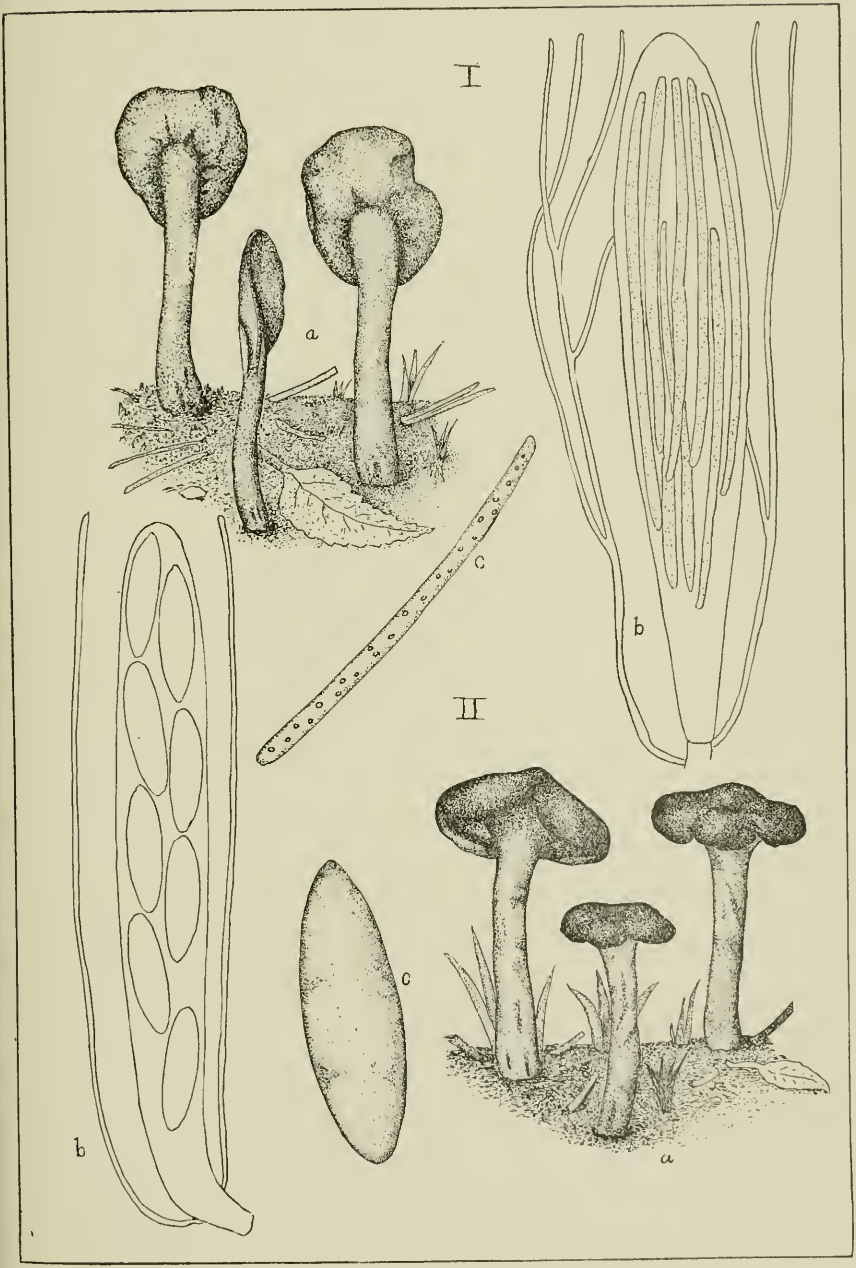
Spathularia clavata (*Schaeff.*) *Sacc.*

Fig. I, *a*. Plants to show habitat, natural size.
Fig. I, *b*. Ascus and paraphyses, x 1000.
Fig. I, *c*. One spore removed, x 1200.

Leotia stipitate (*Bosc.*) *Schr.*

Fig. II, *a*. Several plants, natural size.
Fig. II, *b*. Ascus with paraphyses, x 750.
Fig. II, *c*. One spore removed, x 2000.

PLATE I.



Explanation of Plate II.

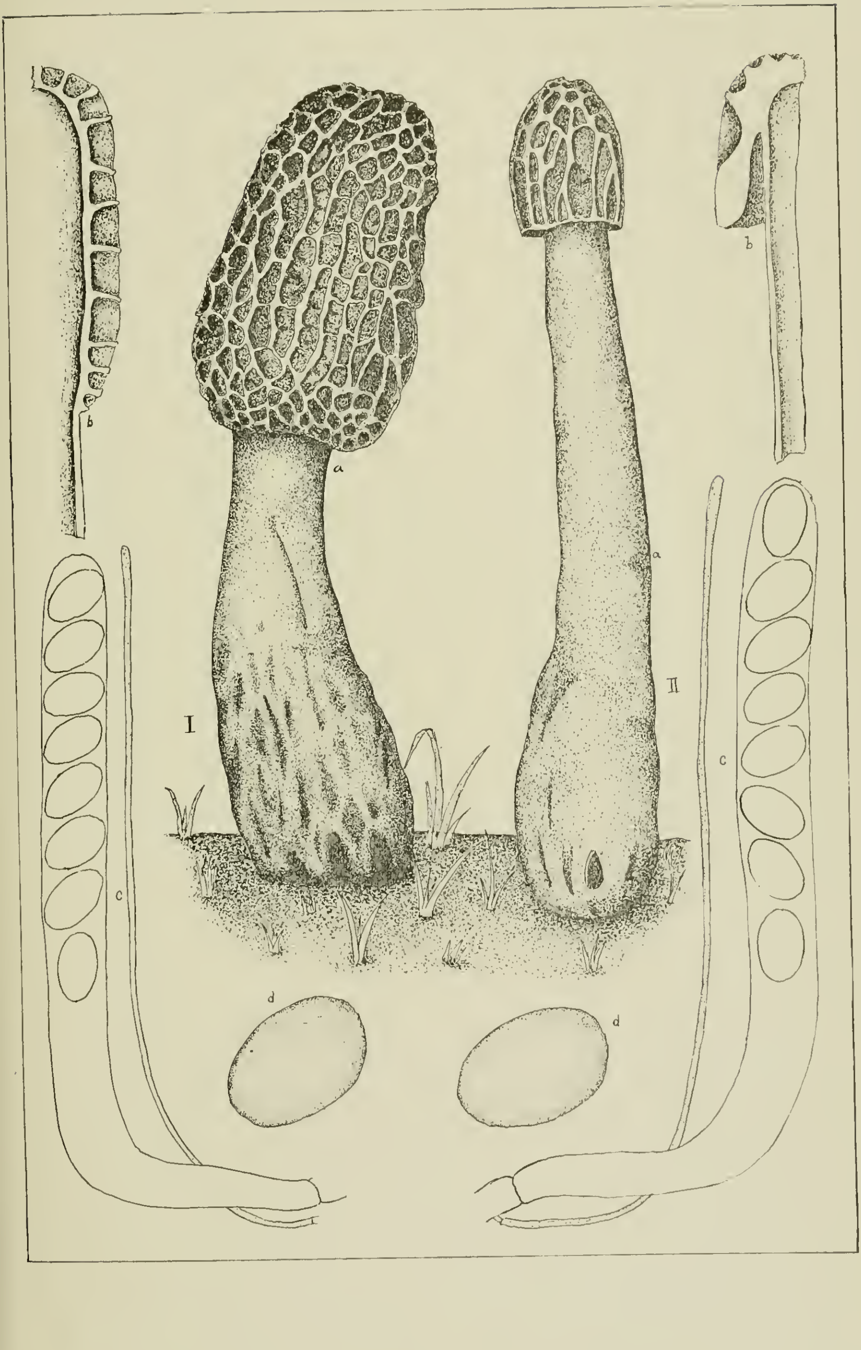
Morchella conica (*Pers.*)

Fig. I, *a*. Plant, natural size.
Fig. I, *b*. Section to show pits.
Fig. I, *c*. Ascus and paraphysis, x 500.
Fig. I, *d*. One spore, x 750.

Morchella hybrida (*Sow.*) *Pers.*

Fig. II, *a*. Plant, natural size.
Fig. II, *b*. Section to show free pileus and pits.
Fig. II, *c*. Ascus and paraphysis, x 400.
Fig. II, *d*. One spore, x 800.

PLATE II.



Explanation of Plate III.

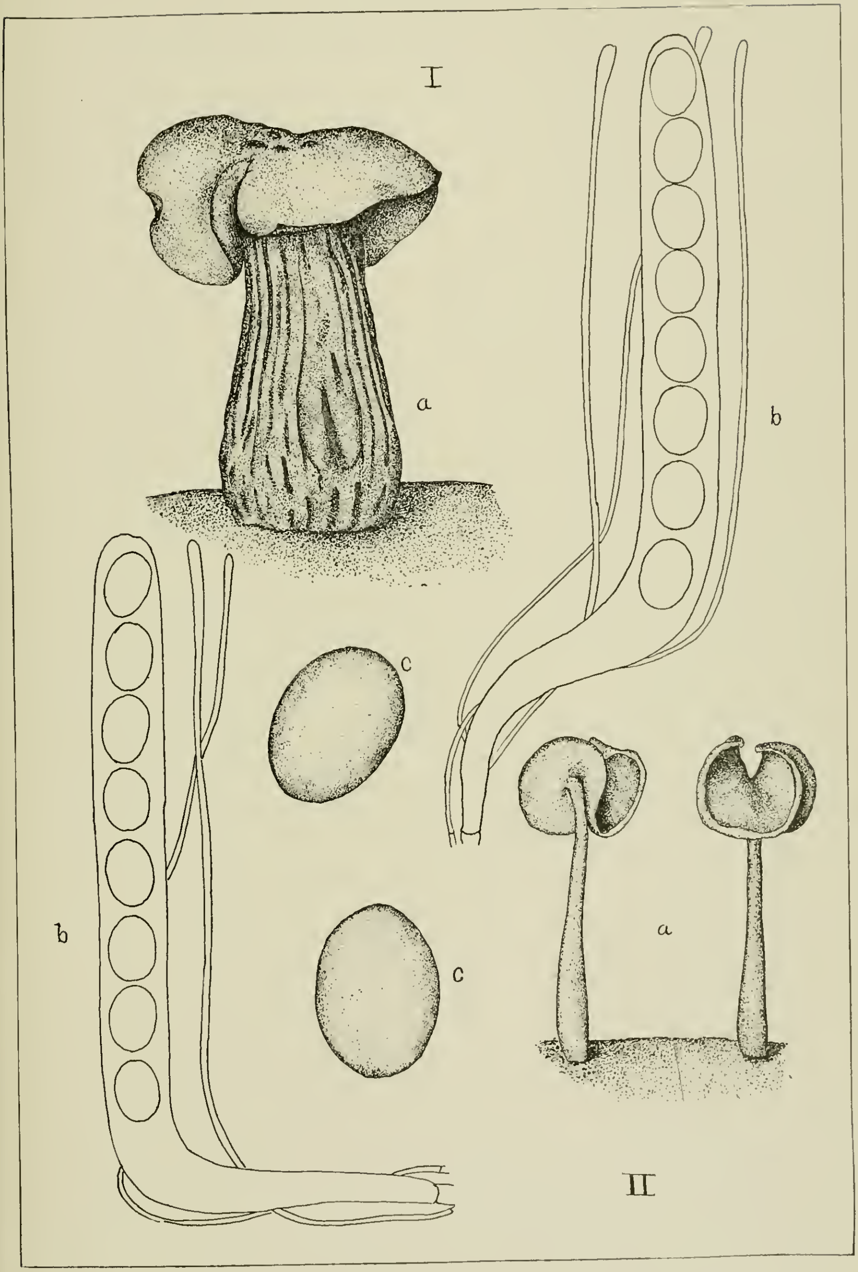
Helvella crispa (*Scop.*) *Fr.*

Fig. I, *a*. One plant, natural size.
Fig. I, *b*. Ascus and paraphyses, x 600.
Fig. I, *c*. One spore removed, x 1400.

Helvella elastica *Bull.*

Fig. II, *a*. Two plants, natural size.
Fig. II, *b*. Ascus and paraphyses, x 500.
Fig. II, *c*. One spore, x 1200.

PLATE III.



Explanation of Plate IV.

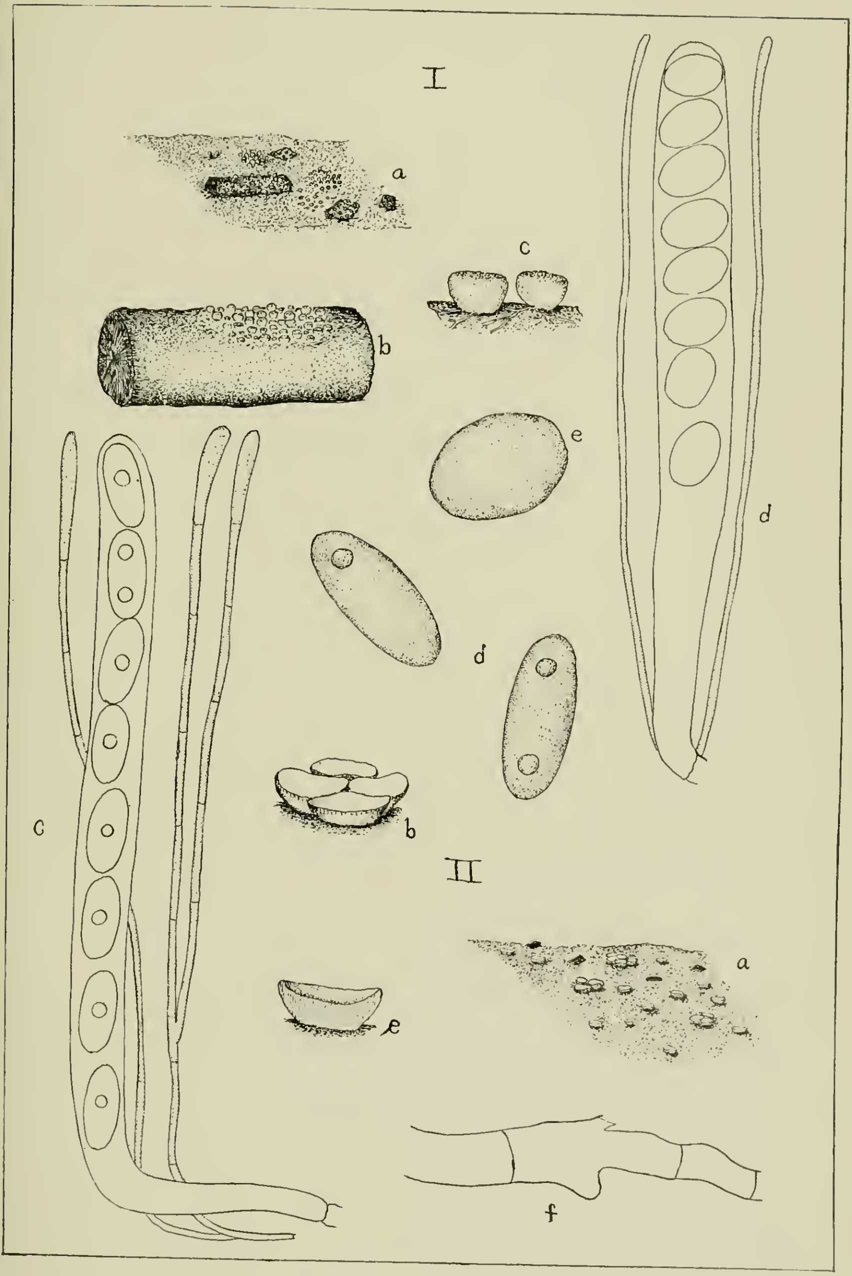
Pyronema aurantio-rubrum (*Fckl.*) *Sacc.*

Fig. I, *a*. Group of plants, natural size.
Fig. I, *b*. Same enlarged to show habitat.
Fig. I, *c*. Two plants removed, x 10.
Fig. I, *d*. Ascus and paraphyses, x 1200.
Fig. I, *e*. One spore, x 2500.

Pyronema melaloma (*Fr.*) *Fckl.*

Fig. II, *a*. Group of plants, natural size.
Fig. II, *b*. Several cups enlarged, x 5.
Fig. II, *c*. Ascus and paraphyses, x 700.
Fig. II, *d*. Spores with guttulæ, x 1000.
Fig. II, *f*. Hair-like structure from cup, x 700.

PLATE IV.



Explanation of Plate V.

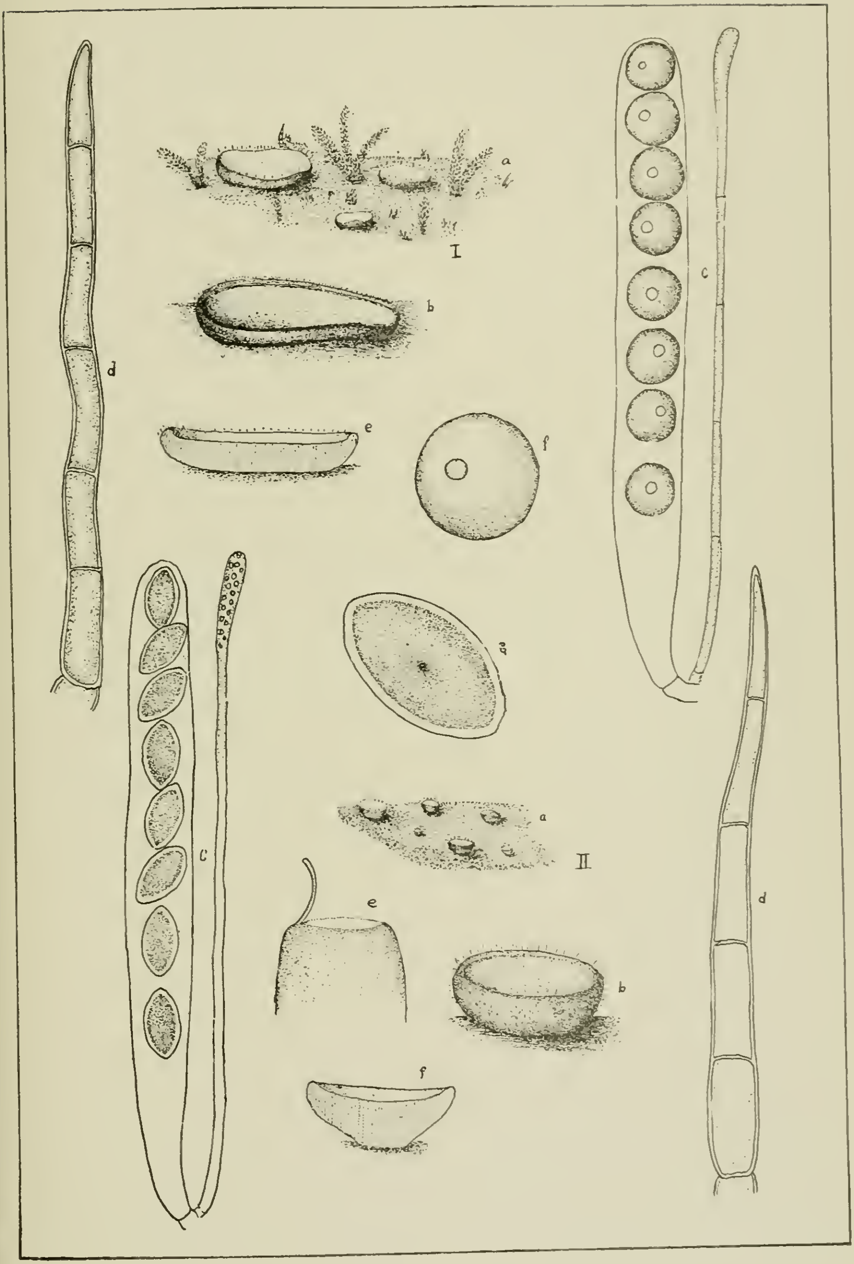
Sphærospora confusa (*Cke.*) *Sacc.*

Fig. I, *a*. Cups, natural size.
Fig. I, *b*. One cup, x 3.
Fig. I, *c*. Ascus and paraphysis, x 500.
Fig. I, *d*. Hair from margin of cup, x 500.
Fig. I, *e*. Diagram section, x 3.
Fig. I, *f*. One spore removed, x 1200.

Neotiella luteo-pallens (*Nyl.*) *Sacc.*

Fig. II, *a*. Several cups, natural size.
Fig. II, *b*. One cup, x 10.
Fig. II, *c*. Ascus and paraphysis, x 600.
Fig. II, *d*. Hair from cup, x 600.
Fig. II, *e*. Ascus to show operculum, x 1200.
Fig. II, *f*. Diagram section, x 10.
Fig. II, *g*. One spore, x 1500.

PLATE V.



Explanation of Plate VI.

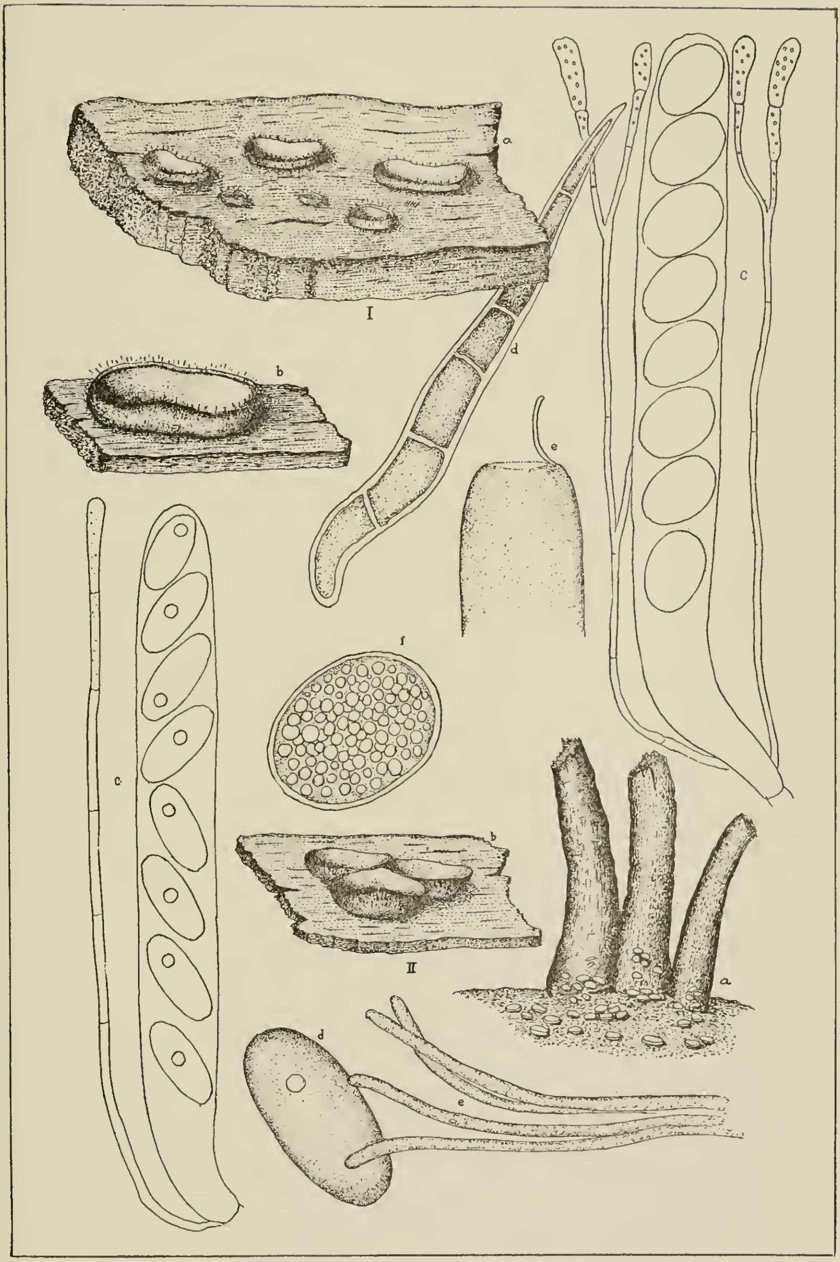
Lachnea scutellata (*Linn.*) *Sacc.*

Fig. I, *a*. Plants showing habitat, natural size.
Fig. I, *b*. One plant, x 2.
Fig. I, *c*. Ascus and paraphyses, x 600.
Fig. I, *d*. Hair from cup, x 500.
Fig. I, *e*. Ascus to show operculum, x 1000.
Fig. I, *f*. Spore with granules, x 1200.

Lachnea melaloma (*A. & S.*) *Sacc.*

Fig. II, *a*. Plants to show habitat.
Fig. II, *b*. Plants, x 5.
Fig. II, *c*. Ascus and paraphysis, x 700.
Fig. II, *d*. One spore, x 1400.
Fig. II, *e*. Hairs from cup, x 700.

PLATE VI.



Explanation of Plate VII.

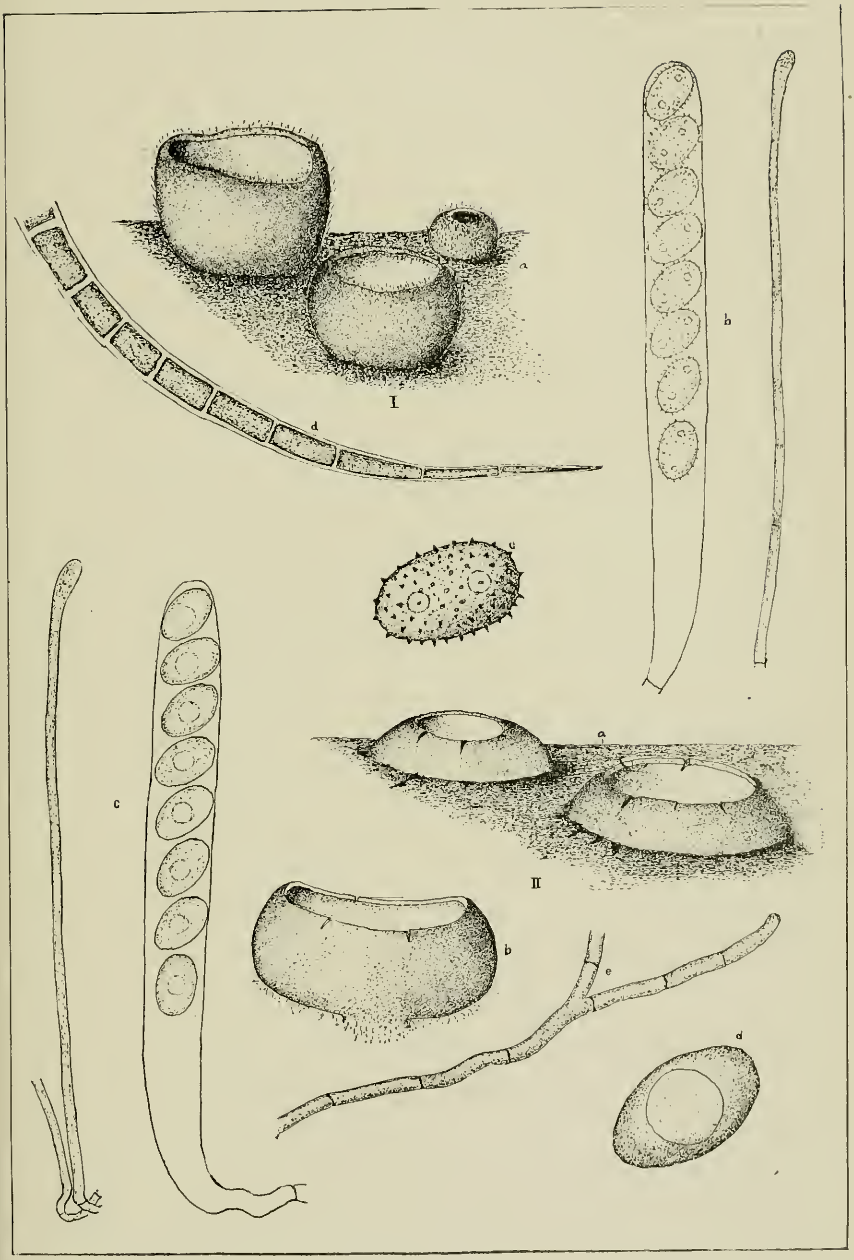
Lachnea hemispherica (*Wigg.*) *Gill.*

Fig. I, *a*. Several cups, natural size.
Fig. I, *b*. Ascus and paraphysis, x 400.
Fig. I, *c*. One spore removed, x 1000.
Fig. I, *d*. Hair from cup, x 500.

Sarcosphæra arenicola (*Lev.*) *Lindau.*

Fig. II, *a*. Two cups a little enlarged.
Fig. II, *b*. One cup removed showing hairs.
Eig. II, *c*. Ascus and paraphysis, x 400.
Fig. II, *d*. One spore, x 1100.
Fig. II, *e*. Portion of hair from cup, x 500.

PLATE VII.



Explanation of Plate VIII.

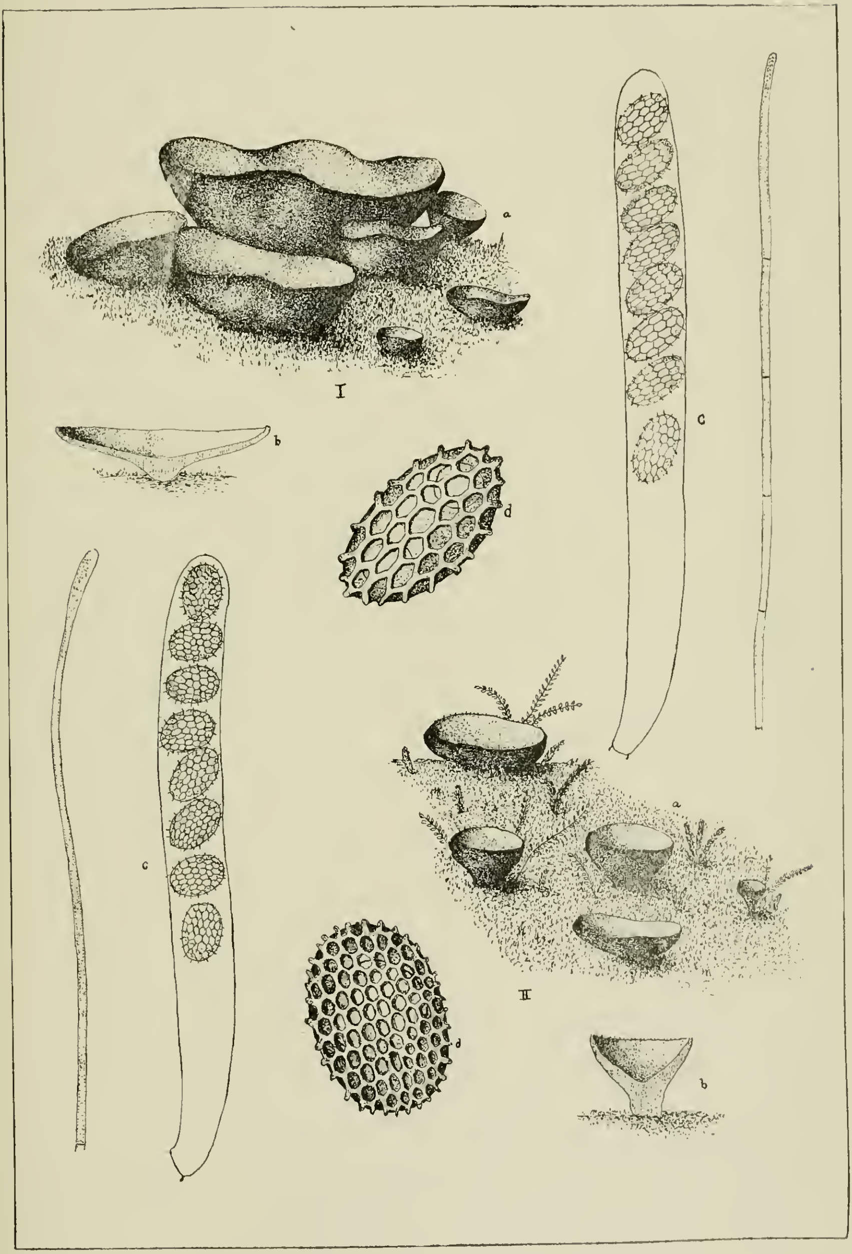
Peziza aurantia *Pers.*

Fig. I, *a*. Group of plants, natural size.
Fig. I, *b*. Diagram section, natural size.
Fig. I, *c*. Ascus and paraphysis, x 600.
Fig. I, *a*. One spore to show reticulations, x 1800.

Peziza rutilans *Fries.*

Fig. II, *a*. Cups showing habitat, x 2.
Fig. II, *b*. Diagram section, x 2.
Fig. II, *c*. Ascus and paraphysis, x 500.
Fig. II, *d*. Spore to show reticulations, x 1500.

PLATE VIII.



Explanation of Plate IX.

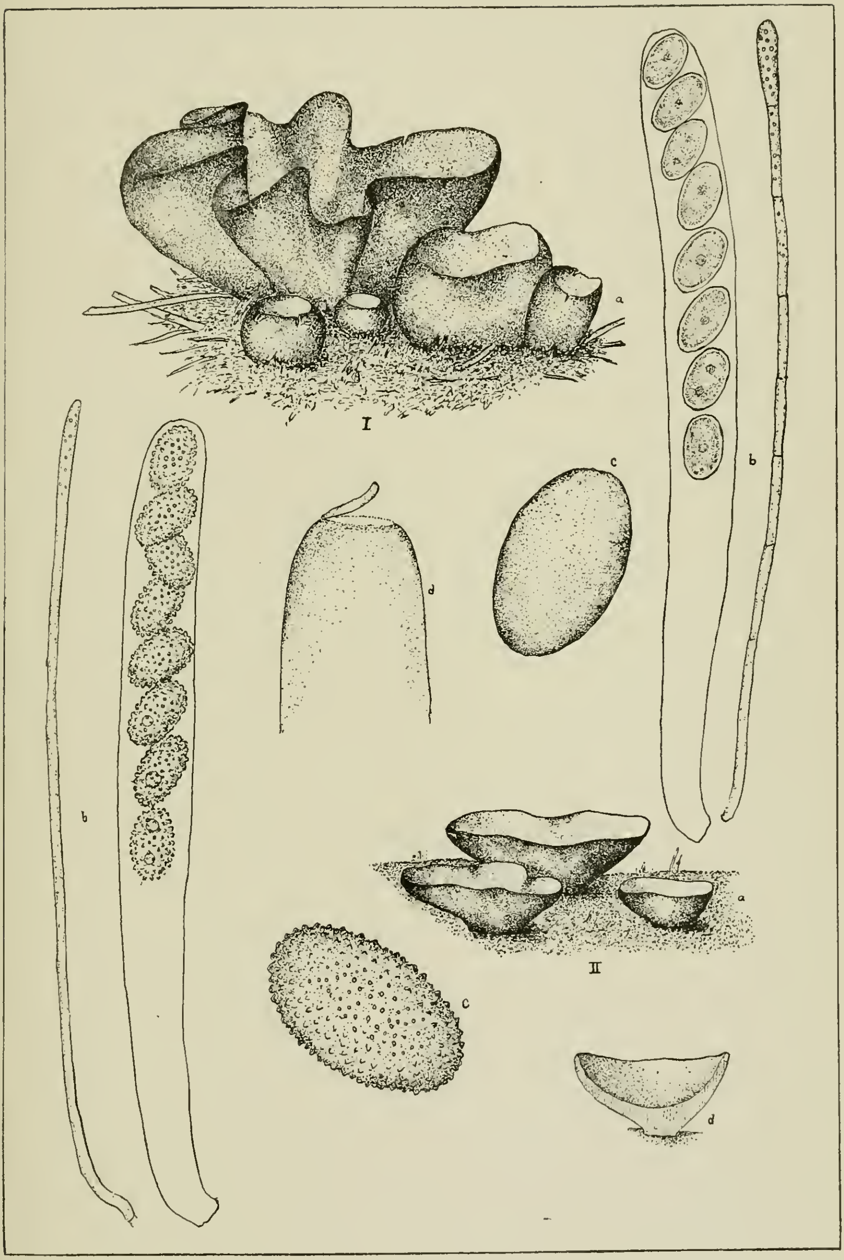
Peziza cerea *Sow.*

Fig. I, *a*. Several cups reduced one-third.
Fig. I, *b*. Ascus and paraphysis, x 500.
Fig. I, *c*. One spore, x 1200.
Fig. I, *d*. Ascus to show operculum, x 1000.

Galactinia succosa *Berk.*

Fig. II, *a*. Several cups, natural size.
Fig. II, *b*. Ascus and paraphysis, x 500.
Fig. II, *c*. One spore to show verrucose markings, x 1500.
Fig. II, *d*. Diagram section, natural size.

PLATE IX.



Explanation of Plate X.

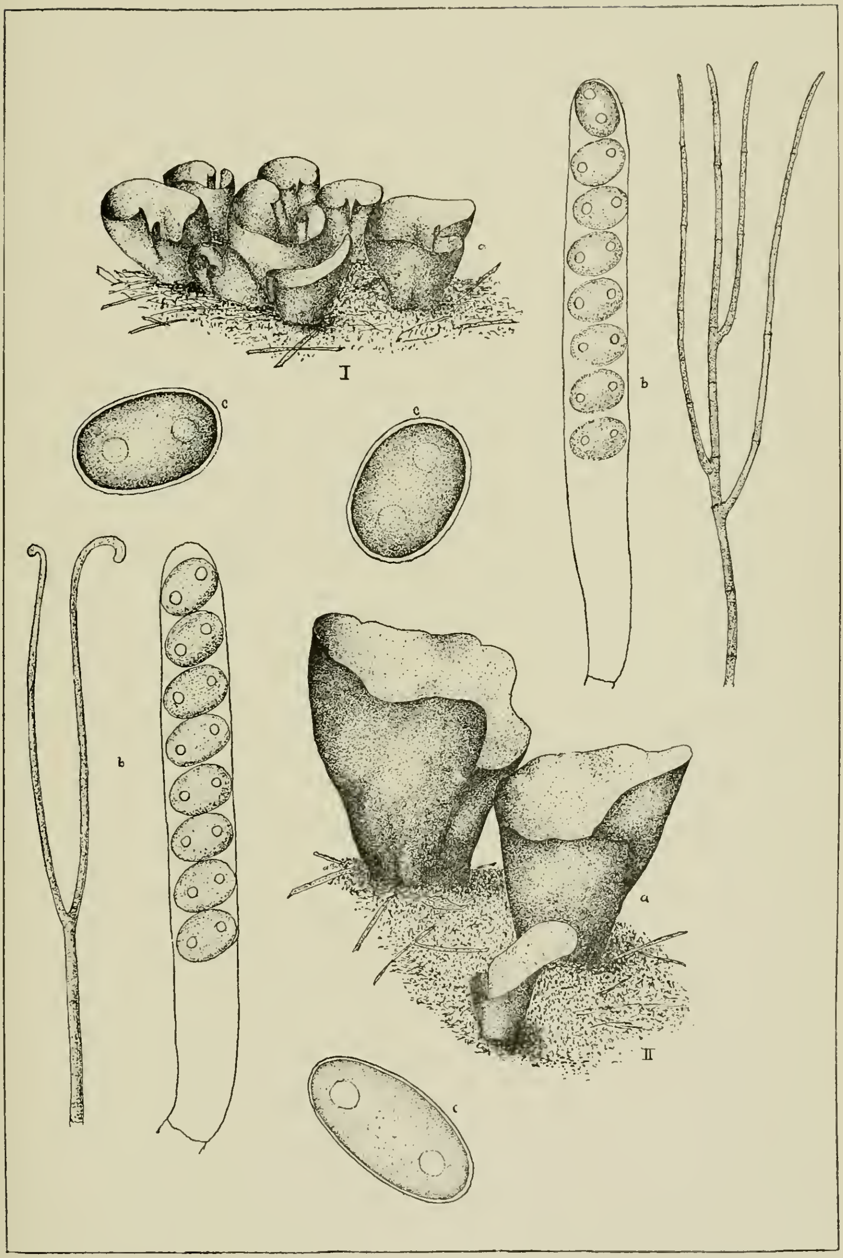
Otidea ochracea (*Fries.*) *Sacc.*

Fig. I, *a*. Several plants, natural size.
Fig. I, *b*. Ascus and paraphysis to show branching, x 800.
Fig. I, *c*. Spores removed, x 2000.

Otidea leporina (*Batsch*) *Fckl.*

Fig. II, *a*. Cups natural size.
Fig. II, *b*. Ascus and parapyosis showing hooked apex, x 700.
Fig. II, *c*. One spore removed, x 2000.

PLATE X.



Explanation of Plate XI.

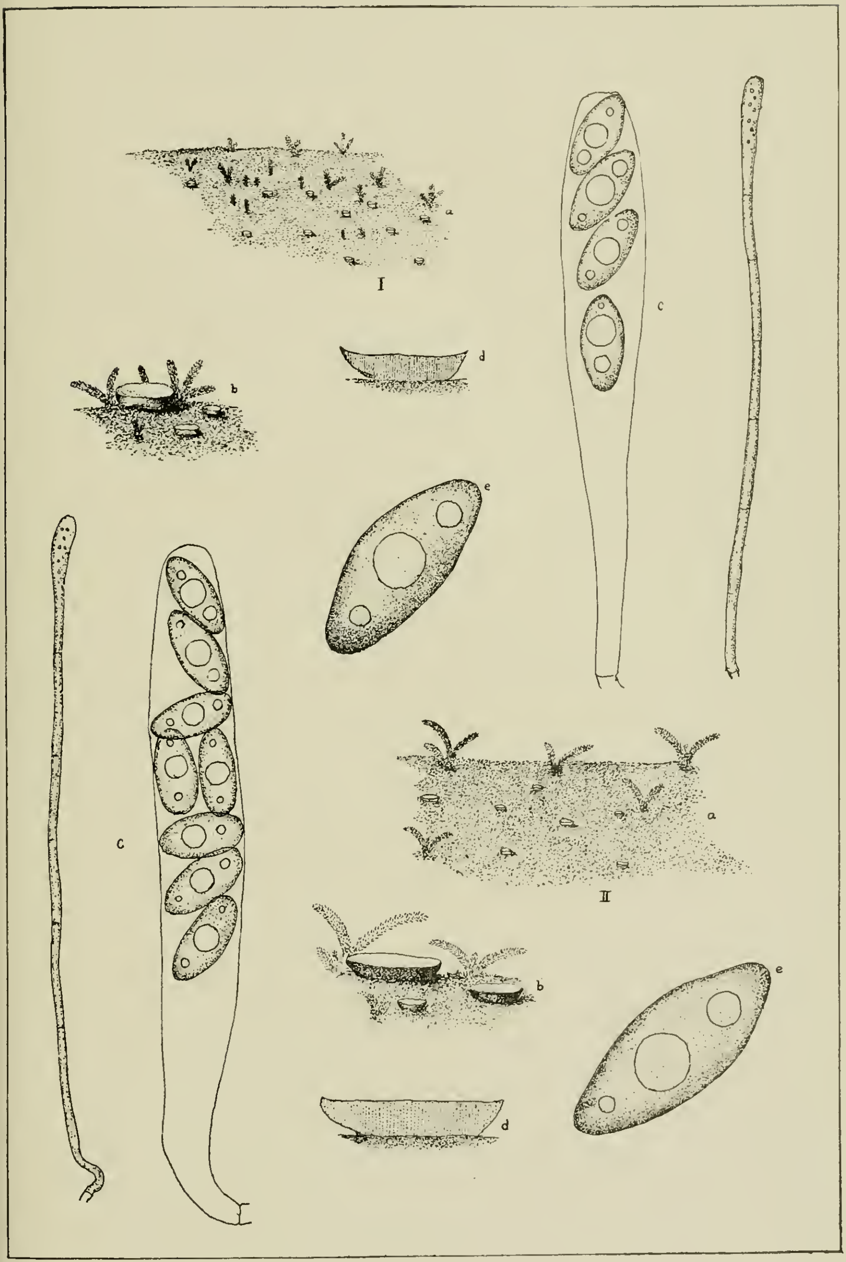
Humaria tetraspora (*Fckl.*) *Sacc.*

Fig. I, *a*. Several plants showing habitat, natural size.
Fig. I, *b*. Three cups, x 5.
Fig. I, *c*. Ascus with its four spores and paraphysis, x 600.
Fig. I, *d*. Diagram section showing concavity of hymenium, x 10.
Fig. I, *e*. Spore with guttulæ, x 1500.

Humaria muralis *Quel.*

Fig. II, *a*. Cups showing habitat, natural size.
Fig. II, *b*. Cups, x 5.
Fig. II, *c*. Ascus and paraphysis with spores, x 400.
Fig. II, *d*. Diagram section, x 10.
Fig. II, *e*. Spores with guttulæ, x 1000.

PLATE XI.



Explanation of Plate XII.

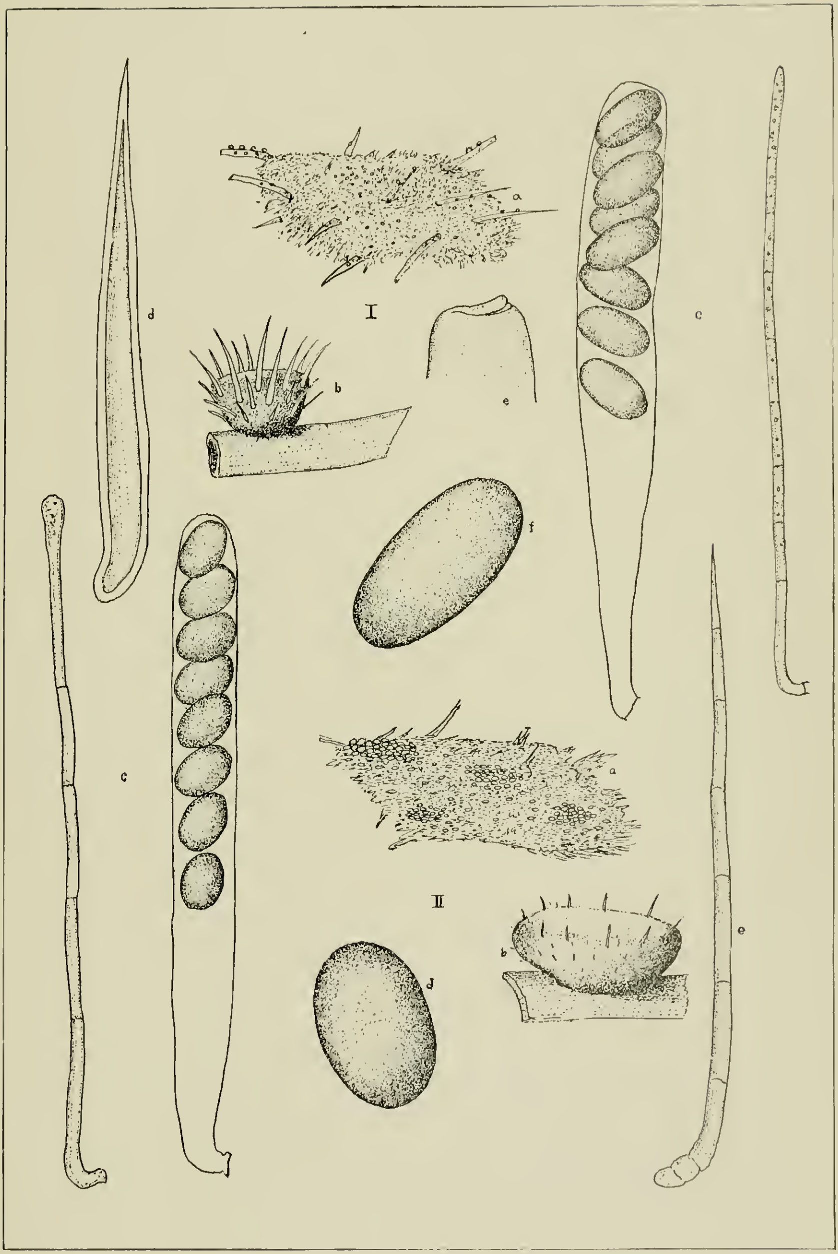
Lasiobolus equinus (*Mull.*) *Karst.*

Fig. I, *a.* Several plants showing habitat, natural size.
Fig. I, *b.* One plant to show spines, x 20.
Fig. I, *c.* Ascus and paraphysis, x 500.
Fig. I, *d.* One spine, x 590, often much longer.
Fig. I, *e.* Ascus to show operculum, x 750.
Fig. I, *f.* One Spore, x 1200.

Lasiobolus raripilus (*Phill.*) *Sacc.*

Fig. II, *a.* Group of plants, natural size.
Fig. II, *b.* One plant spines diagramatic, x 10.
Fig. II, *c.* Ascus and paraphysis, x 400.
Fig. II, *d.* One spore, x 1200.
Fig. II, *e.* Hair, x 500.

PLATE XII.



Explanation of Plate XIII.

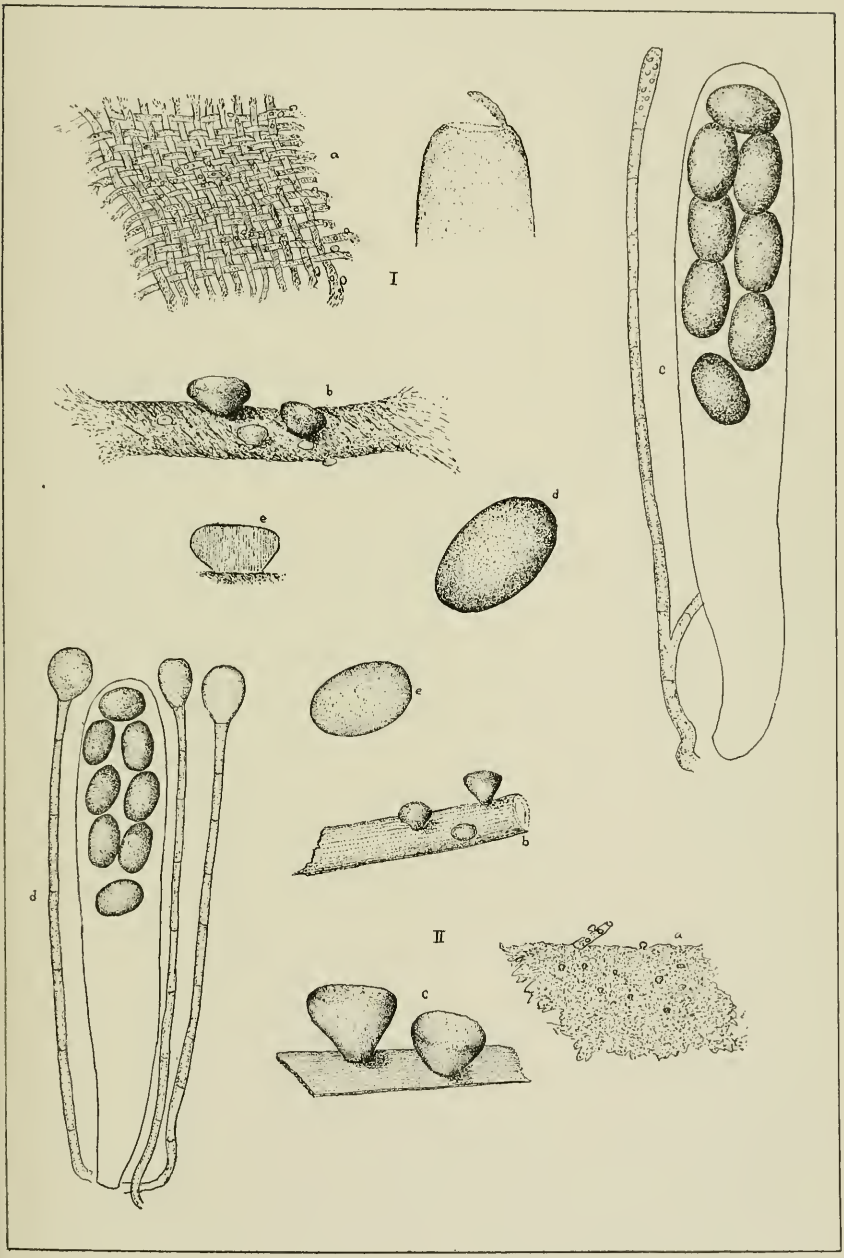
Ascophanus testaceus (*Mong.*) *Phill.*

Fig. I, *a*. Plants showing habitat, natural size.
Fig. I, *b*. Several plants, x 10.
Fig. I, *c*. Ascus and paraphsis, x 600.
Fig. I, *d*. One spore removed, x 1200.
Fig. I, *e*. Diagram section, x 10.

Ascophanus microsporus (*B. & Br.*) *Phill.*

Fig. II, *a*. Several plants, natural size.
Fig. II, *b*. Plants, x 10.
Fig. II, *c*. Two plants, x 20.
Fig. II, *d*. Ascus and paraphyses with globose apices, x 1000.
Fig. II, *e*. One spore removed, x 2000.

PLATE XIII.



EXPLANATION OF PLATE XIV.

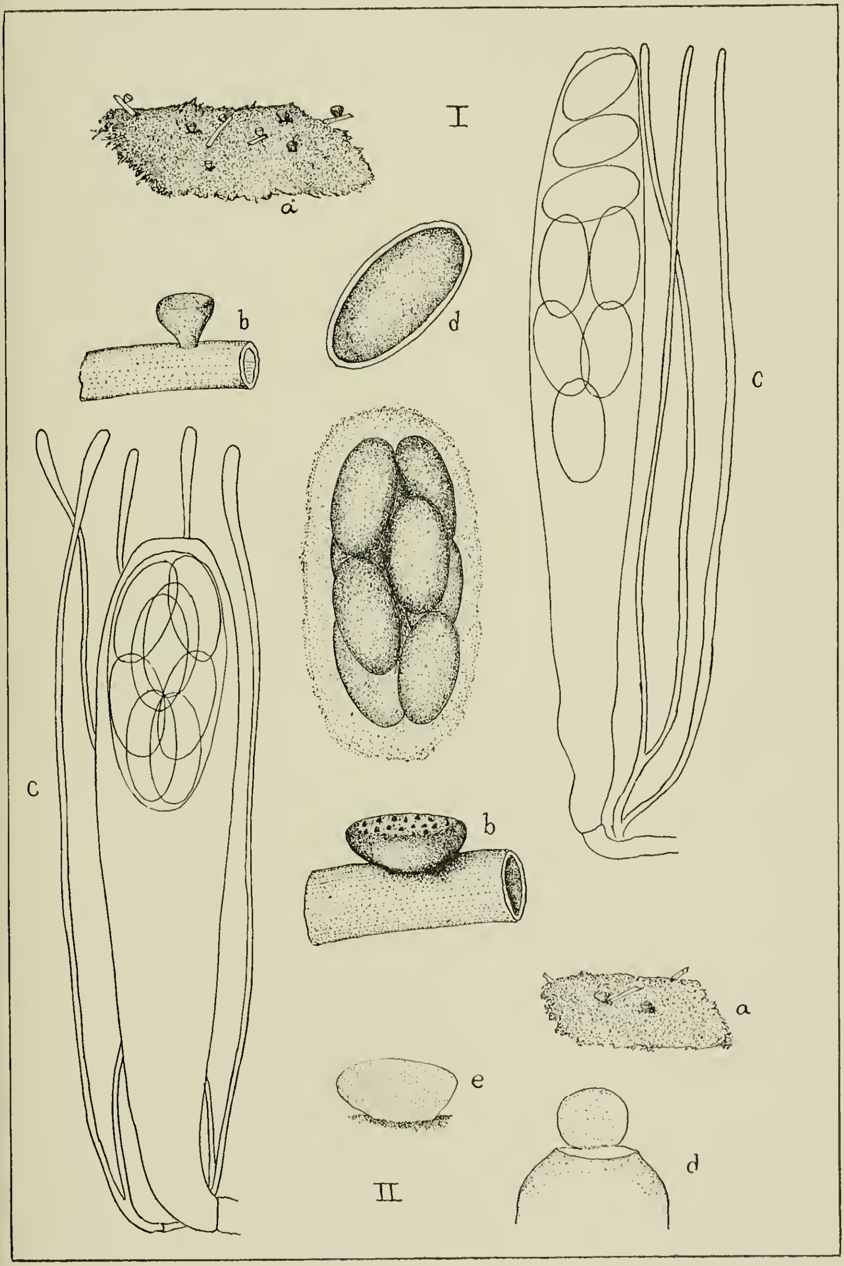
ASCOPHANUS CINEREUS (*Cr.*) *Boud.*

Fig. I, *a*. Plants, natural size.
Fig. I, *b*. One plant, x 10.
Fig. I, *c*. Ascus and paraphyses, x 700.
Fig. I, *d*. One spore, x 1200.

SACCOBOLUS KERVERNI (*Cr.*) *Boud.*

Fig. II, *a*. Plants, a little enlarged.
Fig. II, *b*. One plant, x 25.
Fig. II, *c*. Ascus and paraphyses, x 800.
Fig. II, *d*. Ascus to show operculum, x 800.
Fig. II, *e*. Diagram section, x 25.

PLATE XIV.



Explanation of Plate XV.

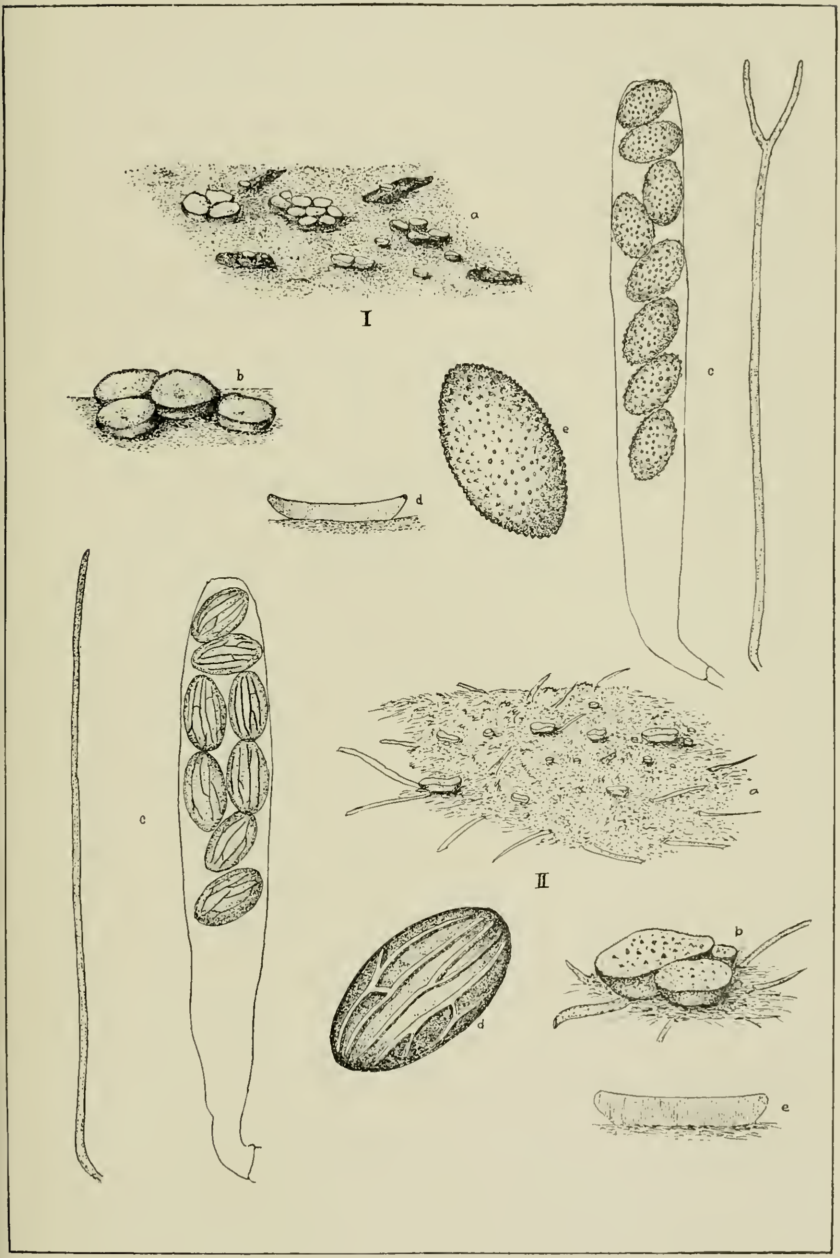
Ascobolus atro-fuscus *Phill. & Plow.*

Fig. I, *a*. Group of plants showing habitat, natural size.
Fig. I, *b*. Several plants, x 2.
Fig. I, *c*. Ascus and paraphyses, x 500.
Fig. I, *d*. Diagram section, x 4.
Fig. I, *e*. One spore showing verrucose markings, x 1200.

Ascobolus furfuraceus *Pers.*

Fig. II, *a*. Group of plants, natural size.
Fig. II, *b*. Plants showing projecting asci, x 3.
Fig. II, *c*. Ascus and paraphysis, x 400.
Fig. II, *d*. One spore to show reticulations, x 1200.
Fig. II, *e*. Diagram section, x 5.

PLATE XV.



Explanation of Plate XVI.

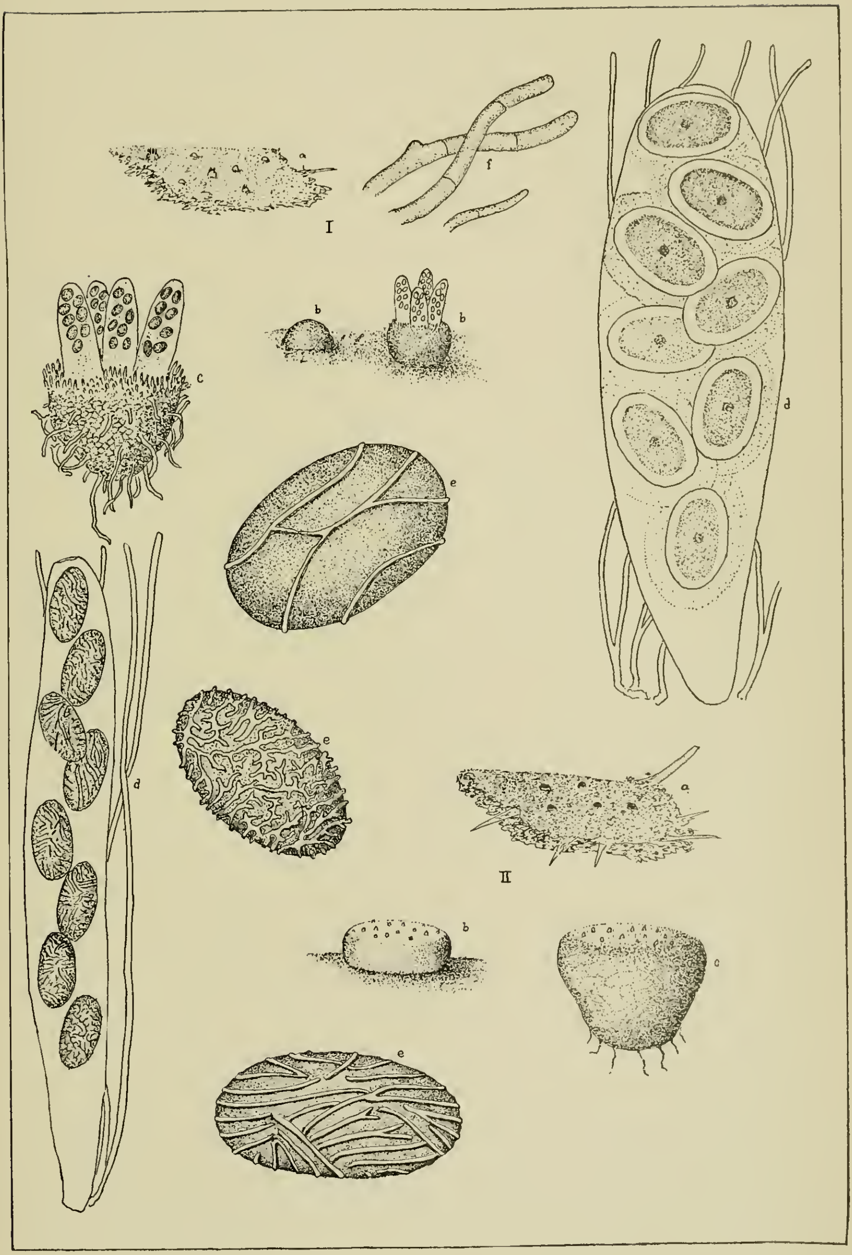
Ascobolus immersus *Pers.*

Fig. I, *a*. Several plants, natural size.
Fig. I, *b*. Mature and immature plant, x 5.
Fig. I, *c*. Mature plant, x 25.
Fig. I, *d*. Ascus with spores and paraphyses, just before maturity, x 300.
Fig. I, *e*. Mature spore showing reticulations, x 600.

Ascobolus glaber *Pers.*

Fig. II, *a*. Several plants, natural size.
Fig. II, *b*. Mature plant with projecting asci, x 20.
Fig. II, *c*. Same removed from substratum.
Fig. II, *d*. Ascus with mature spores and paraphyses, x 411.
Fig. II, *e*. Mature spores showing numerous reticulations, x 1299.

PLATE XVI.



Explanation of Plate XVII.

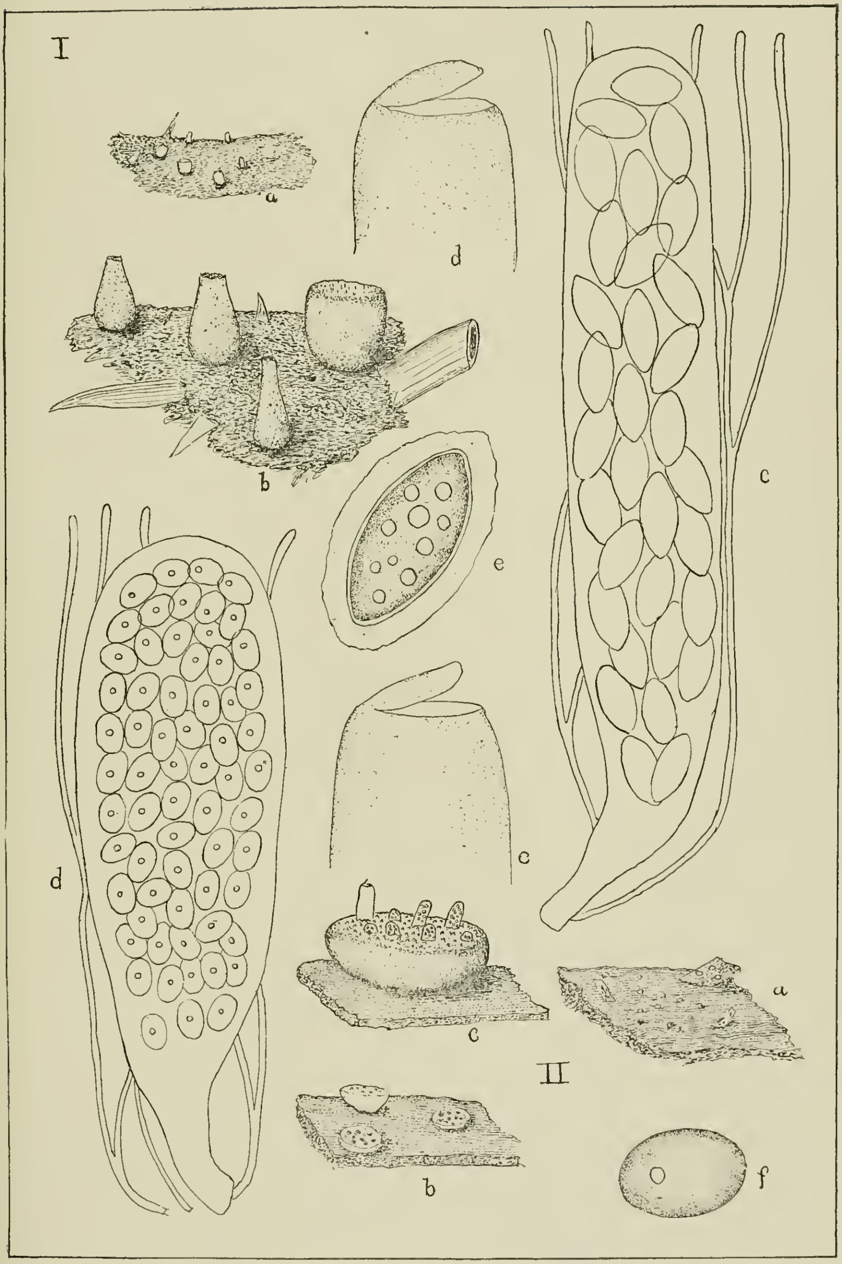
Ryparobius pelletieri (*Cr.*) *Sacc.*

Fig. I, *a*. Several cups, natural size.
Fig. I, *b*. Mature and immature cups, x 10.
Fig. I, *c*. Ascus and paraphyses, x 411.
Fig. I, *d*. Ascus to show operculum, x 400.
Fig. I, *e*. One spore with membrane, x 1000.

Ryparobius crustaceus (*Fckl.*) *Rehm.*

Fig. II, *a*. Plants, about natural size.
Fig. II, *b*. Plants, x 10.
Fig. II, *c*. One plant to show projecting asci, x 30.
Fig. II, *d*. Ascus and paraphyses, x 1000.
Fig. II, *e*. Ascus to show operculum, x 800.

PLATE XVII.



Explanation of Plate XVIII.

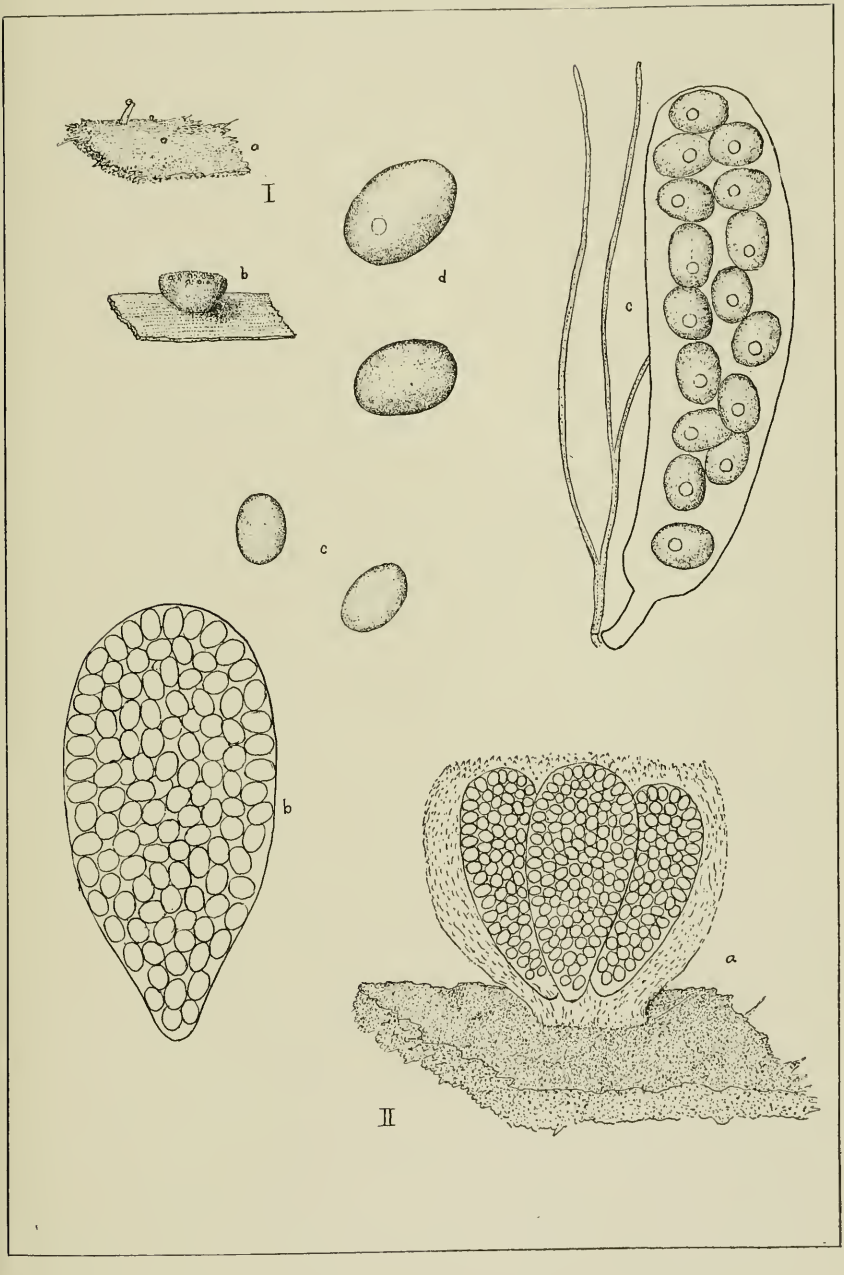
Ryparobius sexdecimsporus (*Cr.*) *Sacc.*

Fig. I, *a*. Plants, natural size.
Fig. I, *b*. One plant, x 20.
Fig. I, *c*. Ascus and paraphyses, x 1000.
Fig. I, *d*. Spores, x 1500.

Ryparobius pachyascus *Rehm.*

Fig. II, *a*. Diagram section, x 500.
Fig. II, *b*. Ascus with spores, x 1111.
Fig. II, *c*. Spores, x 2000.

PLATE XVIII.



Explanation of Plate XIX.

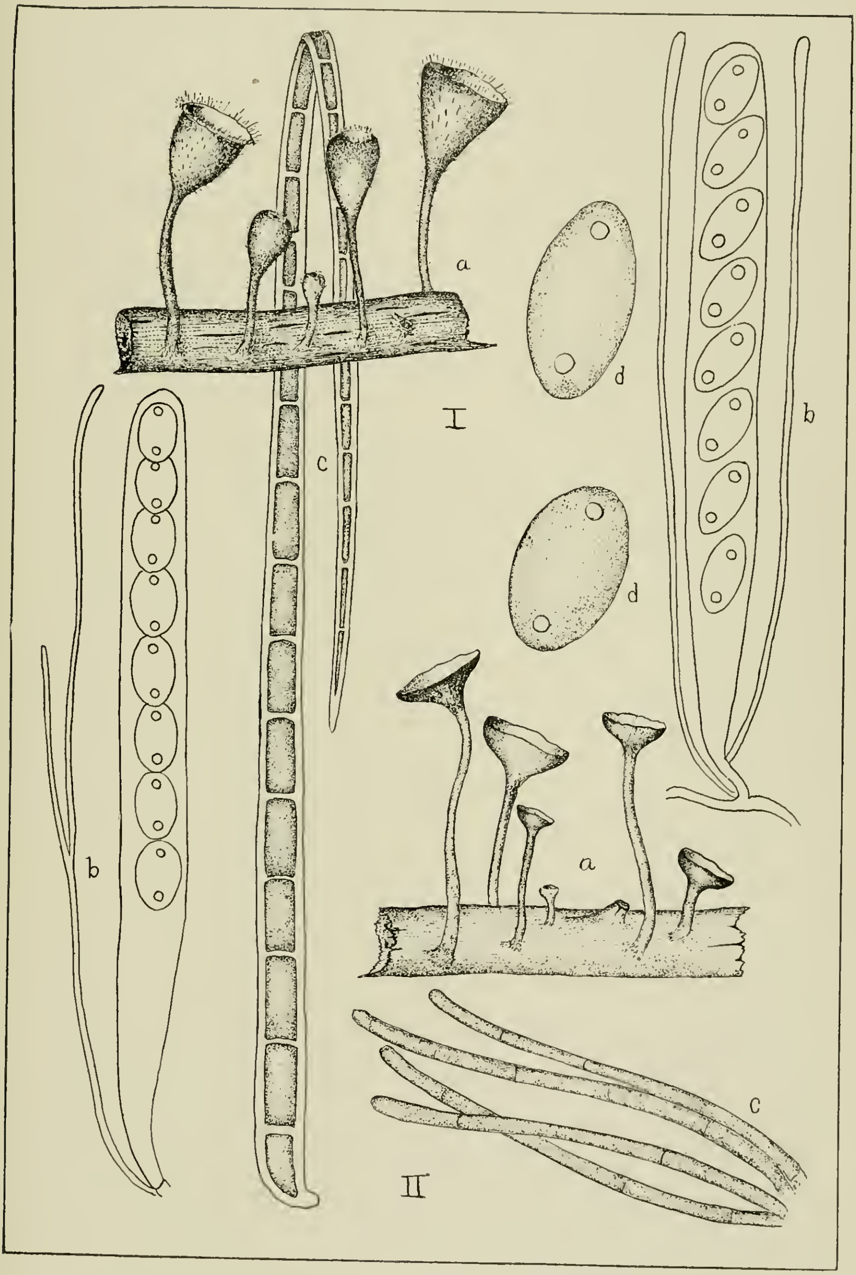
Sarcoscypha floccosa (*Schw.*) *Sacc.*

Fig. I, *a*. Several cups showing habitat, natural size.
Fig. I, *b*. Ascus and paraphyses, x 500.
Fig. I, *c*. One hair removed, x 500.
Fig. I, *d*. Spore with guttulæ, x 1000.

Sarcoscypha occidentalis (*Schw.*) *Cke.*

Fig. II, *a*. Cups to show habitat, natural size.
Fig. II, *b*. Ascus with paraphsis, x 500.
Fig. II, *c*. Hairs, x 500.
Fig. II, *d*. One spore removed, x 1000.

PLATE XIX.



Explanation of Plate XX.

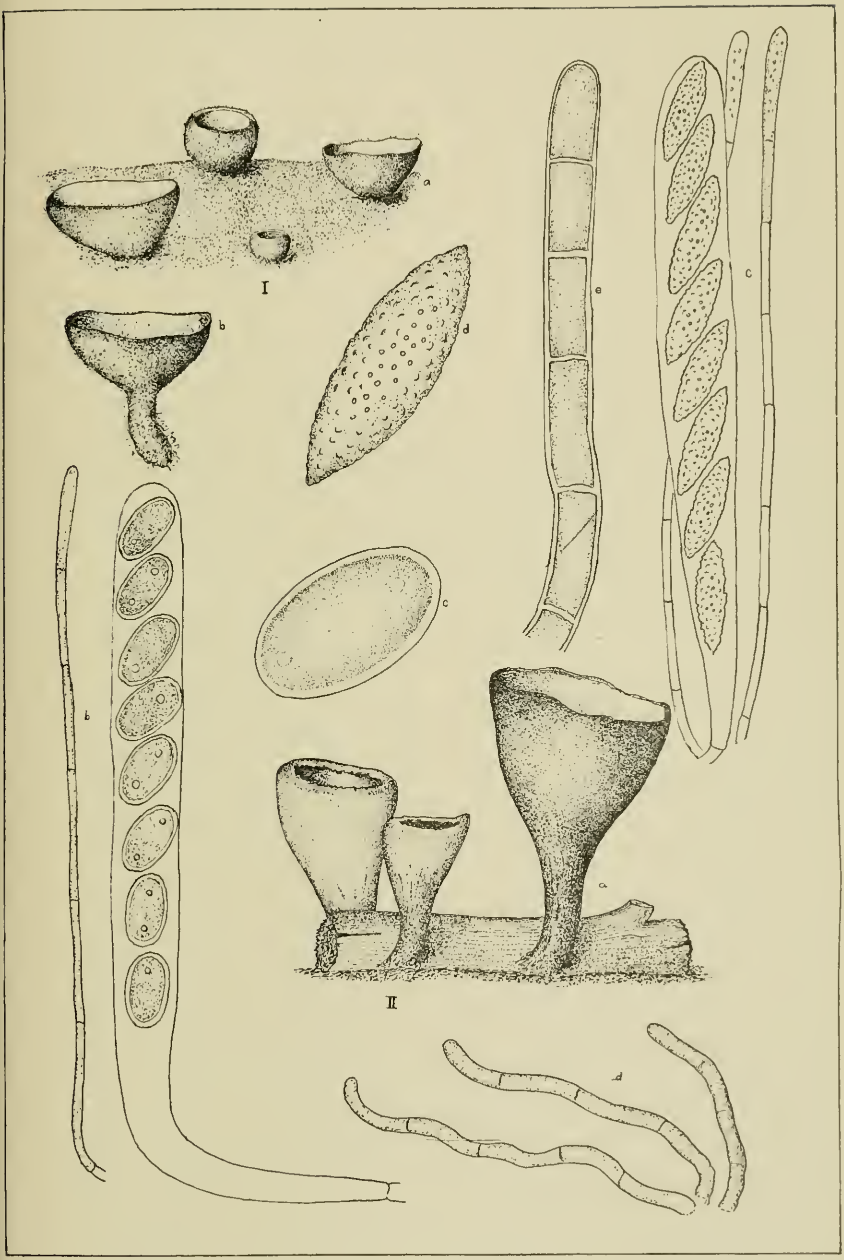
Macropodia pubida *B. & C.*

Fig. I, *a*. Cups, natural size.
Fig. I, *b*. Cup removed to show stem, natural size.
Fig. I, *c*. Ascus and paraphyses, x 400.
Fig. I, *d*. One spore showing verrucose markings, x 1000.
Fig. I, *e*. Portion of hair, x 700.

Sarcoscypha coccinea (*Jacq.*) *Sacc.*

Fig. II, *a*. Cups to show habitat, natural size.
Fig. II, *b*. Ascus and paraphysis, x 400.
Fig. II, *c*. One spore, x 1000.
Fig. II, *d*. Hairs, x 1400.

PLATE XX.



Explanation of Plate XXI.

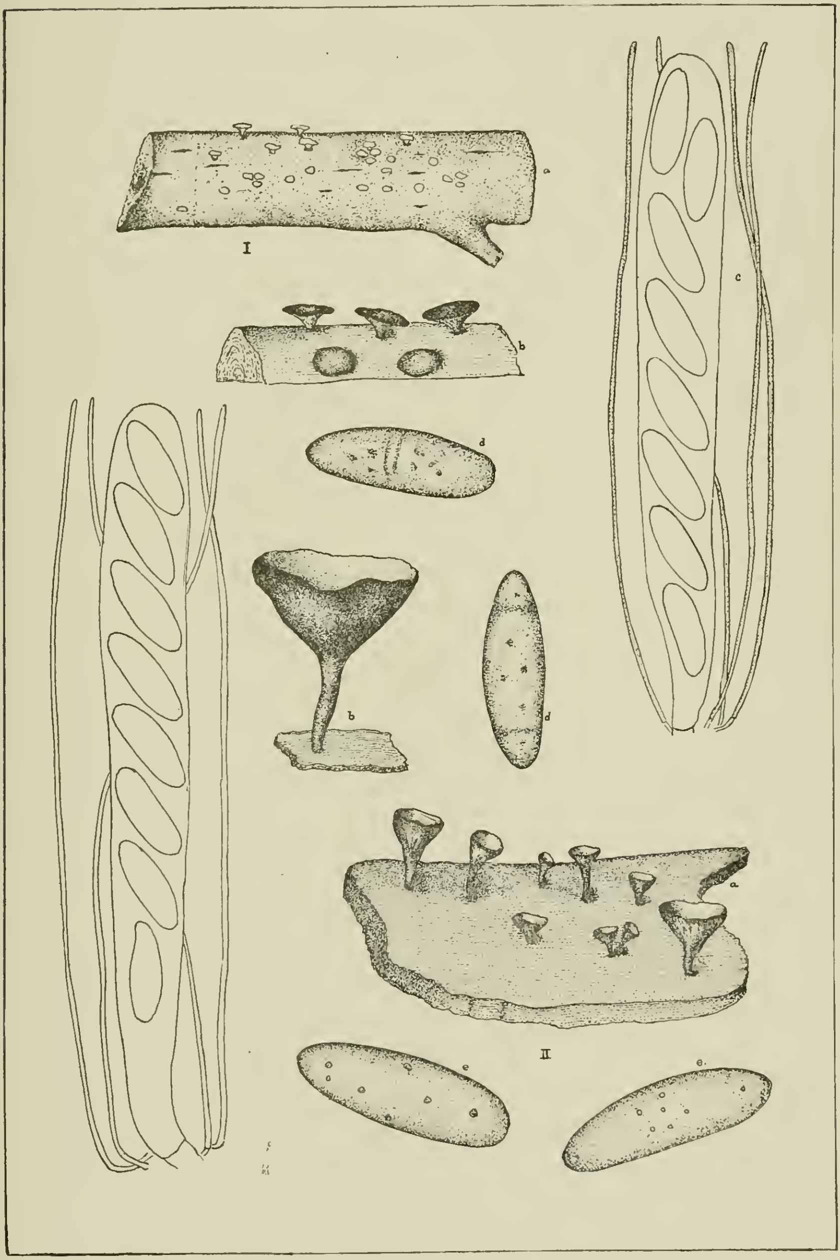
Helotium citrinum (*Hedw.*) *Fr.*

Fig. I, *a*. Group of plants to show habitat, natural size.
Fig. I, *b*. Plants enlarged, x 3.
Fig. I, *c*. Ascus and paraphyses, x 1500.
Fig. I, *d*. Spores, x 2000.

Geopyxis nebulosa (*Cke.*) *Sacc.*

Fig. II, *a*. Group of plants showing habitat, natural size.
Fig. II, *b*. One plant, x 3.
Fig. II, *c*. Ascus and paraphyses, x 500.
Fig. II, *e*. Spores, x 800.

PLATE XXI.



Explanation of Plate XXII.

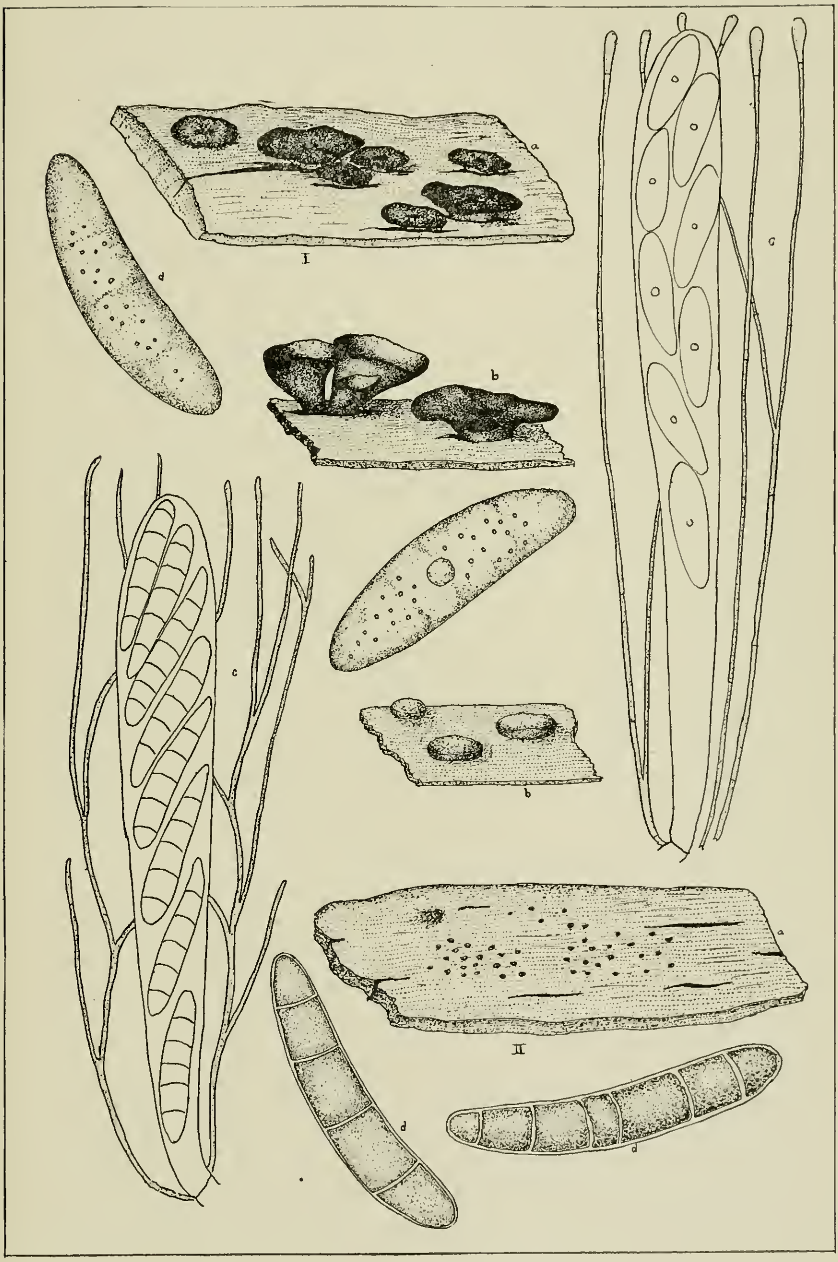
Coryne sarcoides (*Jacq.*) *Tul.*

Fig. I, *a*. Several plants to show habitat, natural size.
Fig. I, *b*. Plants a little enlarged.
Fig. I, *c*. Ascus and paraphyses, x 1000.
Fig. I, *d*. Spores removed, x 2000.

Petallaria melaxantha (*Fries.*) *Phill.*

Fig. II, *a*. Plants showing habitat, natural size.
Fig. II, *b*. Several plants, x 10.
Fig. II, *c*. Ascus and paraphyses. x 1000.
Fig. II, *d*. Two spores removed, x 2000.

PLATE XXII.



Explanation of Plate XXIII.

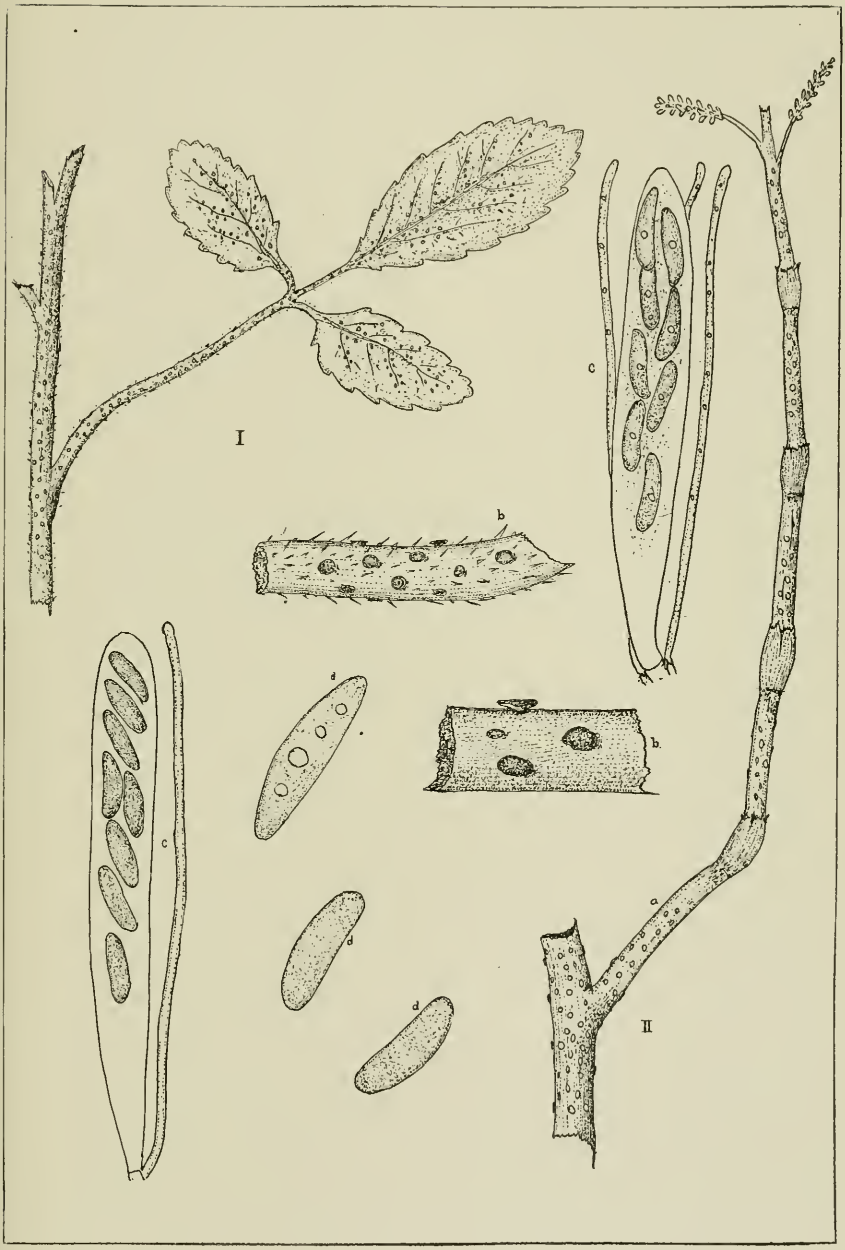
Mollisia dehnii (*Rabenh.*) *Karst.*

Fig. I, *a*. Plants showing habitat, natural size.
Fig. I, *b*. Several plants, x 3.
Fig. I, *c*. Ascus and paraphyses, x 1000.
Fig. I, *d*. One spore, x 2500.

Mollisia polygoni (*Lasch.*) *Gill.*

Fig. II, *a*. Plants showing habitat, natural size.
Fig. II, *b*. Several plants, x 5.
Fig. II, *c*. Ascus and paraphysis, x 1200.
Fig. II, *d*. Two spores, x 2300.

PLATE XXIII.



Explanation of Plate XXIV.

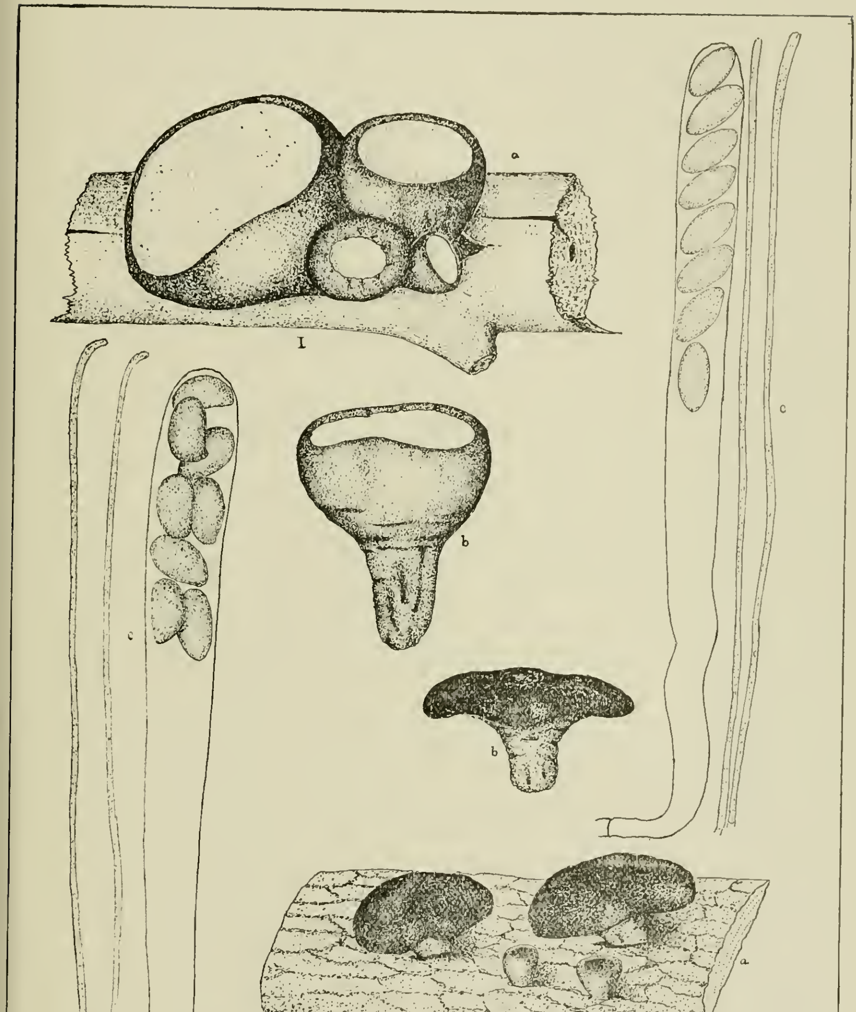
Bulgaria rufa *Schw.*

Fig. I, *a*. A cluster of cups showing habitat, natural size.
Fig. I, *b*. One cup removed showing stem, natural size.
Fig. I, *c*. Ascus and paraphyses with spores, x 500.

Bulgaria inquinans *Fries.*

Fig. II, *a*. Young and mature plants to show habitat, natural size.
Fig. II, *b*. One plant removed to show stem.
Fig. II, *c*. Ascus and paraphyses, x 750.
Fig. II, *d*. One spore with guttulæ, x 2000.

PLATE XXIV.



Explanation of Plate XXV.

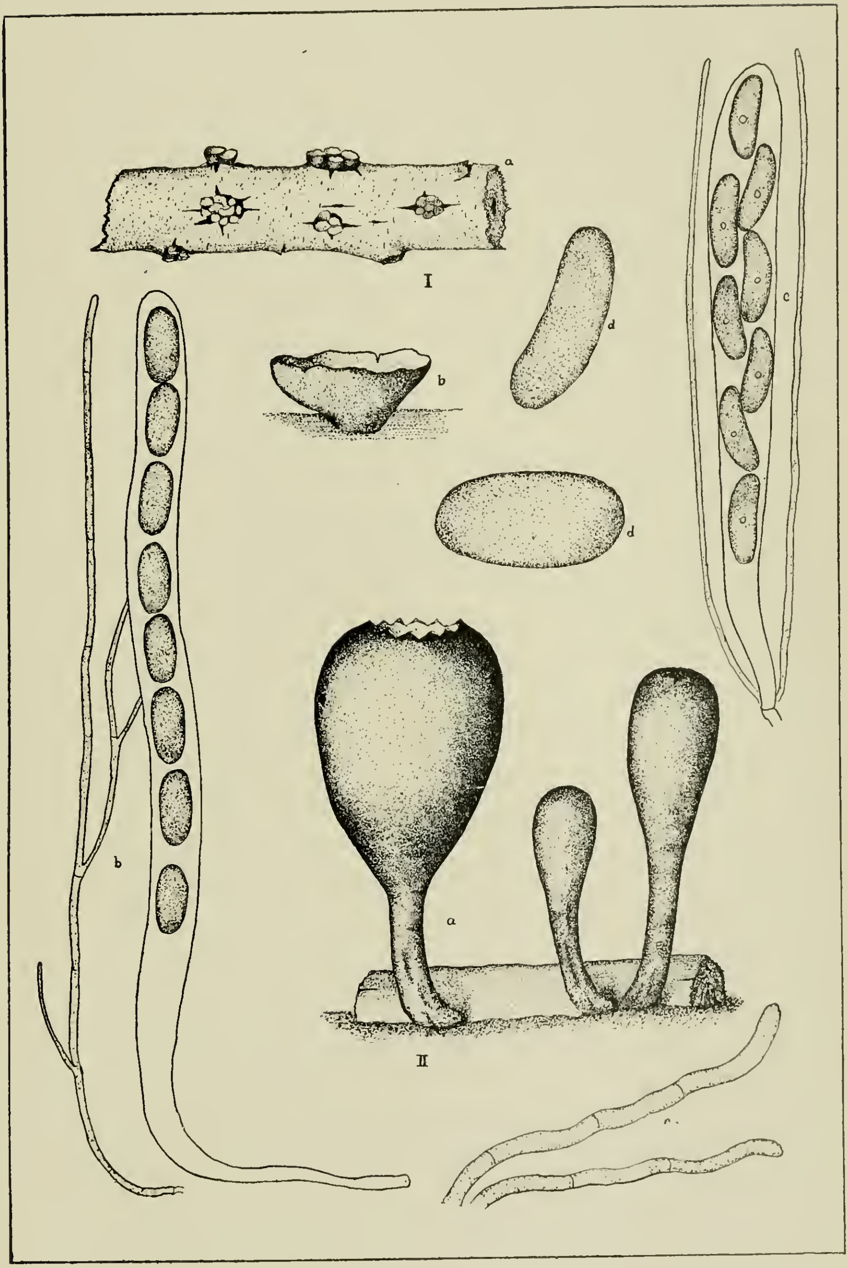
Cenangium populneum (*Pers.*) *Rehm.*

Fig. I, *a*. Cups natural size to show habitat.
Fig. I, *b*. One cup, x 5.
Fig. I, *c*. Ascus and paraphyses, x 1000.
Fig. I, *d*. One spore, x 2000.

Urnula craterium (*Schw.*) *Fr.*

Fig. II, *a*. Three stages in development of cup, natural size.
Fig. II, *b*. Ascus and paraphyses, x 500.
Fig. II, *c*. Hairs from cup, x 1000.
Fig. II, *d*. One spore, x 1200.

PLATE XXV.



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PAPERS ON THE LOESS.

By B. Shimek.

The question of the genesis of the loess of the Mississippi valley has interested two generations of geologists. Until quite recently the great majority of American writers on the subject ascribed the deposition of the loess to water in some form or manner. This general conclusion was fortified and entrenched by a series of able papers by professors Chamberlin, Salisbury, McGee, Hilgard, and others, which appeared in various journals and periodicals in the years 1878 to 1892. A lull followed this period of activity. Some of the earlier champions of the aqueous theory turned to other lines of effort, and those who remained had little to say upon the subject in a public way. But it is not just to judge of the latter class today by their writings of several years ago, for some of the ablest former advocates of the aqueous theory have materially changed their views upon the subject. It is true that here and there individual efforts were made to strengthen the aqueous side of the case, and recently these have been more frequently renewed largely for the purpose of sustaining theories or views on related subjects. But it is safe to say that no material facts have been added in a dozen years to strengthen the aqueous theory oi hypothesis. Those who have recently argued in its favor have relied not so much upon new confirmatory observations, as rather on the earlier utterances of men whose more mature judgment and experience today contradict their former views.

The recent discussions of the Lansing skeleton have again precipitated the question of the origin of the loess because of the attempt to deduce the age of the skeleton from the age of the deposit under which it was buried, and which was assumed to be loess.

The writer's own contributions to the literature of the loess in recent years have been on the æolian side. One of these, that on the Loess of Natchez, Miss., published in the American Geologist,* should have been credited at the time of publication to this Bulletin as an advanced publication. It is reprinted here because originally prepared for this Bulletin, and because it bears more or less directly on the reply to Professor Wright, and advantage is taken of this opportunity to add a few notes to the original paper. The paper on the Loess and the Lansing Man also appeared in the American Geologist, and is here reproduced to make the subsequent notes and articles intelligible.

THE LOESS OF NATCHEZ, MISS.

PLATES I–VII.

The loess of Natchez, Miss., and of the lower Mississippi valley, besides presenting a specially interesting field to the student, is classic ground, for here loess was first recognized in America by Sir Charles Lyell, who visited the region in 1846.

It has received much attention since that time, and has been reported upon successively by Wailes*, Hilgard†, Chamberlin and Salisbury‡, McGee§, and Mabry||, while its fossils have received some attention from Binney.¶

**Vol. XXX, pp. 279–299, Nov., 1902.

*Wailes, B. L. C. Report on the Agri. and Geology of Mississippi, 1854.

†Hilgard, E. W.—Agriculture and Geology of Mississippi, 1860.

‡Chamberlin, T. C., and Salisbury, R. D.—Sixth An. Rep. U. S. Geol. Survey, 1885.

§McGee, W. J.—Twelfth An. Rep. U. S. Geol. Survey, 1891.

||Mabry, T. O.—Journal of Geology, vol. VI., 1898.

¶Binney, W. G.—A Manual of American Land Shells. Appendix IX, 1885, etc.

While it was at first regarded as distinct from the loess of the upper Mississippi drainage, it is indistinguishable from it in its physical characters,—especially from that which may be designated as Missouri river loess. There are certain peculiarities of the fossil fauna of the southern deposit which have already received some notice, but for the most part the references to them are vague and unsatisfactory and do not sufficiently set forth their significance.

It was the writer's good fortune to visit Natchez (and also Vicksburg) in May and June, 1898. The visit was made chiefly for the purpose of studying the fossils of the loess and comparing them with the modern molluscan fauna now inhabiting the same region. As a result of this investigation more than 4,600 fossil shells were secured; and some additions were made to the collections of modern molluscs from Mississippi and adjacent states made by the writer in previous years. The season, however, was very unfavorable for collecting living snails because of the long-protracted drought which caused them to hide away. This probably accounts for the comparatively small number (less than 900 specimens) of modern snails in the Natchez collection, of which more than one-half belong to a species (*Succinea grosvenorii*) not represented in the local loess.

In all more than fifty exposures of loess were studied at Natchez, and several were examined at Vicksburg, where but one day was spent. The location of the principal exposures which received attention at Natchez is shown in the accompanying map. The topography of the region is striking. The Mississippi has cut away the deposits on the east side until bluffs exceeding 200 feet in height face the river. In addition to this smaller streams have washed out deep gullies, whose almost perpendicular sides rise from 50 to nearly 200 feet. In all the region which was investigated the highest points are uniformly close to the river, while the outlying region is much lower. This is well illustrated by the ridge on which Natchez stands. Reference to the map will show that the altitudes* in

*These were obtained in part from barometric readings, and in part from more exact data furnished by Captain Babbit of Natchez.

the western part of Natchez, near the bluffs, vary from 180 to 210 feet above low water in the river, but gradually drop to 75 feet on the plain into which St. Catherine's creek has cut its channel. This plateau, or broad ridge, is seamed and cut by the "breaks," "gulfs" and "guts" described by McGee,* which offer abundant opportunities for the study of numerous exposures, most of which reach far below the loess, and permit easy penetration into its undisturbed mass. The loess is uniformly the uppermost deposit, forming the immediate subsoil on the ridge on which Natchez is located. Underlying it in most of the exposures is the Yellow or Brown loam, which closely resembles loess, but is not fossiliferous and is usually of a deeper red color, though sometimes practically indistinguishable from it. Hilgard**described the Yellow or Brown loam as overlying the loess. Later McGee†, in giving the order of the members of the Columbia formation, places the Brown or Yellow loam above the loess, but adds: "The order of the first two members might be reversed with equal propriety in the southern portion of the embayment; for the loess is but a phase of the loam, and is frequently underlain as well as overlain by the loamy deposits." Again(p.393) referring to the succession of strata at Natchez, he places the loess at the surface and the brown loam below it,—which accords with the writer's observations in that vicinity. Still later Mabry‡ discussing the relation of the brown loam to the loess, said: "It would appear that, if my observations be accurate, the Brown loam and the loess of this region are not only homotaxial but synchronous as well."

Whatsoever may be the exact relation existing between these two deposits elsewhere, at Natchez there appears no trace of the brown loam above the loess so far as the writer was able to determine.

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*McGee, W. J., l. c., p. 434. See also Plate II.
**Hilgard, E. W., l. c., pp. 194-195.
†McGee, W. J., l. c., p. 392.
‡Mabry, T. O., l. c., p. 295.

The thickness of the loess at Natchez has been variously reported. Lyell§ gave it as sixty feet, but he probably included the brown loam; Hilgard|| reported its average thickness as between twenty-five and thirty-five feet; McGee¶ states it as ten to fifty feet; while Capt. C. W. Babbit, of Natchez, an experienced surveyor and civil engineer, who has had much to do with excavations, assured the writer that it nowhere exceeded twenty-five feet in thickness. The writer's own measurements showed a maximum thickness of about thirty feet, though in the exposures numbered 29 and 31 on the map, it seemed to be much more, but accurate measurements could not be made. It is probable that the front portion of the bluff had slipped in part and thus exaggerated the apparent thickness of the loess. Such slipping was well illustrated opposite exposure No. 12 at *x*. A mass of loess about 25 feet high, 15 feet wide and 165 feet long, slipped vertically about two feet. Subsequent erosion of the face of the bluff at one end of the mass made it appear as though the mass extended from the original upper surface to the new lower surface,—a distance of about 27 feet. The underlying Orange sands, which are easily washed out, always make such faults possible, and consequently care must be exercised in making measurements on the exposed faces of bluffs.

The material of the deposit possesses typical loess characters. It is a fine yellow or slightly bluish clay, showing a tendency toward vertical cleavage, containing lime nodules and iron tubules, occurring on higher grounds, and abundantly fossiliferous. Its hypsometric distribution is also like that of the northern loess, for it mantles the hills, and varies but little in depth. This is well illustrated in Plate III. In many respects it is strikingly like the loess along the Missouri river, being somewhat coarser and containing more lime, and consequently eroding less readily, than the loess of the upper Mississippi valley in Iowa and Illinois. But for the under-

§Prin. of Geology, vol. I, p. 460.
||P. 313, l. c.
¶P. 397, l. c.

mining of the underlying sands and gravels it would long resist the action of air and water. Along the N. O. & N. W. R. R., in the cut near the depot, (exposure 1 on the map), the very steep sides still retained the marks of pick and shovel at the time that the photograph reproduced in Plate IV. was taken, though the excavation had been made about seven years before.

This similarity of the Natchez loess and that of the Missouri river bluffs in all excepting fossils suggests the probable source of much, if not all, of the material which composes it.

The fossils are the most interesting feature of the southern loess. Here, as elsewhere, the characteristic fauna is molluscan, but differs in many respects from that of the northern loess. Notwithstanding the fact that the fossils formed the special object of the writer's investigations, there were found among them no species which are aquatic, or in any sense even "semi-aquatic." Not even those forms which belong to the fauna of the small pond and shallow stream, and which sometimes occur in northern loess, were found here. Singularly, too, such species are quite absent from the modern fauna of the uplands in and about Natchez, for there are no springs, or ponds, or swampy areas in which such snails as *Physa*, *Limnæa*, etc., might thrive. It is true that aquatic species have been reported from this loess, but in all cases the reports are either indefinite, or refer to that which may not be loess.

As early as 1846, Lyell* noted a deposit at Natchez resembling loess and with "land, fluviatile and lacustrine shells of species still inhabiting the same country," but he did not designate them by name. Later, discussing the loess of Natchez in the London Times† he said that the deposit "contains abundance of fresh water and land shells, of which I myself obtained more than 20 species . . . . They belong to the genera *Helix*, *Helicina*, *Pupa* and *Succinea*, accompanied or rather replaced in a few places where the loam passes into shell-marl by *Lymnea*, *Planorbis*, *Physa*, *Cylas* . . . . All

*Athenæum, Sept., 1846.

†Dec. 8, 1846; reprinted in the Am. Jour. Sci. and Arts, 2nd series, vol. III, pp. 267–269, 1847.

species are identical with Testacea, now inhabiting the same part of the U. S." The species of *Helix*, *Helicina*, *Pupa* and *Succinea* are, however, in no sense aquatic, and it will be observed that the deposit from which the shells of the species belonging to the aquatic genera *Limnæa*, *Planorbis*, *Physa* and *Cyclas* (*Sphærium* or *Pisidium*) were obtained is very doubtfully loess,—certainly not typical loess. Finally, in the Principles of Geology* Lyell says that this loess is "full of land-shells such as Helix and Pupa, together with the amphibious genus Succinea, all of species now living in the same country. At a few points in the lower part of this formation, I observed shells of living species of Lymnea, Planorbis and Cyclas,—genera which inhabit ponds. . . . The only fossils of a truly fluviatile character, which have been met with anywhere in this loess are the remains of three fish discovered lately (March 19, 1866) by Colonel Green. They were found in the great platform of loess, two miles north of Vicksburg, and only four feet below the surface, at the height of 200 feet above highwater mark."

The genus *Succinea* cannot be properly designated as amphibious. It consists of two very distinct groups of species, to only one of which, represented by the species *retusa* (*ovalis*), the term may be applied, and this one is not represented in the southern loess, and but very sparingly in that of the north. The common and characteristic species of the loess, not only at Natchez but in all the Mississippi valley, belong to the other section of the genus, of which *S. obliqua*, *S. grosvenorii* and *S. avara* are members, and all of these are upland species, or at least are commonly found on higher grounds,—and none of them are in the remotest sense aquatic or "semi-aquatic." Viewed in the light of the quotation from the *London Times*, the deposit in which the pond snails were obtained can scarcely be referred to as typical loess. The occurrence of the fish-bones is unique and throws no light on the prevaili g loess conditions. Such limited quantities

*Vol. I, p. 460, 1872.

of material might have been carried to the highlands by birds or mammals, and subsequently buried deeply by dust.

McGee also says* that this loess "yields . . . shells of land snails sometimes associated (particularly at lower levels) with shells of water snails and other fluviatile mollusca." No names are given, and the reference is probably based on Lyell's statements. The same is probably true of the following reference:** "The loess is unusually rich in shells of land and swamp mollusca, together with a few aquatic species."†

Altogether the evidence of the occurrence of aquatic shells in the southern loess is very unsatisfactory. They certainly cannot be very abundant or widespread if among the 4,600 specimens collected by the writer there is not one aquatic shell.

The occurrence of vertebrate remains in the southern loess is quite as doubtful. Lyell's fishes have already been discussed. He had previously stated‡ that the shells already noted are "associated with bones of mastodon, elephant, tapir, and other megatheroid mammals." Again, in the Principles of Geology§ he says: "As to the mammalia of which some bones have been found in the lowest part of the loess and in clay at its base, they are many of them extinct species. Among them are *Mastodon giganteus*, a species of *Megalonyx*, a *Mylodon*, *Bison latifrons*, *Equus americanus*, *Felis atrox*, . . . two species of deer, two of bear and other quadrupeds, some extinct and others still living."

Wailes, in his first report, said:|| "The following list of the mammals found in a solid blue clay, said to belong to this formation ("bluff," or loess), was furnished by Dr. Leidy:

*P. 393, l. c.

**P. 399, l. c.

†See also notes on Dr. Amos Binney's paper at close of this paper.

‡Athenæum, 1846.

§P. 461, vol. I, 1872.

||See also Hilgard, l. c., p. 196.

Felis atrox, Leidy.
Ursus Americanus, foss.
Ursus amplidens, Leidy.
Megalonyx Jeffersonii, Harlan.
Megalonyx dissimilis, Leidy.
Mylodon Harlani, Owen.
Ereptodon priscus, Leidy.
Tapirus Americanus, foss.
Tapirus Haysii, Leidy.
Equus Americanus, Leidy.
Bootherium cavifrons, Leidy.
Cervus Virginianus, foss.
Bison latifrons, Leidy.
Elephas primigenius.
Mastodon giganteus.

Of these the last named is by far the most common. . . . · They are found about twenty feet below the surface, and the bones of other animals are associated with them."

A comparison of the two citations shows that the two lists are practically the same. The "solid blue clay" is in all probability not loess. The writer found no trace of these mammals in the loess at Natchez, though molluscan remains were abundant. But even if it proves that these mammals are found in true loess, the problem herein discussed will not be affected, as they are terrestrial and, if in true loess, only in its lowest, or oldest, parts.

The characteristic fossils of the loess at Natchez, as elsewhere, are land snails. They are found in all fossiliferous loess-exposures north and south, and the writer at least, has failed to find any other fossils in undoubted loess in the south.

These fossils have already received some attention. Lyell's references to them have already been quoted. Wailes† gives the first specific list‡ of species from the southern loess, identified wholly or in part by Conrad. They were obtained from the "bluff formation," or loess, of Mississippi, and most of them were probably from Natchez. They are:

Helix albolabris
Helix alternata
Helix concava
Helix elevata
Helix fraterna
Helix perspectiva
Helix profunda
Helix thyroides
Helix tridentata

To this list Hilgard adds *Helix monodon* and "a large *Achatina* found in Wilkinson county." Of these species *H.*

†P. 283, l. c., also quoted in Hilgard, l. c., p. 196.

‡This is an error. See Dr. A. Binney's list in additional notes at the close of this paper.

§P. 195, l. c.

alternata and *H. perspectiva* are now placed in the genus *Pyramidula*, *H. concava* in the genus *Circinaria*, and the remaining species of *Helix* in the genus *Polygyra*, *H. fraterna* being a variety of *P. monodon*. The "*Achatina*" is probably *Bulimulus*, and not from the loess. At least it has not been found in the loess along the Mississippi, though it is a characteristic species of the southern modern terrestrial molluscan fauna, and its occurrence as a fossil would not be surprising.

W. G. Binney frequently refers to the loess or "post-pliocene" fossils in his works on modern terrestrial molluscs, and many of them are unquestionably from the bluffs of the lower Mississippi,—some of them being specifically reported from Natchez. In 1865* he reported two species of terrestrial molluscs from the "post-pliocene of the Mississippi valley"(for the most part undoubtedly loess), one of them being a southern species which is known from the Natchez loess. In 1869† he reported 19 terrestrial species from the same indefinite source. Of these 15 species were found by the present author at Natchez. They are the following:

Hyalina (now *Gastrodonta*) *ligera*.
Macrocyclis (now *Circinaria*) *concava*.
Helix (now *Pyramidula*) *alternata*.
Helix (now *Pyramidula*) *perspectiva*.
Strobila (now *Strobilops*) *labyrinthica*.
Helix (now *Polygyra*) *stenotrema*.
" " " *hirsuta*.
" " " *monodon*.
" " " *palliata*.
" " " *inflecta*.
" " " *albolabris*.
" " " *elevata*.
" " " *exoleta*.
" " " *profunda*.
Succinea obliqua (now *ovalis* Say).

Of the remaining four species one, *Helix* (now *Pyramidula*) *solitaria* does not belong to the southern fauna.‡

*Smith. Miscell. Coll., no. 144, Sept., 1865.

†In Binney and Bland,—Land and F. W. Shells of N. Am.—Smith. Miscell. Coll., p. 194; Feb., 1869.

‡The writer has reason to believe, from private correspondence with Mr. Binney, that the shells reported under this name are *Pyramidula strigosa ioensis*, a species belonging to the northern loess.

The remaining three species, *Helix* (now *Polygyra*) *thyroides*, *H. clausa*, and *Helix* (now *Gastrodonta*) *gularis*, are found in the modern southern fauna and their occurrence in the southern loess would not be surprising. Mr. Binney later specifically reported *P. clausa* from the "post-pliocene" of Natchez. In 1870, in the 2nd edition of Gould,* he similarly reported nine of the foregoing species, of which the present author failed to find but one at Natchez, namely *H. thyroides.* The variety *bucculenta* of this species does, however, occur at Natchez, and may have been the form to which reference was made. In 1878 Binney again similarly reported† the nineteen species already mentioned, and added *Zonites* (now *Omphalina*) *fuliginosa* and *Z.* (now *Gastrodonta*) *intertexta*, and specifically reported *Triodopsis* (now *Polygyra*) *obstricta* from "Natchez Bluff." These three additional species are southern. The specimen reported as *Zonites fuliginosus* is really *Omphalina kopnodes*, a species not rare in the loess of Natchez. *Gastrodonta intertexta* (Binn.) Pils. is not known from Natchez, but is found in the South. *Polygyra obstricta* is frequent in the Natchez loess. The same species were again reported in the text of his Manual of Am. Land Shells in 1885, but in addition to this that work contains a catalogue of the Binney collection donated to the U. S. National Museum‡ in which twelve species are reported from the "post-pliocene" of Natchez. They are the following:

Macrocyclis	(now	*Circinaria*)	*concava*	4	specimens.
Zonites	(now	*Omphalina*)	*fuliginosus*	1	"
Stenotrema	(now	*Polygyra*)	*stenotremum*	2	"
"	"	"	*hirsutum*	2	"
"	"	"	*monodon*	4	"
Triodopsis	"	"	*obstricta*	1	"
"	"	"	*inflecta*	4	"
Mesodon	"	"	*albolabris*	4	"
"	"	"	*elevatus*	2	"
"	"	"	*exoletus*	3	"
"	"	"	*clausus*	4	"
"	"	"	*profundus*	3	"

*Invertebrata of Mass., A. A. Gould. Edited by W. G. Binney, 2nd ed. 1870.

†The Terr. Air-Breathing Moll. of the U. S., vol. V.

‡See Appendix IX, pp. 475–499.

It was the writer's privilege to examine this collection in 1899, and he found that not only is the single specimen marked *Zonites fuliginosus* (No. 38,806 of the collection) doubtfully from the "post-pliocene," but it is *Omphalina kopnodes.* Mr. Charles T. Simpson of the U. S. National Museum, to whom the question was later referred, states in a private letter that "this *Omphalina* is more solid than any *capnodes*, *friabilis*, or *fuliginosa* I have seen but agrees most nearly with *capnodes*."* *Omphalina fuliginosa* is therefore omitted from the final list of Natchez loess fossils, as Mr. Binney's specimen is the only one reported from the loess. Its occurrence as a fossil, however, would not be strange as the species is common in the south, and occurs living on the bluffs at Natchez.

With the exception of *Polygyra clausa* all the species in Binney's list were found by the writer in the loess at Natchez and 27 species and recognized varieties were added to that locality list, and two further species, *Polygyra fraudulenta* and *P. palliata*, were added at Vicksburg. Of these 29 species *Polygyra thyroides bucculenta*, *P. fraudulenta*, *Pyramidula alternata costata*, *Gastrodonta multidentata*, *Vitrea placentula*, *Punctum pygmæum*, *Vertigo tridentata* and *Carychium exile*, are here reported for the first time from undoubted loess, while *Polygyra palliata* and *Gastrodonta ligera* have heretofore appeared only in Binney's rather indefinite "post-pliocene" lists, without locality. Inasmuch as several of the fossil species are now also living in the vicinity of the loess exposures great care was exercised in collecting the fossils. Some specimens of every species in the list of fossils, with the exception of *Pupoides marginatus*, were obtained by digging in undoubted undisturbed loess. Plate IV. shows one of these excavations at the right. In some cases additional specimens were collected in the loess talus, but their characteristic heavy chalky appearance, the presence of like shells in the undis-

*It is a striking fact that the shell quite uniformly appears heavier in loess fossils than in modern specimens of the same species.

	1	2	3	4	5	6	7	8	9	11	12	13	14	16	17	18	19	21	22	23	25	27	28	32	33	34	Vicksburg	Modern S. bluffs	Modern N. bluffs
Helicina orbiculata Say	19	9	49	....	3	77	32	17	3	212	....	....	....	....	3	....	....	....	....	....	....	....	2	....	....	....	7	3	36
Polygyra fraudulenta Pils	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	13	....	....
Polygyra inflecta (Say) Pils	39	40	32	....	2	36	40	26	2	313	3	2	....	....	7	....	1	....	1	....	....	4	4	2	....	2	12	5	5
Polygyra profunda (Say) Pils	3	6	5	....	2	7	16	32	2	70	4	....	....	....	2	....	2	....	....	....	....	2	1	2	....	1	17	....	....
Polygyra albolabris (Say) Pils	5	5	2	....	1	3	2	8	1	12	....	....	....	....	....	1	....	1	....	....	....	....	....	....	....	....	1	....	....
Polygyra exoleta (Binn.) Pils	9	18	4	....	2	8	11	56	6	58	1	....	1	1	5	....	2	1	1	....	1	6	....	....	1	2	9	1	....
Polygyra palliata (Say) Pils	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	11	....	....
Polygyra obstricta (Say) Pils	4	6	....	....	3	1	10	17	7	42	1	....	....	....	1	....	1	....	....	....	....	....	1	1	....	....	1	....	10
Polygyra elevata (Say) Pils	13	51	32	....	9	42	38	95	16	145	3	....	1	....	21	1	1	....	....	....	....	3	1	1	1	2	....	....	....
Polygyra thyroides bucculenta (Gld.) Pils	2	1		....	....	....		....	....	4	....		....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	8	9
Polygyra stenotrema (Fer.) Pils	15	12	6	....	....	4	11	3	....	87	....	1	....	....	2	....	2	1	4	1	....	2	....	....	....	1	4	8	....
Polygyra hirsuta (Say) Pils	22	18	7	....	....	9	15	6	....	263	5	1	2	1	3	....	2	....	2	....	....	4	....	1	2	3	21	....	....
Polygyra monodon (Rack.) Pils	....	....	1	....	....	....		....	....	....		....	....	....	....	....	....	....	....	....		1	....	....	....	....	....	12	31
Polygyra monodon fraterna (Say) Pils	4	6	6	....	....	10	3	7	....	41	1	....	1	....	1	1	....	....	....	....	....	....	....	1	2	....	7	....	....
Strobilops labyrinthica (Say) Pils	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Pupoides marginatus (Say) Pils. et Van	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....
Bifidaria armifera (Say) Sterki	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Bifidaria contracta (Say) Sterki	....	....	....	....	....	....	....	....	....	25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Bifidaria corticaria (Say) Sterki	....	....	....	....	....	....	....	....	....	16	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Bifidaria curvidens (Gld.) Sterki	2	....	....		....	....	....	....	....	31	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....
Vertigo tridentata Wolf	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....
Cochlicopa lubrica (Mull.)	2	....	2	....	....	....	....	....	....	6	....	....	....	....	2	....	1	....	....	....	....	....	....	....	....	....	1	....	....
Circinaria concava (Say) Pils	21	25	17	1	4	28	18	28	1	114	4	1	....	3	12	2	1	1	2	....	....	....	....	5	2	3	21	1	....
Omphalina kopnodes (Binn.) Pils	3	6	4	....	2	3	5	16	1	28	....	....	....	....	5	2	1	....	....	....	....	1	....	....	....	1	....	....	....
Vitrea hammonis (Strom.) Pils	2	1	....	....	....	1	....	....	....	11	....	....	....	....	....	....	....	....	....	....	....	....	....	....		....	....	1	....
Vitrea indentata (Say) Pils	14	1	....	....	....	....	....	....	....	24	....	....	1	....	....	....	2	....	....	....	....	....	....	....	....	....	3	6	1
Vitrea placentula (Shuttl.) Pils	....	3	2	....	....	....	....	1	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Euconulus fulvus (Drap.) Reinh	....	....	....	....	....		....	....	....	18	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Zonitoides arboreus (Say) Pils	2	....	2	....	....	1	....	1	....	14	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....
Zonitoides minusculus (Binn.) Pils	1	....	3	....	....	....	....	....	....	300	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	4	....
Gastrodonta ligera (Say) Pils	20	17	7	....	1	13	14	16	2	133	2	....	2	....	13	....	1	....	....	....	....	1	1	1	1	1	6	3	....
Gastrodonta multidentata (Binn.) Try	1	....	....	....	....	1	....	....	....	35	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....
Pyramidula alternata (Say) Pils	11	19	11	....	5	25	17	30	5	89	4	....	....	....	6	1	1	4	....	....	....	....	....	1	1	1	....	....	....
Pyramidula alternata costata (Lewis) Clapp	....	....	....	....	....	....		3	....	18	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	28	....	....
Pyramidula perspectiva (Say) Pils	12	16	25	—	....	22	14	4	1	103	1	1	2	....	2	....	2	....	....	....	....	....	....	2	....	1	6	....	....
Helicodiscus lineatus (Say) Morse	2	....	....	....	....	....	....	....	....	23	....		....	....	....	....	....	....	....	....	....	....	....	....	....		1	....	....
Punctum pygmæum (Drap.) Binn	....	1	....	....	....	....	....	....	....	124	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sphyradium edentulum (Drap.) Sterki	....	5	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Succinea ovalis Say	3	5	3	....	....	2	1	4	....	12	....	....	....	....	3	1	....	....	2	....	....	....	....	....	....	....	....	....	....
Succinea avara Say	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Carychium exile H. C. Lea	....	....	....	....	....	....	....	....	....	33	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Snail-eggs, 3mm. in diam	1	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Snail-eggs, 1.5mm. in diam	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

turbed loess above the talus, and the absence of modern shells of the same species from the immediate vicinity of the particular exposures from which the shells were obtained, leave no doubt that they too are true loess fossils. The single specimen of *Pupoides* was collected in such talus, but its appearance is that of a loess fossil. Moreover, the species occurs in the loess elsewhere. It is therefore here included as a fossil.

In some cases the fossil shells were imbedded in large limestone nodules, and occasionally small nodules form partial casts of the shells. Some are shown in Plate V. Fossils were collected from twenty-six exposures at Natchez, and from a cut along the Vicksburg and Meridian Railway at Vicksburg, and the several locality sets were kept separate. The accompanying table of species gives the number of fossils of each species collected from each exposure,* thus giving a comprehensive view of the distribution and relative abundance of the several species. In making comparisons, however, it must be borne in mind that the several exposures are not of equal extent, nor are they even relatively equally fossiliferous. Eight of the larger exposures† proved to be non-fossiliferous. Exposures 1, 2, 3 and 4, are really in the same large cut, and exposures 5 and 6 are likewise opposite sides of one cut, while on the other hand No. 11 is a more or less broken series of exposures around the great "gulf," shown on the map, just south of Natchez. It is especially fossiliferous on the south and east sides of the "gulf."

Numbers 1, 2, 3, 6, 7, 8, 9, 11 and 17, are the most extensive of the fossiliferous exposures, and relatively the richest. They are all located in the southwestern part of the area under discussion.

Exposures 19 to 26, inclusive, along the Liberty road, are mostly smaller cuts and "guts" along a wagon road, and are not to be compared with the large exposures mentioned.

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*The Natchez exposures are numbered, the number at the top of each column corresponding to the number on the map. No fossils were found in the exposures not included in the table.

†Compare map and table of fossils.

The number of modern shells of each species found at Natchez is given in the last two columns of the table. In order that some conception of the peculiarity of the local distribution of modern shells may be gained, the collections made on the bluffs toward the north are listed separately from those which were taken on the hills southwest of Natchez. The grouping of the fossils of the species in the loess is singularly like that of modern shells on the surface.

The modern shells were all collected on higher slopes. No collections were made on the Mississippi bottom lands.

Polygyra clausa should be added to the list of Natchez fossils on the authority of Binney.

It will be noticed that all the species of the accompanying table are terrestrial, and all are now found living either on the hills in the immediate vicinity, or in similar situations in other parts of the south. The fossil molluscan fauna of Natchez resembles the modern fauna of the southern spurs of the Cumberland mountains in northern Alabama and Georgia, so far as terrestrial forms are concerned only, for it contains no aquatic species. It therefore presents a distinctly southern facies. It belongs to the fauna of the interior region of the eastern province of Binney,* and with the possible exception of *Vertigo tridentata* and *Sphyradium edentulum*, all its species are now found living in the southern part of that region, within the limits of which Natchez is located. The distribution of *Vertigo tridentata* has not yet been satisfactorily determined, partly because the species is often overlooked on account of its small size, and partly because it has commonly been confused with other species. It has, however, not yet been reported south of the Ohio river. *Sphyradium edentulum*, which now seems to be restricted to the northern region, is a common fossil in the loess of the upper Mississippi drainage, and was evidently once much more widely distributed. It is also a species rather easily overlooked on account of its small size, though it is more readily recognized than the preceding species.

*Terr. Air-Br. Moll., vol. V, pp. 26-34.

Not only do so many of these species occur in the southern part of the Interior Region, but several are restricted to it. Such are *Helicina orbiculata*, *Polygyra stenotrema*, *Polygyra thyroides bucculenta*, *Omphalina kopnodes*, *Vitrea placentula* and *Pyramidula alternata costata*. *Polygyra obstricta* and *P. inflecta*, whose northern range is but little greater, may also be added to this list. The predominance of the larger species of land shells* is also characteristically southern, the Natchez fauna approaching that of the Cumberland subregion. Moreover, the small form of *Polygyra hirsuta*, the *Polygyra monodon* with nearly closed umbilicus, and the large form of *Circinaria concava*, all suggest a southern origin, the fossils being like the predominating corresponding living forms in that section.

Only four species of modern molluscs occurring at Natchez were not found as fossils. They are: *Polygyra espiloca* (Bld.) Binn., *Omphalina lævigata* (Pfr.) Pils., *Gastrodonta gularis* (Say) Try., and *Succinea grosvenorii* Lea. The first three species are restricted to the southern states. *Succinea grosvenorii* is now locally very common northward to South Dakota, especially in the country bordering the Missouri. Its center of distribution is far north of Natchez, and its southern extension may be of comparatively recent date. The species is very common in the northern loess along the Missouri river.

The Natchez fossils bear out the writer's oft-repeated statement that the loess fossils of any given region are practically identical with the modern molluscan fauna of the same region.† Indeed, they furnish the most convincing proof of this interesting and important fact which has yet been presented. The most characteristic and widely distributed species of the north-

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*See Plate VI.

†Bull. Nat. Hist. St. Univ. Iowa, vol. I, p. 213.—1890.
Proc. Ia. Acad. Sci., vol. III, p. 84.—1896.
Proc. Ia. Acad. Sci., vol. V, p. 41.—1898.
Proc. Ia. Acad. Sci., vol. VI, p. 99.—1899.
Jour. Geol., vol. VII, p. 132.—1899.

ern loess, such as *Helicina occulta*, *Succinea grosvenorii*, *Pyramidula striatella*, *Vallonia gracilicosta*, *Polygyra multilineata* and *Pupa muscorum*, are wholly absent from the southern loess, as, with the exception of *S. grosvenorii*, they are from the modern fauna of that region, while *Succinea avara*, so common in the north, and so frequent there as a fossil, is very rare in both the fossil and modern faunas of Natchez.

More than one-half the species in the Natchez list of fossils have also been found in the northern loess, while the following eighteen species are thus far known only from the loess of the south:

Helicina orbiculata	*Omphalina kopnodes*
Polygyra fraudulenta	*Vitrea placentula*
" *inflecta*	*Gastrodonta ligera*
" *albolabris*	" *multidentata*
" *exoleta*	*Pyramidula alternata costata*
" *palliata*	*Punctum pygmæum*
" *obstricta*	*Strobilops labyranthica* (probably*)
" *elevata*	
" *thyroides bucculenta*	
" *stenotrema*	

Polygyra albolabris and *Punctum pygmæum* are the only species in this list which, judging from present distribution, are likely to be found in the northern loess. The remaining twenty-four of the species listed in the table of fossils have all been found more or less abundantly in northern loess.

Several additional points of interest are presented by some of the Natchez fossils. Only two of the shells of *Polygyra thyroides bucculenta* have the parietal tooth. The remaining edentate specimens somewhat simulate *P. clausa*, but they are less elevated, and not so heavy nor so coarsely striate as the shells of that species. The parietal tooth is easily broken off in the fossils of this and other species, and in identifying fossil species, too much importance must not be attached to its absence.

The fossil *Polygyra hirsuta* is the small form, approaching

*The *S. labyrinthica* of the earlier reports on northern loess fossils is probably all *S. virgo*.

maxillatum, which is the common form in the south. *Polygyra monodon* is the form usually named *leai*, and *P. monodon fraterna* is the form generally known as typical *monodon*.*

The modern shells and the two fossils are of the *leai* type, but have a smaller umbilicus than the northern form. Most of the fossils are of the larger *fraterna* type. It was at first thought by the writer that the fossil shells of *Gastrodonta multidentata* might be *G. lamellidens* Pilsbry†, but a careful examination of the teeth shows that the fossils are without doubt *G. multidentata*. Modern *G. multidentata* is reported from southeastern Tennessee by Ferris.‡

Fossil *Pyramidula alternata* and var. *costata* are not always sharply distinguishable, but the specimens listed as *costata* all show more or less clearly the coarse ribs which characterize this southern variety.

Succinea ovalis Say is the species well known as *S. obliqua*.§ The snails' eggs could not be identified, but they are undoubtedly eggs of land snails. Two species were collected.

The Natchez loess is of special interest because it furnishes particularly weighty arguments against both the aqueous and glacial theories of the origin of the loess. That this loess is not of aqueous origin is shown by its fossils, which are terrestrial upland species, and by its distribution over a high ridge, higher than the surrounding country for many miles around. A body of water sufficient to cover this ridge would form an inland sea, with land on which the molluscs might develop so remote from present Natchez hill that it would have been necessary to transport them a great distance by water. That it is extremely improbable that the shells of the loess at any point have been transported any considerable distance by water

*On authority of Pilsbry.—Proc. Acad. Nat. Sci. Phil. for 1900, pp. 454–5.

†See Nautilus, vol. XI, p. 134.

‡Nautilus, vol. XIV, p. 58.—1900.

§See The Mollusca of Chicago Area, Frank C. Baker, in Bull. Chicago Acad. Sci., No. III, pt. 2.

has already been shown by the writer.* That those of Natchez have not been so carried seems to be established beyond a doubt by the following facts:

1. At Natchez several shells of *Helicina orbiculata* were found with the operculum lying within the aperture, a position which it could not occupy if the shell-bearing animal had been deposited in water, for it becomes detached immediately after decay has set in, and would be carried away. Modern upland dead specimens are frequently found with the operculum lying within the shell.

2. The extremely delicate shells of snails' eggs are preserved in the loess. They are so frail that they would scarcely stand transportation by water.

3. The larger perfect fossil snails uniformly have the spire of the shell empty, no clay having been carried into the shell beyond the body-whorl, as would have been the case in drifting and finally submersed shells.

4. The fact that the local fossil and modern faunas are very similar, has already been emphasized, and further indicates that transportation of shells from a distance has not taken place.

5. There are no traces of beaches, shore-lines, etc., such as would be left by a large body of water such as this theory postulates, nor does the remarkable homogeneity of the deposit taken together with its distribution suggest the possibility of deposition in flooded streams.

That the Natchez loess was not deposited by glaciers or icebergs is, if possible, even more evident. Natchez lies far south of the limits of glaciation, hence floating icebergs only need to be considered. Icebergs, however, would require a great body of water to float them over Natchez hill, and the objections to this have already been considered. Moreover, the fossils of the Natchez loess are, as shown herein, in large part

* Proc. Ia. Acad. Sci., vol. V. pp. 40-41.-1898.

such species as inhabit the warmer parts of our country today, and there is nothing in the molluscan fauna of this loess which would suggest even the remotest possibility of a glacial climate.

It appears that the aeolian theory offers the best explanation of the origin of the loess not only of Natchez, but of all the Mississippi drainage. The writer's first paper in which a modified form of the aeolian theory was presented,* was based almost wholly on the study of fossils, and subsequent investigations, geological, paleontological and botanical (for the loess presents an interesting problem to the plant ecologist, and the influence of plants on the formation of the deposit seems to be great), have only served to emphasize in the main the conclusions therein presented, though perhaps modifying them in some details. The chief purpose of the subsequent papers† was rather the demonstration of the impracticability and impossibility of the generally accepted theories which postulated aquatic and glacial conditions.

While it is not purposed here to enter upon a detailed discussion of the positive evidence in favor of the aeolian theory, this being reserved for a more extended paper on that subject, certain considerations which have a direct bearing upon loess in general, and upon that of the southern Mississippi valley in particular, are here presented together with the writer's conception of the origin of the loess.

To make the formation of such a deposit as the loess possible it is necessary to have: 1) A source of supply of material at hand; 2) an agency capable of transporting the material; and 3) a lodging place upon which it may be safely anchored. Where any of these conditions fail there can be no deposition

*A Theory of the Loess.—Proc. Ia. Acad. Sci., vol. III, pp. 82–89. —1896.

†Proc. Ia. Acad. Sci., vol. V, pp. 32–45, 1898; vol. VI, pp. 98–113, 1899; vol. VII, pp. 47–59, 1900.

Journal of Geology, vol. VII, Mch., 1899.

Bull. Lab. Nat. Hist. St. Univ. of Iowa, vol. V, pp. 195-212, May, 1901.

of material, and no loess will be formed; where these conditions are best developed, there the deposit will be thickest. It has long ago been observed that the loess is best developed along our larger river-courses, and it is there that these conditions are all most likely to be presented. A more detailed reference to these conditions may be of interest:

1. *The source of supply.*—It is quite generally conceded that the finely comminuted particles which make up the loess originated primarily in the drift. In the north it was loosened and sifted out from the coarser material by rain, by wind, by burrowing worms, insects, mammals, etc., and by scratching birds, and to some extent by growing plants, while its volume was increased by the chemical decomposition and disintegration of the coarser materials thus exposed.*

Some of this material was washed into the streams, and some of it was (and is) blown about by the winds. In the southern Mississippi valley, where there is no glacial drift and yet an abundance of loess, the material of the loess was probably all brought down by the great river, and chiefly by its Missouri branch. During the summer months our streams reach their lowest levels. Great bars of sand and mud are thereby exposed to the dessicating influence of sun and wind. During the summer, too, strong winds sweep along their valleys and gather up the fine material so exposed.†

With it is also mingled more or less of the finer material gathered by the winds directly from higher grounds, and perhaps with calcareous particles from fluviatile shells where present in the streams, but the main supply in the south and perhaps in large part elsewhere where loess was formed, was obtained from the bars of the stream.

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*That finer material is thus removed and the coarse material so concentrated near the surface has already been observed. See Proc. Ia. Acad. Sci., vol. IV, p. 70, 1897; etc.

† For discussion of the probable amount of this material see Jour. Geol., vol. VII, p. 135.—1899; or Proc. Ia. Acad, Sci., vol. VI, pp. 109 and 110.—1899.

2. *The agency.*—The objections to water and ice as agencies of transportation have already been briefly stated. Wind does carry large quantities of material, and in the loess regions winds are strong and frequent during the summer season when the soils are loose and easily eroded. Moreover, the general southerly course of the larger streams in the Mississippi valley, along which most of the loess is deposited, favors the concentration of the prevailing southerly winds in the troughs of the valleys, through which they crowd with increased force, and dislodge the fine particles of detritus brought down by the streams and exposed in bars. In the north drifting snows, especially in the Missouri river region, also gather up and carry great quantities of dust.

3.—*The anchorage.*—The material so gathered up must be deposited in a place from which it cannot easily be dislodged by erosion if it is to add to the sum-total of the deposit. It is a well known fact that plants check or prevent erosion. The more luxuriant the vegetation the less erosion is produced by rainstorms. The most violent rainstorms will scarcely disturb the finest leaf-mould even on very steep slopes in the woods, while they wash out great quantities of material in more open country. Vegetation, and especially forest vegetation, is best developed along the streams.

It will thus be seen, that these three favorable conditions, while not restricted to streams, are yet best developed adjacent to them, and could accomplish more than would be possible at more remote points. That this is true appears also from the evidence of the snail fauna. The loess is thickest, and also most fossiliferous, in close proximity to streams, and near them, too, modern land-snails are most abundant. The fact that fossils are more abundant near streams than they are in more remote regions, does not indicate a difference in the origin of the respective deposits,* but merely further shows that torrestrial conditions along streams, even on high grounds

*See Hershey's article in Am. Geol., vol. XXV, pp. 369-374.—1900.

favor the development of snails. The reason that snails are not found fossil in the loess remote from streams is that when living, they do not, to any extent, inhabit such places.

Time.—The element of time is also to be taken into account. It might seem that, if loess was deposited most abundantly where vegetation was comparatively vigorous, there ought to be an abundance of plant remains in the deposit. The rate of deposition, however, must have been so slow that all organic matter would have disintegrated long before it could have been covered and sealed in the deposit. Organic remains can thus be preserved only when overwhelmed, especially in wet places, and their absence would rather militate against the aqueous theory. If the rate of net deposition, after deducting loss by erosion, already estimated by the writer,* namely, 1 mm. per year, be accepted, it is evident that a stick or log, or even a leaf, would decay long before it could be entombed in the deposit. At that rate a log one foot in diameter, for example, would require more than three hundred years for burial. The shells of molluscs do not similarly disintegrate, and are preserved as fossils, partly because of their composition and texture which better enable them to resist exposure, and partly because all of these terrestrial snails are more or less inclined to burrow, or at least conceal themselves in the lowest strata of leaf-mould, etc., and their shells are soon covered up.† In many respects the borders of of the drift-sheets in the north, especially where morainic, presented conditions similar to those now existing along the larger streams. This question, however, does not concern the loess of Natchez and Vicksburg, and will be discussed at another time.

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*Jour. Geol., vol. VII, p. 135, and Proc. Ia. Acad. Sci., vol. VI, pp. 109 and 110.

†To collect some of our smaller species of modern snails which are also represented in the loess, in autumn or during dry summers, it is necessary to pull up the roots of smaller plants among which many of the snails are concealed.

Whatsoever may be the difference of opinion concerning the soundness of the foregoing conclusions, the loess of Natchez materially reinforces the evidence against the possibility of the aqueous origin of the loess, and practically renders the theory of glacial origin untenable.

The writer desires here to express his obligations to President Fish of the Illinois Central R. R. and Prof. Samuel Calvin of the Iowa Geological Survey, whose kindly courtesy made the preparation and public ition of this paper possible.

Since the publication of the foregoing paper the writer has obtained other papers on southern loess, in which references to fresh-water shells are made.

The earliest of these is by Dr. Amos Binney,* who discussed the loess of Natchez as follows:†

"It is made up of nearly parallel strata of calcareous loam, clays, sands and gravels, which contain in the different layers, besides inorganic substances, great numbers of terrestrial, and some fluviatile, shells, remains of mammalia, and numerous water-worn, agatized pebbles, imbedding corals, madrepores, encrinites, and marine shells. The most remarkable portion of the formation is the upper bed, or that next below the soil of the surface. It consists of a yellowish calcareous loam, thickly filled in many places with terrestrial shells, and in others, with a few fluviatile species. The depth or thickness of this bed is described to be from twenty to fifty feet. Below the loam is a bed of light ash-colored marl, containing fluviatile shells, and having a thickness of from five to ten feet; this with only an intervening stratum of fine gravel, is succeeded by a bed of sandy loam, from twenty to thirty feet in thickness, containing bones of the mastodon."

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*Proc. Boston Soc. of Nat. Hist., vol. II, pp. 126–130; read April 1, 1846, published in July, 1846.

†Pp. 126–7, 1 c.

The first of the quoted statements shows clearly that Dr. A. Binney's information concerning the limits of loess, evidently obtained at second-hand, was very much confused. The description of the deposit, probably furnished to Dr. Binney by Mr. John Bartlett who collected the shells, shows that there was here an indiscriminate reference of practically all the looser superficial deposits to the loess, probably including even tertiary.*

Evidently only the uppermost "yellowish calcareous loam" is loess, and even a portion of this may be brown loam. From this part of the deposit "a few fluviatile species" are reported, together with many terrestrial shells. None of these "fluviatile shells" are mentioned by name. Not only is there doubt as to the exact character of the deposit from which they came, but Dr. Binney's use of the term "fluviatile" was not exact. This is shown in a discussion of the Wabash deposit, probably loess, written at about the same time as the paper on the Natchez loess, or a little earlier,† in which he says that it "contains, in vast numbers, terrestrial and fluviatile shells," and in a foot-note on the same page he enumerates the land shells (ten species), and adds that these occur "together with several species of *Limnea*, *Planorbis*, *Amnicola*, *Valvata*." As these are the only aquatic shells mentioned he evidently considered them fluviatile. *Limnæa* and *Planorbis* are pulmonate pond-snails which occur commonly in small ponds. *Valvata*, while sometimes found in larger streams and lakes, often occurs in small ponds, and the same is true of *Amnicola*, though the shell here referred to may be *Pomatiopsis lapidaria*, a terrestrial species, which was then included in *Amnicola*. The aquatic shells here mentioned indicate, both by their scarcity and their habits, that the bodies of water in which they occurred were individually and collectively of slight extent.

*See Wailes, l. c., pp. 269 et seq., for discussion of the deposits in which the marine forms mentioned by Binney occur.

†Terr. Air-breathing Moll. of the U. S., vol. I, p. 181, written by Dr. Binney prior to 1847, the year of his death, but published under the editorship of A. A. Gould in 1851.

Even if such shells had been found at Natchez, though there is nowhere any definite record of their occurrence in the loess of that vicinity, they would prove only the existence of a few scattered small ponds, such as are not infrequently found upon loess ridges today.

The description of the deposit containing bones of the mastodon shows also that it was not loess. It is probably the same as the deposit containing mammalian remains described by Lyell and Wailes. It was probably a deposit of mud formed in marshes on the pre-loessial surface.

Dr. A. Binney's paper gives the first* specific report of fossils from the southern loess, and contains only terrestrial forms. The list follows:†

Helix albolabris	*Helix inflecta*
" *alternata*	" *ligerus*
" *concava*	" *monodon*
" *elevata*	" *palliata*
" *exoleta*	" *perspectiva*
" *gularis*	" *profunda*
" *hirsuta*	" *thyroidus*
" *inornata*	*Helicina orbiculata*

Succinea obliqua

It will be observed that this list is nearly identical with that published by W. G. Binney,‡ lacking but three speccies of that list, and containing in addition *Helix inornata* and *Helicina orbiculata*. All the species in this list but two were collected by the writer at Natchez. The two exceptions are *Helix gularis* and *Helix inornata*. The former has been noted on p. 308, and the latter (*Omphalina inornata* (Say) Pils.) is closely related to *Omphalina fuliginosa* and *O. kopnodes* (see p. 308), and may have been confused with the latter. It is, however, a southern shell, and its presence in the loess of the region would not in any way affect the argument herein presented.

*This is a correction of the statement made on p. 306 of this Bulletin.

†For correction of generic names see pp. 307 and 308 of this Bulletin.

‡See p. 307 of this Bulletin.

In addition to the references already given to Lyell's works, there should be mentioned the several editions of his Principles of Geology, beginning with the ninth, and of the Manual of Elementary Geology following the third(?). In these so far as noted (a few were not available) there are references to land and freshwater shells, and to bones of mammals, in the loess of the lower Mississippi valley, similar to those already noted in the previous citations of Lyell's works. They are evidently based on the same observations.

The list of fossils quoted from Wailes' first report* is given on p. 283 of that report. Another list appears on p. 339, in which three species of the first list are wanting, namely: *Helix alternata*, *H. fraterna*, and *H. tridentata*, while three additional species are enumerated, namely: *Helix palliata*, *H. sayi*, and *H. helicina*. The first of these was found by both W. G. Binney and the writer. The second, *Helix* (now *Polygyra*) *sayi* is closely related to *P. albolabris*, and it is very probable that large forms of the latter species were mistaken for it. Like all the shells of Wailes' lists it is terrestrial, and belongs to the modern southern fauna. Hence, even if the identification was correct, it does not affect the status of the case. *Helix helicina* of this list is *Helicina orbiculata*, a common southern loess fossil.

Another probable source of subsequently repeated errors is Humphreys and Abbot's Report.†

Speaking of the bluffs between Vicksburg and Baton Rouge the authors say: "They are composed of loess, a post-pliocene formation, similar to that of the Rhine . . . . That of Vicksburg . . . . is 300 feet high, and underlain near low-water mark by a solid stratum of blue clay . . . Above the latter is a stratum containing many marine shells and corals. Next are deposits of yellow loam and sand containing vast numbers

* See p. 306 of this Bulletin.

† Report on the Physics and Hydraulics of the Mississippi River, by Capt. A. A. Humphreys and Lieut. H. L. Abbot, no. 4, Professional Papers of the Corps of Topographical Engineers, U. S. Army,—1861; p. 95.

of fresh-water shells . . . The Natchez bluff is about 150 feet in height. The lower part is composed of gravel and sand, containing many corals and other fossils. Next comes a stratum of clay, rich in fossils of large extinct species of quadrupeds. The top is made up of yellow loam, sand, and clay, also fossiliferous."

Here again the authors included various deposits under one name. Evidently only the uppermost portion is loess. If the "yellow loam" of Vicksburg is loess, as seems probable, the statement that it contains "vast numbers of fresh-water shells" is a myth, and the authors evidently knew nothing of the habits of these snails. Of a similar nature is Foster's statement* that the shells of the loess "are all of fresh-water origin." Foster subsequently,† however, speaking of the southern loess, says: "The Tertiary beds are of marine origin, while those of the loess are of fresh-water, and contain numerous shells, all of which are of terrestrial origin."

On p. 61 of the same work Foster also discusses the reported occurrence of human remains in the Natchez loess, with this conclusion: "The probabilities are a hundred to one, that this bone was not of Bluff formation."‡

Dr. A. Binney's, and Humphreys and Abbot's reports of marine fossils from the loess are probably referred to by Hilgard§ when, discussing the Natchez Bluff, he says that "marine shells have also been reported as occurring." He, however, adds that there are no fossiliferous marine deposits.

Finally Dana|| speaking of the "Bluff formation" states that "south of New Orleans there are marine shells," evidently confusing the Gnathodon beds with loess.

*J. W. Foster, The Mississippi Valley,—1869; p. 345.

†Prehistoric Races of the U. S. of America,—1873; p. 59.

‡This bone was also discussed by Lyell in his "Second Visit to America," vol. II, p. 197.

§E. W. Hilgard, On the Geology of Lower Louisiana, Smithson. Contrib. to Knowledge, no. 248,—1872; pp. 3 and 4.

||J. D. Dana, Manual of Geology, 2nd ed.,—1875; pp. 547–8.

Discussing chiefly the loess of the lower Mississippi Dana also says:* "The loess of the Mississippi contains numerous fresh-water shells, among them *Paludina ponderosa* Say, *Melania canaliculata* Say, *Cyclas rivularis* Say, *Cyclostoma lapidaria* Say, *Physa heterostropha* Say, *Limnæa elongata* Say, *Planorbis bicarinatus* Say, *Valvata tricarinata* Say, *Unios*, etc."

The first three species of this list, and the Unios, are fluviatile, *Cyclostoma* (=*Pomatiopsis*) *lapidaria* is terrestrial, and the remaining species are chiefly pond snails. Evidently these shells came from the deposit below loess, noted on p. 304 and referred by Wailes† to Lake Marl, which he properly recognized as distinct from the loess.

These additional citations add nothing to the weight of the testimony concerning the occurrence of fluviatile shells in the loess. They only show additional sources of the errors which have been thus transmitted to those who have not investigated the details of the case for themselves in the field.

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*P. 548, l. c.

†Pp. 231 and 283, l. c.

THE LOESS AND THE LANSING MAN.

The discovery of certain human remains near Lansing, Kansas, has provoked much discussion* which reveals a difference of opinion as to the value of the discovery. The writer has nothing to contribute directly to the facts concerning the Lansing remains, as his knowledge of them and their environment was gained at second hand.† But an effort has been made to correlate the Lansing skeletons with the formation of a supposed loess horizon,†† and the theory of the glacio-fluviatile origin of the loess has been resurrected to form the basis of an estimate of their age. It is to this that the writer desires to give attention.

Notwithstanding the fact that many trained geologists have in recent years been engaged in field work in the loess-covered regions of the Mississippi valley, no material facts have been added in a dozen years past to the support of the fluviatile theory, which was formerly generally maintained in this country in various modified forms. The recent arguments in its support are not based on additional observations and field investigations, but are specifically founded‡ upon the great works of Chamberlin and Salisbury on "The Driftless Area of

*S. W. Williston, Science, vol. xvi, pp. 195-6, Aug. 1, 1902. Warren Upham, Science, vol. XVI, pp. 355-6, Aug. 29, 1902; Am. Geologist, vol. XXX, pp. 135-150; Sept., 1902. N. H. Winchell, Am. Geologist, vol. XXX, pp. 189-194; Sept., 1902. T. C. Chamberlin, S. Calvin, and R. D. Salisbury, Jour. of Geol., vol. X., pp. 745, et seq., Nov., 1902. Warren Upham, Am. Geol., vol. XXXI, pp. 25-34, Jan., 1903. N. H. Winchell, Bull. Geol. Soc. of Am., vol. 14, pp. 133-152, Apr., 1903; Am. Geol., vol. xxxi, pp. 263-308, May, 1903, etc.

†See additional notes at the close of this article.

††Warren Upham, Science, l. c.; Am. Geol., vol. xxx, p. 143, etc.; vol. xxxi, pp. 25-34. N. H. Winchell, Bull. Geol. Soc. of Am., vol. xiv, p. 141; Am. Geol., vol. xxxi, p. 268, etc., May, 1903.

‡See Amer. Geol., vol. xxxi, pp. 26-27; 268; 278; etc.

the Mississippi Valley," published in 1885, and that of McGee on "The Pleistocene History of Northeastern Iowa," published in 1891.

The cautious, conservative statements of Chamberlin and Salisbury scarcely warrant the declaration that they "leave no doubt" as to the fluviatile origin of the greater part of the loess. Furthermore, at least one of the authors, Dr. Chamberlin, has materially modified his views concerning the loess since the publication of the work cited.

The splendid work of McGee, like that of Chamberlin and Salisbury a classic in glacial literature, had for its purpose the presentation of fundamental facts and conclusions bearing on glacial phenomena. If we omit loess from the series of deposits discussed therein, the conclusions still remain of great value. It is a fact long established that the loess forms a mantle pretty uniformly covering the underlying deposits of drift, etc., especially in eastern Iowa, and that, therefore, the so-called "loess-topography" is really drift-topography. If the loess could all be removed, the underlying drift would present essentially (though not exactly, especially along the Missouri river,) the topographic features of the present surface. The altitudes of the more broken regions would be relatively less, as the loess is usually thicker in hilly country. Whatever, then, is prominent or striking in the topography of the present surface, was at least approximately equally striking in the post-glacial surface before loess was deposited upon it, and many of the peculiarities in the structure and distribution of these underlying deposits were well elucidated by that author, and are in no wise affected by dissent with the inclusion of the loess.

In justice to Professor McGee it should also be stated that he was misled by erroneous information concerning the fossils of the loess, for his inclusion of the loess among glacial or subglacial deposits was evidently due largely to this fact. Several species which are not only terrestrial, but frequent uplands, had been reported as aquatic or semi-aquatic; other species were incorrectly identified; and in still other cases conclusions concerning the mollusks were unwarranted by the facts.

Some of the earlier reports upon the fossils of the loess were inexcusable. Aughey's list of fossils from the loess of Nebraska* is impossible. No such series of shells was ever obtained in the loess. His method of identification as related by himself** is sufficient to condemn the list as unworthy of serious notice. This list contains a large number of southern fluviatile molluscs, and the author states positively that "fresh-water shells are quite abundant at some horizons." He also states that many of his specimens fell to pieces, and consequently he had no specimens to show! It was the writer's privilege to examine a remnant of Professor Aughey's collection while at Lincoln in 1889-1890, and he found a small set of very ordinary loess fossils of terrestrial species. It is remarkable that the heavy-shelled *Viviparidæ*, *Strepomatidæ* and *Unionidæ* mentioned in the list should have so disintegrated, while the delicate Pupæ, and other fragile forms of the ordinary loess fauna should have been preserved!

Similar to this are the erroneous reports concerning the modern habits of the species of snails found in the loess.

Lyell speaks of the "amphibious genus *Succinea*"† and of the abundance of fresh water and land-shells in the vicinity of Natchez, yet no aquatic shells have been discovered since.‡

Todd§ refers to Succineas and Helicinas as semi aquatic.

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*See Hayden's U. S. Geol. Sur. of Colorado and adjacent territory, 1876, pp. 266-269; also a practical reprint in Sketches of Phys. Geog. and Geol. of Neb., 1880, pp. 287-290.

**See "Sketches of Phys. Geog.," l. c.

†For discussions of Succinea see the writer's recent paper on the Loess of Natchez. Am. Geol., vol. xxx, pp. 283-284.

‡In a recent private letter Dr. Hilgard, for many years a student of the loess in Mississippi, corroborates the writer's recent declaration (l. c. p. 282) that no aquatic species are as yet known from the loess of Natchez.

§Reprint from Proc. A. A. A. S., vol. xxvii, 1878, p. 6.

Call, who alone of this list of writers made a pretense of special knowledge of conchology, reported *Helicina occulta** and *Pomatiopsis lapidaria*† as aquatic, and *Succinea* as semi-aquatic!

But these forms are terrestrial, and a mere tyro who would have taken the trouble to go to the field could have avoided such misstatements. Yet they have been accepted with others quite as unreliable and have been incorporated in geological papers to form the basis of important conclusions. Todd and Call both reported (l. c.) on the depauperated shells of the loess, and concluded that cold was responsible, and these conclusions were relied upon by McGee‡ who used them to support the theory of the sub-glacial origin of the loess. Yet the living fauna of the loess-covered regions shows essentially the same depauperation. The comparisons which Call makes in the paper on the Des Moines loess are based in part, at least, upon measurements of eastern modern shells.§

Had the author taken recent shells from Iowa, especially from the prairie sections, he would have been left practically without support for his conclusions.||

The causes which produced a "depauperation" of some of the shells are in operation today in Iowa and adjacent territory, for practically all of the fossil cases may be duplicated in the modern fauna.

Another source of error of a more excusable nature in the

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*As Helicina oculata:—Am. Nat. vol. xv, p. 586, 1881. This error concerning habit is copied by McGee, l. c. p. 461, in a statement at the close of a list of fossils quoted from the present writer. There was no warrant for such a statement in the article quoted.

†Am. Nat., l. c., Ark. Geol. Sur., vol. ii, pp. 166, 167, 168, 1891; The Löss and Associated Deposits of Des Moines, p. 16, 1882.

‡See Löss and Associated Deposits of Des Moines, p. 23, et seq.

§The present writer, then a college student, made the drawings for the plate which illustrates that paper.

||For discussion of depauperation of shells by the present writer see; Proc. Ia. Acad. of Sci., vol. iii, p. 85, 1896; vol. v, pp. 43-4, 1897: vol. vi, p. 101, 1899; Jour. Geol., vol. vii, pp. 126, 127, 1899.

reports on fossils is to be found in misconception of species and incorrect identification. For example, what was generally reported as *Vallonia pulchella* from the loess is *Vallonia gracilicosta*, a northwesterly upland species; under fossil *Succinea obliqua* were included two, possibly three species; *Carychium exiguum* (reported as semi-aquatic by Call, in paper on Des Moines loess, l. c., p. 16!) has not been found in the loess, the fossil species being *C. exile*, a decidedly upland species ; the form commonly reported by earlier writers as *Pupa blandi* is *Bifidaria pentodon* (though *P. blandi* occurs in the loess), and possibly a *Vertigo;* and other instances might be cited showing that species were not clearly recognized by conchologists, and in consequence comparisons of fossil shells were sometimes made with recent shells of different species. Manifestly conclusions drawn from such comparisons are valueless.

Both Drs. Chamberlin and Salisbury, and Professor McGee, relied upon such information and were misled by it. The aquatic shells of the loess are relatively very few, and all of that type which inhabit small ponds. There is not a single well authenticated species of fluviatile molluscs known from clearly undisturbed loess in this country! And yet reference is constantly made to the few paltry pond snails, coupled with vague references to "semi-aquatic" forms, while the vastly greater number of truly terrestrial and upland species is made subordinate!

The writer thus refers to these details at some length to show that the supposed information upon which these eminent authors based their conclusions, at least in large part, was erroneous, and that consequently the conclusions themselves cannot be entirely correct. Mere reference to these conclusions, therefore, does not settle the case. Both the great works cited represent the results of pioneer efforts, and were not primarily concerned with the origin of loess, that question being largely incidental. With this prop removed there remains nothing but generalities for the support of the recent revival of the glacio-fluviatile theory.

In this connection the writer desires to refer at some length to certain statements made by Professor Winchell* concerning the Unio which was found in the Lansing deposit. In order that there may be no misunderstanding concerning these statements they are here reproduced in full:

"In case the Unio were a true fossil, it would be, of itself, sufficient proof of the subaqueous deposition of the materials in which it lay. Land shells may form fossils in aqueous deposits, but never water shells in land deposits. It is, a priori, however, the strongest evidence of sub-aqueous origin of the loess in which it was found, ...and the agreement which it has with obvious other features of the deposit serves to accumulate such a weight of testimony in the same direction that it requires the greatest hardihood to attempt to explain it on the hypothesis of land origin of the deposit."

The same author had previously† made the following statement:

"Many land forms may exist in an aquatic formation but the *existence of a single aquatic fossil species in the loess requires the presence of water.* Many have been identified by good authorities."

In face of the foregoing statements it may be an exhibition of greatest hardihood to venture to still maintain the ground that the loess is of land origin, and that as evidence of the sub-aqueous origin of the loess the Lansing Unio is worthless, but regard for scientific truth makes the exhibition imperative.

Granting for the sake of argument that the Lansing deposit is true loess,—though the difference of opinion among those who have examined it makes this extremely doubtful,‡—if it can be shown that aquatic shells of the fluviatile types, or at least, types of aquatic shells other than such as inhabit

*Am. Geol., vol. xxxi, p. 282.

†Bull. Geol. Soc. of Am., vol. 14, p. 145, April, 1903.

‡See discussion of the Lansing deposit in the following paper.

insignificant pools and ponds, are extremely rare, if occurring at all in the loess; and if it can be demonstrated that fresh-water shells are sometimes transported to higher points by agencies other than floods; then the dogmatic statements quoted above fall of their own weight.

The present writer has repeatedly called attention to the absence of fluviatile shells from the loess,* giving in each case specific detailed lists. He here takes the liberty to state that he has searched for loess fossils north and south for nearly a quarter of a century; that starting out as a believer in the water theory of loess deposition he diligently sought aquatic forms, and for many years would have welcomed them with the same avidity with which the advocates of the theory have pounced upon the Lansing Unio; that after the conviction was forced upon him, against his earlier views, that the loess was not of aqueous origin, he equally carefully collected and preserved all fossil shells of aquatic species;—and the result of these efforts has been that no fluviatile shells were found in undoubted loess, the aquatic species, comparatively insignificant in number, being all such as are known to conchologists as pond-shells. The same species occur today all over the loess territory in small bodies of water,—creeks and ponds,—which may remain dry during many weeks, or even months, each year. This negative evidence is not conclusive excepting as to one point, namely: that fluviatile shells are extremely rare, if not wholly wanting, in the loess.† That modern fluviatile shells may occasionally be transported to

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*Proc. Iowa Acad. Sci., vol. v. pp. 32-45, 1898; vol. vi, pp. 98-113, 1899; Jour. Geol., vol. vii, March, 1899; Bull. Lab. Nat. Hist. State Univ. of Iowa, vol. v, pp. 195-216, 1901, (reprint Am. Geol., Dec., 1901); Am. Geol., vol. xxx, pp. 280-298, 1902.

†The writer has collected a few fluviatile Unios at Sioux City and Hamburg, Iowa, in a loess-like deposit, probably washed loess, lying far below the adjacent typical bluff loess, where high water might have reached it. Dr. Bain reports Unios from a deposit in Plymouth county, Iowa, which he does not consider true loess. See Iowa Geol. Sur., vol. viii, p. 340.

higher grounds without floods has also been shown by the writer.*

The following specific references may be added: Several years ago the writer saw a crow picking at a small fresh Unio on a timbered river-bluff not less than fifty feet above the river, near the state quarries north of Iowa City. The Unio was on the ground and was probably brought up from the river, then at a low stage, by the crow.

About twenty-two years ago, while engaged in zoological work as a college student, the writer shot a solitary sandpiper one of the toes of which was clasped by a living *Sphærium transversum*, a small aquatic bivalve. This might easily have been dropped on high ground in one of the longer flights of the bird.

Three years ago the writer found a medium-sized shell of *Campeloma subsolidum* on a rocky, almost inaccessible slope below the University observatory at Iowa City, at a point not less than forty feet above the river. The shell, though dead, still retained its epidermis. *Campeloma subsolidum* lives abundantly in the river, and at low water is often exposed on the sand-bars near this bluff, from which blue-jays or other birds could have easily carried it for food while it still contained the soft parts.

In view of these facts, and of the numerous possibilities suggested by them, it is extremely rash to say that "the existence of a single aquatic fossil species in the loess requires the presence of water," for such shells as those which have been mentioned could be covered by dust, and in time become fossils in a land-deposit. Manifestly, this "strongest evidence of the subaqueous origin of the loess" is very weak and unsatisfactory.

The advocates of the aqueous theory can find little solace in the fossils of the loess, and without them their case has but little tangible support.

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*Proc. Ia. Acad. Sci., vol. v, p. 37, 1898.

In the papers cited it is assumed:

1. That there "were widely extended depressions of our vast glacial area,"—and that in these depressions loess was deposited in water, and by subsequent elevation was brought to the present level.

2. That the streams flowed in ice-walled channels, and the swollen rivers were uplifted on them to hights of 150 to 250 feet above their present beds, and that the floods of these rivers deposited loess in successive layers.

3. That the valleys were filled with loess and subsequently eroded, so that the loess now represents only a remnant which remained after extensive erosion.

4. That the loess was deposited wholly (or at least in greater part) during the Iowan stage of glaciation.

5. Since the evidence of æolian origin cannot be wholly set aside, it is assumed that there is an "upland loess" of æolian origin, but that a "valley loess" owes its origin to fluviatile agencies.

6. Professor Winchell, (l. c.) especially maintains that there is no satisfactory distinction between the loess and the drift.

The first of these assumptions has been made repeatedly simply to meet an emergency. There is no direct evidence that such movements have taken place in more recent time. There is evidence in other parts of the world that slight movements do take place, but nothing has thus far been produced in the area under discussion, other than the assumption which is essential to a theory of the formation of the loess. Such depression would result in the formation of large bodies of water. Where are the shore-lines or other evidences of the existence of such bodies of water?

The second assumption is based on McGee's explanation of the formation of the river-valleys along the highest ridges, which, while applying to the underlying drift cannot be extended to the loess. The ice-walled channels would call for climatic conditions which are impossible in view of the fossil fauna of the loess, and the vegetation which was necessary to maintain it. To show the possibility of the existence of plants, etc., even in close proximity to perennial ice, attention has been called to the fact that in alpine regions trees and other plants sometimes grow on masses of earth which were carried over glaciers by land slides. The conditions in the glacier-covered Mississippi valley, however, must have been entirely different. If the glacial mass was so thin and in a climate so warm that it melted away during each season to expose the necessary land surfaces, then there could have been no steady advance of the ice-mass by which enormous quantities of material were carried hundreds of miles from the northern ledges of rock to which they can be traced. If on the other hand the greater part of the ice-mass persisted year after year, the climate must have been such that snails of the species which we find in the loess, and the plants which they required for food, could not have existed. Glaciers in mountainous regions are not to be compared with such a mass, and do not necessarily indicate a cold climate. A difference of a few feet in altitude, or the protection offered by a sheltered valley or ravine, may be sufficient to preserve a small glacier even in a climate in which plants may grow abundantly. The writer has seen a profuse mass of summer flowering plants growing against the side of an ice-house within two feet of a great mass of ice! But imagine plants and snails growing in such a region as is pictured by McGee in pl. LX, p. 575 of his great report!

The third assumption is untenable. It would be remarkable indeed if over the greater part of the loess-covered region the assumed loess-silt originally filling the valleys should have been removed with such nice exactness that a practically uniform thickness remains, covering the irregularities of the drift surface beneath, on sides and tops of slopes, even on opposite sides of the same ridge, and hence in different drainage areas! Moreover, loess frequently shows a lamination *parallel with the present surface*, and hence not often horizontal. This is especially noticeable in northeastern Iowa, where the loess-sheet thins out, as for example in most of the exposures north of Decorah. It is also common along the Missouri.

The fourth assumption, that loess is of the Iowan age, has a certain amount of foundation in fact, but is unwarranted in the extent of its attempted application. It is based on the investigations and reports of the geologists of the Iowa Geological Survey,* who investigated the loess in some of the counties along the border of the Iowan drift. All the Iowa references cited have special reference to this restricted area, and in most cases the authors specifically so state. Bain (l. c., p. 461) says: "The loess found in the region has been referred to the Iowan since it is believed to be in this region the equivalent of the Iowan drift farther north, and now in part buried under the Wisconsin. It is believed that loess of widely different ages occurs in the Mississippi valley." Calvin (l. c., p. 118) says: "Loess, or a product resembling loess, was developed in connection with more than one drift sheet, and it is possible that the Iowan loess blends into loess-like deposits of different age in some portions of the extra-marginal territory."

There is at present no warrant whatever for the reference of all loess, and especially that of the Missouri river, to the Iowan age, and even if it be possible to show that the Lansing skeletons rested in undisturbed loess, this will not prove that they belong to the Iowan.

A thin layer of loess is found over a part of the Iowan and the Wisconsin† and no connection has yet been established

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*Calvin, S., Ia. Geol. Sur., vol. vii. p. 89, 1897; vol. viii, pp. 173-4, 216, 1898; Bull. Geol. Soc. of Am., vol. x, p. 118, 1899. Bain, H. Foster, Ia. Geol. Sur., vol. v, pp. 155-6, 1896; vol. vi, pp. 461-3, 1897. Beyer, S. W., Ia. Geol. Sur., vol. vii. p. 236, 1897; vol. x. p. 281, 1900. Leverett, Frank, of the U. S. Geol. Survey, also tentatively refers a part of the loess of Illinois to the Iowan. See U. S. Geol. Sur., vol. xxxviii, p. 153, 1899.

†Shimek, B., Proc. Ia. Acad. Sci., vol. iv. pp. 68-72, 1898. Bain, H. F., Ia. Geol. Sur., vol. ix, p. 91, 1899. Calvin, S., Bull. Geol. Soc. of Am., vol. x. p. 119, 1899: Iowa Geol. Sur., vol. xiii, pp. 328-9, 1903.

between the Iowan and the loess of the Missouri and Big Sioux river regions. Indeed, Bain refers to the northwestern loess in the following words:*

"It is known, however, that loess in northwestern Iowa probably belongs to more than one geological epoch, and Professor Macbride's observations in Humboldt county make it conclusive that the Iowan did not cover the region immediately north of Carroll county, as has heretofore been believed. The correlation of this loess in Carroll county with the Iowan drift is accordingly open to considerable doubt."

If these words apply to loess comparatively near to the Iowan border, what shall be said of the great mass of loess along the Missouri and lower Mississippi rivers, covering an area vastly greater than the known Iowan border region, and between which and the Iowan no connection whatever has yet been established? †

It is the writer's opinion that the accumulation of a comparatively large amount of loess along the border of the Iowan drift is explained by the fact that this border follows the larger streams of this part of the state, the Iowa, Cedar, Wapsipinicon, Maquoketa and Turkey. The deposit is thickest in the southern portions of the area, where the river valleys are broad, and where winds could easily gather up quantities of dust from the sand and mud bars exposed at low water. In any case no proof has yet been furnished that the Lansing loess is contemporaneous with the Iowan drift.

The attempt which Upham makes‡ to divide the loess into an aeolian "upland loess" and an aqueous "valley loess," which is practically a repetition of Hershey's effort,§ is not successful. He says: ". . the winds . . . blew away much of

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*Ia. Geol. Sur., vol. ix, p. 92, 1899.

†See paper on Loess and the Iowan Drift, which follows.

‡Am. Geol, l. c., p. 29.

§See Am. Geol., vol. xxv, pp. 369-374, 1900.

the fine loess dust and spread it far and wide over the interfluvial higher lands." Unfortunately the interfluvial lands are often lower than the loess ridges along the streams. As the loess recedes from the streams it usually becomes thinner and its materials finer, both of which facts can probably be accounted for by the greater distance from the source of supply of the material,—the bars of the streams. He further states that "In these great areas of eolian loess only terrestrial shells are found." As a matter of fact most of the loess remote from streams (the "upland loess") is non-fossiliferous. However, where fossils do occur they are chiefly, or wholly, terrestrial. But so are the fossils from Natchez and Council Bluffs; so are the fossils of by far the greater part of the loess wherever it is found. No line of demarkation, vertical or horizontal, can be drawn between two such divisions of the loess. There certainly is nothing known at present to indicate genetic differences.

Hershey (l. c.) attempted to separate the upland non-fossiliferous loess from that which is fossiliferous, but the presence or absence of fossils does not prove difference in origin. This point has already been sufficiently discussed by the writer.* Neither differences in altitude nor differences in fossils offer satisfactory characters for a division of the loess, for both fail when subjected to the only reliable test,—namely, application in the field.

Differences in composition and texture may frequently be observed in the loess. It is evident that not all loess is of the same age as measured with reference to the several drift sheets which have extended southward into the latitude of Iowa. The deposition of loess has continued through all the intervals of the ice age. In the more northerly regions (i. e. Iowa, etc.) over which the several ice-sheets passed, there were more or less sharply defined differences between different portions of the loess. Such differences have been observed by Todd

*The Distribution of Loess Fossils, Proc. Ia. Acad. Sci., vol. vi, pp. 98-103, 1899; Jour. of Geol., vol. vii, March, 1899.

and other earlier observers. Tilton reported two loesses in Warren county,* and in Madison county, Iowa.† The present writer reported differentiation in the loess at Council Bluffs.‡ Calvin discovered two distinct beds of loess in Page county, Iowa.§ During the past summer professor Calvin found two superimposed loesses in sec. 20, Bluffton township, Winneshiek county, Iowa, the lower, evidently pre-Iowan, being bluish-gray, with very large iron-tubules and numerous lime-nodules, while the upper is yellow and homogeneous. The writer subsequently examined a similar exposure in sec. 3, Decorah township, and several were observed in other parts of the county. In these exposures the line separating the two loesses is distinct, and they evidently differ very much in age. Even more striking is the case of two loesses, both fossiliferous, discussed by Udden in Rock Island county, Illinois, and reported by Leverett,|| for they are separated by more than 90 feet of drift and black soil. Loess is found upon the Wisconsin, the Iowan, the Illinoisan and the Kansan drift-sheets, and some of it is evidently pre-Iowan. Certainly all of it is not Iowan.¶

Southward, in the regions not reached by the later drift-sheets, including therefore the vicinity of Lansing, there were no such abrupt interruptions in the deposition of loess, and this continued to the present time, possibly in varying degree, through all the climatic changes which so materially modified the northern surfaces, but southward probably affected only the character of the vegetation. Thus a deposit of southerly loess might be the equivalent in age of several of the northern drift periods, without showing lines of demarkation between the several periods, which in the south were more or

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*Ia. Geol. Sur., vol. v, pp. 318-19.

†Proc. Ia. Acad. Sci., vol. iv, p. 49.

‡Proc. Ia. Acad. Sci., vol. vi, pp. 107-8; Jour. of Geol., vol. vii, pp. 132-3, 1899.

§Ia. Geol. Sur., vol. xi, pp. 444-5, 1901.

||U. S. Geol. Sur., vol. xxxviii, p. 115: 1899.

¶See paper on Loess and the Iowan Drift, which follows.

less merged into one. With our present knowledge it is certainly impossible to correlate southern loess, or any part of it, with any particular drift-sheet.

The seventh proposition, that loess and drift intergrade, is emphasized by Winchell* for the purpose of showing that the loess was deposited under glacial conditions. To judge from his statement there is no clear distinction between the two deposits, yet the statement that loess can be "in most cases certainly identified by student and layman alike" is just as true as it was when McGee wrote it. It is true that at some points, especially along the border of the Iowan drift, sand is more or less mingled with the base of the loess and that usually the line between the loess and the drift is not absolutely sharp, but this is precisely what would be expected under the aeolian hypothesis. The recession of the glaciers left the surface covered with till, boulders and sand. Along the drift-borders, and especially along the streams near the Iowan border, there were ridges of overwashed sand presenting sand-dune conditions perhaps not unlike those which now prevail along the Missouri, near Missouri Valley and Modale, Ia., and Blair, Neb., or along the Platte river near Fremont, Neb. As soon as a vegetation, at first scant, gained a foothold, dust was retained more or less, but for a time stronger winds, perhaps in drier seasons, would occasionally sweep sand over the plant-covered areas, and a mingling of sand of different degrees of fineness, and of dust, was the result. As vegetation gained a better foothold over larger areas these incursions of sand became less frequent, and finally ceased. Such mingling of sand and fine soils may be observed today at the localities named, and fine illustrations may be seen along the road leading east from West Point, Neb., where sand and loess, evidently wind-blown, are interstratified in various ways. At one point along this road fossiliferous loess has been covered by wind-blown sand in comparatively recent years. That the fine sands at

*Bull. Geol. Soc. of Am., vol. 14, pp. 141-2; Am. Geol., vol. xxxi, pp. 279-282.

the base of the loess sometimes (though rarely) contain fossils is not inconsistent with the æolian hypothesis. The writer has found living *Succinea grosvenorii* in mingled sand aud loess on top of the high ridge northwest of Hamburg, Iowa. Some of the dead shells, still somewhat fresh, were already partly covered with dust and sand. . Some of the sand so transported by wind today is coarse and even contains small pebbles.

The "southern loess" discussed by McGee, whom Dr. Winchell quotes so extensively, is the loess of the Iowan border in Iowa, and this rests upon morainic sands,* which must have presented ideal conditions for such a mingling of sand and dust. It is here that his hybrid "drift-loess" was formed. There is no connection, so far as known, between this "drift-loess" and Calvin's "flooded-valley deposits" which are referred to the "drift-loess" by Winchell.†

The occurrence of real till in loess, excepting where slipping may account for its presence, has not yet been demonstrated. Even Bain's example,‡ is not conclusive. He says that the exposure of till to which he refers is "about 150 feet above the river, and the till is above any similar deposit known to occur in this vicinity." Anyone who is familiar with the topography and altitudes of the part of Woodbury county referred to, will be very slow to make unquestioned application of Bain's careful statement concerning a point only 150 feet above the river. In any case the extreme rarity of such cases should lead to great caution. Loess and drift are not so intermingled as to warrant sweeping conclusions concerning genetic relationship.

The fineness and homogeneity of the loess, together with the presence of numerous terrestrial fossils which required abundant vegetation for their maintenance, are sufficient to

*Calvin, S., Ia. Geol. Sur., vol. vii, pp. 88-9, 1897. Beyer, S. W., Ia. Geol. Sur., vol. vii, p. 236, 1897; vol. x, p. 281, 1900.

†Am. Geol., l. c. p. 279.

‡Cited by Winchell, Am. Geol., l. c. p. 281.

show that the loess was not deposited by ice. If it is maintained that the loess was deposited by flooded streams after the ice receded, then it devolves upon the advocates of this theory to explain the following phenomena:

a. The region immediately adjacent to the larger streams in our loess-covered sections is the highest, as a rule, and has the thickest deposit of loess. There are no bluffs or elevations lying beyond, which could have formed the banks of the swollen streams. If there were great barriers southward which retained the vast volumes of water postulated by this supposition where are traces of them?

b. The loess is fine and comparatively homogeneous. The movement of such enormous volumes of water, would certainly have resulted in the transportation of more coarse material.

c. The loess is usually of approximately uniform thickness on tops and slopes of hills, and is often laminated parallel to the surface. Under what conditions could flooded streams have produced this result. If it is assumed that the loess was deposited in enormous lakes, where are their shorelines, and where were the land areas which produced the terrestrial molluscs?

d. The loess is more or less fossiliferous, especially where it is thickest, and where therefore the floods should have had greatest influence. The shells are, with slight exceptions, those of land snails which are not found, at least in large part, upon alluvial low lands adjacent to streams. Great floods covering such areas would render them wholly unfit for such plant life as these snails require. Presumably these floods would come in late spring and summer. How much advancement of plant and snail growth could be expected in the fall, winter and early spring?

In his recent article* Upham makes the remarkable statement that in "the summers of each year the floods pouring along the valleys from the ice melting and rains added little

*Am. Geol., l. c. p. 29.

to the surface of the whole flood plain; but in autumn, winter, and spring, the diminished rivers flowed in comparatively narrow channels, probably permitting the main part of the flood plain to become more or less covered by grass and other vegetation, and to be inhabited by air-breathing mollusks."*

It is fair to presume that under the climatic conditions here assumed the winters were still long, and that much ice was formed each season. If the streams were flooded four months each year, as suggested, and much of the remainder of the year was winter, when did the grass and snails grow? And, furthermore, where do modern representatives of the loess species of molluscs live under such conditions?

If it is argued that the mass of loess was gradually accumulated by a succession of floods, which periodically receded sufficiently to expose land-surfaces, then it is necessary to consider movements of enormous volumes of water in comparatively short time, for the loess-covered regions are not in restricted depressions, and enormous floods would be required to cover them. In Iowa, for example, these floods would have covered the greater part of the state. The loess-topped hills at Iowa City are lower than the loess border near the Mississippi river, and the hill south of Carroll about 275 miles west of Iowa City, and more than 600 feet higher,† and forming a part of the great divide between the Mississippi and Missouri, is covered with fossiliferous loess! To periodically drain such an area sufficiently to leave land areas exposed for a sufficient length of time each year to enable a flora and a snail fauna to develop, would require currents so strong that much coarse material would be transported, and the loess would not be so uniformly fine in texture.

But the absurdity of the proposition that snails could grow under such conditions, will appeal to everyone familiar with their rate of growth and their habits. It may be that those

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*Substantially the same statement had been previously made by him in Bull. Geol. Soc. of Am., vol. 5, p. 94.

†See R. R. profiles, Iowa R. R. Commission, 1881.

who have made the earth's surface in the loess-covered region conveniently move down and up through a vertical distance of 300-500 feet to accommodate their theories, may find it easy to conceive of a change in the habits of insignificant snails, or may not consider their testimony of much weight. But those who have studied these snails in the field know that many of them show a remarkable persistence in habits. Thus *Helicina occulta*, the most universally distributed loess fossil of the northern Mississippi drainage, lives in a few restricted and widely separate areas,* invariably upon high grounds in hilly country covered with abundant vegetation. *Succinea grosvenorii*, also common in the loess, habitually seeks dry and more or less elevated surfaces,—whether in Mississippi or Nebraska,—and, so far as the writer's experience goes, is never found living on low alluvial bottom lands.

Such forms as *Vallonia gracilicosta*, *Strobilops virgo*, *Leucocheila fallax*, *Bifidaria holzingeri*, *B. curvidens*, *Cochlicopa lubrica*, *Vitrea indentata*, *Succinea avara*, *Pyramidula alternata*, and *P. perspectiva*, of our northern loess, and most of the species of the southern loess,† habitually frequent higher grounds, while all the species, without exception, which are found in the loess north or south, are living today upon high grounds which are not subject to overflow, though in some cases these species also extend to the lowlands.

The fauna of the loess is not such, species for species, as is found today on the alluvial bottom lands along our streams, and it is lacking in fluviatile forms. The significance of this fact must not be underestimated, and the value of such testimony must be placed far above merely supposed phenomena for the support of which there is no direct evidence, but which are necessary to sustain a theory. Fossil shells are not rare in the loess. They are as widely and as generally distributed in that deposit as their modern prototypes are upon the sur-

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*At Iowa City, Eldora and Dubuque, and in Allamakee, Clayton, Howard, and Winneshiek counties in Iowa; Winona, Minn.; and isolated localities in Wisconsin, Pennsylvania, Virginia and Tennessee.

†See Am. Geol., vol. xxx, p. 290, etc,, 1902.

face today.* The habits of these snails are known. They present a tangible, definite basis for conclusions, and their occurrence is wholly consistent with, and best explained by the æolian hypothesis of the origin of the loess. These fossils will continue to be the rock which will wreck the arguments of the advocates of the glacio-fluviatile and aqueous theories, until an explanation of their presence in the loess, consistent with these theories and based upon observation and fact, can be presented.

THE LANSING DEPOSIT NOT LOESS.

The preceding paper was written, as stated therein, before a visit was paid to the Concannon locality, and deals only with the general question of the loess. The writer has since visited the Lansing cave, and made an examination of the deposit under which the Lansing human remains were found, and fully agrees with Dr. Chamberlin† "that the deposit is not true original loess." The Concannon cave and its surroundings have been quite fully described and discussed, ‡ but there are still certain features of the Lansing case, and of the loess in general, which call for further discussion.

In the paper cited (p. 264), Professor Winchell describes the Lansing deposit as "upland loess of the mixed nature of much

*See the writer's discussion of this subject: Ia. Acad. Sci., vol. v., pp. 14-15, 1898; vol. vi, pp. 98-113, 1899; etc.

†Jour. of Geol., vol. x, p. 769,—1902.

‡See especially the following:

Chamberlin, T. C., Jour. of Geol. vol. x, pp. 754-769, 1902.

Winchell, N. H., Am. Geol., vol. xxxi, pp. 295-303, 1903.

of the upland loess in southwestern Minnesota and in Iowa," and attempts to convey the impression that it is not unusual to find loess mingled with rock-material, and that, therefore, the Lansing deposit might be loess notwithstanding the presence of rock-fragments. The writer's examination of the Minnesota loess has not been sufficiently extensive to warrant a general statement concerning its character, but so far as the loess of Iowa is concerned, there is no similarity between any known part of it and the Lansing deposit. Professor Winchell's statement is based chiefly upon McGee's description of the loess of Northeastern Iowa, but McGee states explicitly* that the "deposit is approximately homogeneous from summit to base; but below it passes quickly yet by imperceptible gradations into a sheet of sand, gravel, and bowlder-charged clay....," and those who have examined the deposits in the field know that but for occasional difficulty in a thin intermediate portion, the loess and drift are readily distinguished. Even in those sections along the border of the Iowan drift† which show alternating bands of fine sand and loess, the several layers are clearly marked. There is nowhere in it such mingling with rock-debris as occurs in the Lansing deposit. The writer has examined great numbers of loess-sections from Minnesota to Mississippi, and from Nebraska to Indiana, but has not elsewhere seen such a mixture excepting in very limited masses where the evidences of land-slides were indisputable, or where the environment indicated the very great probability of such land-slides.

Of the remaining citations‡ which are intended to sustain the contention that such a heterogeneous mass as that which entombed the Lansing remains may be loess, and which might appear to have a real bearing on the question at issue, only those from the reports of Calvin, Bain and Udden contain

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*P. 436, l. c. For more complete discussion of McGee's observations see the following article.

†See the following paper.

‡See pp. 279–281, l. c.

descriptions of specific exposures which can, therefore, be definitely discussed.

It is evident from Professor Calvin's own words that he did not regard the Page county deposit as loess, for he states that "unlike loess it contains pebbles and pockets of sand," and in private conversation he pronounced this deposit equivalent to the member of this series which is designated as "gumbo" in this and the following papers.

The possibility of the derivation of the material reported by Bain from some higher deposit of the same kind has already been noted (see p. 342), and too much stress should not be placed on the occurrence of such material in the loess in an isolated instance, unless all such doubt is removed.

The Loveland exposure, discussed by Udden, has certainly been misunderstood by Professor Winchell. The writer recently made an examination of this exposure, and was able to confirm Professor Udden's observations, though with some modifications. There are two loesses, separated more or less distinctly by a narrow dark band, and both are fossiliferous, though unequally so. The lower loess, however, does not rest directly on drift. Professor Udden evidently recognized the fact for he says that "it is possible that the lower, darker division corresponds to the gumbo in other localities." He evidently did not intend to include in the loess all that lies between the drift and the dark band between the two loesses, for this portion is clearly divisible into a lower part, which is the gumbo referred to, and an upper part which is certainly loess. The sequence of deposits in the Loveland bluff, beginning at its base, is as follows: A blue clay, probably pre-Kansan, two feet at the very base of the bluff; Kansan drift, about forty feet; gumbo, about twenty feet; lower loess, about twenty feet; a dark inter-loessial band, from one to three quarters of an inch; upper loess, probably fifty feet. The gumbo is wholly devoid of fossils, so far as the writer could discover after careful search. It contains pebbles, especially in its lower part, large calcareous nodules in its basal portions, and a few small nodules in its upper part. It is darker in color than the loess, and is much harder, as was revealed by digging. As far as the writer was able to ascertain on the accessible parts of the bluff, at this level much obscured by talus, the transition from the gumbo to the loess above it is quite abrupt, though no sharp line appears. The lower loess is much softer than the gumbo, contains fossils, and is wholly devoid of pebbles. It is true loess in all its characters. The whole series much resembles that which is splendidly displayed in the first cut northeast of Carroll, Iowa, along the C. G. W. Ry., and which is described in the following paper. In both cases the distinction between the gumbo and loess is clear enough. It may be added that in describing what appears to be the same deposit at Emerson and Malvern, Iowa, Udden says* that "the transition from this gumbo to the loess above is usually well-marked." This gumbo is evidently not loess and the writer knows of no point where these deposits occur in the same exposure, where they cannot be as satisfactorily differentiated as other pleistocene deposits. The confusion is found in the literature of the subject rather than in the deposits themselves. While the line between loess and associated deposits is not always sharp, the transition, excepting in cases of evident rearrangement, takes place within very narrow limits,—usually about one to three inches. There is however, no such wholesale mingling of rock-materials and loess as would be necessary to parallel the Lansing deposit.

Professor Winchell intimates that "a typical loess deposit" is a question of definition. While it is true that there has been some difference of opinion as to what should be included under the term in certain local cases, no very great doubt as to what constitutes real loess was entertained until the publication of McGee's great report, and no more extreme application of his definition has been attempted than in the case in which it was so expanded as to cover the Lansing deposit under discussion. A detailed discussion of some of the de-

*Geol. of Mills and Fremont county, Iowa Geol. Sur., vol. xiii, p. 167, 1903.

posits evidently erroneously included in loess by McGee is given in the following paper. The objection to the inclusion of the Lansing deposit in typical loess is that both its composition and position indicate that it was formed largely by slumping or creeping from the adjacent highlands, and that it is, therefore, a talus. If shells, or the bones of a mammal, were buried in the sandy talus at the base of a Minnesota St. Peter sandstone bluff, we would scarcely assign such remains to the St. Peter formation. Similarly, even if the clay under which the Lansing remains were found was originally loess, if it has been disturbed, either by a slow creeping movement or by a sudden land-slide, we cannot include any remains overwhelmed in such movement with the original loess. If only the possibility or probability of such movement can be shown, it at least throws doubt upon the age of materials imbedded in such a deposit and makes the evidence of their age extremely unsatisfactory.

As already indicated the composition of the Lansing deposit shows that it is not loess, and its position is such that the probability of creeping and slumping is at once apparent.

The details of the location of the Concannon cave have been quite fully set forth in the papers of Chamberlin and Winchell, but the accompanying plat and views may be of assistance in still further elucidating the environment of the deposit in which the excavation was made, and showing its probable origin.

The cave or tunnel, is situated at the base of a long ridge which slopes downward toward the north.*

The core of this ridge consists of carboniferous rocks, covered in its upper part with more or less drift and loess, and at the base with the talus in question. Carboniferous limestone here crops out high above the talus in which the cave was excavated and this, and the loess and drift above, appear to have furnished the material which makes up the talus. The higher

*See Plate viii, c for location of cave, and Plate ix, figs. 1 and 2 for the ridge.

portion of the ridge rises at least 180 feet above its northern base, and an abundance of such material lies above the bottom of the cave.

Two species of land molluscs are common in the talus, namely *Polygyra albolabris* and *Pyramidula alternata.* Both were also found living on the higher slopes of both ridges, *a* and *b*, Pl. VIII, and their shells could have been mingled with the slipping material. Recent specimens of these species, and of *Polygyra profunda* and *P. leai*, were found at an altitude of over 100 feet above the cave.

The position of the deposit in which the human remains were found is, therefore, such that the source of all the material can be traced to higher points south of the Concannon house. Much has been written concerning the thin, laminated band which appears only on the west side of the cave, and Dr. Chamberlin* regards it as probable that it was deposited by the Missouri river when it occupied a higher level, about sixty feet above its present bed. Professor Calvin† thinks the increased altitude was "less than fifteen or twenty-five feet," through which the Missouri may have cut since the formation of the band, which would probably be approximately since the deposition of the skeleton. Both of these writers were evidently anxious to allow all the benefit of doubt on the side of the greatest possible age of the deposit. Dr. Salisbury expresses‡ the opinion that the water-laid layer was formed "when high water in the Missouri ponded the tributary." This might be possible, as the floor of the cave at the entrance is less than four feet above the Missouri river high-water mark in 1903, but it seems to the writer that the presence of this band can be accounted for without reference to the Missouri river. The hill north of the cave, marked *b* on Pl. VIII, is higher and more abrupt than the ridge *a*, in which the cave is excavated. There has, however, been more or less washing and slipping

*Pp. 774, etc., l. c.

†In comments on Dr. Chamberlin's paper, l. c., p. 778.

‡In comments on the same paper, l. c., p. 778.

from *b*, so that a lower talus has been formed, which extends to the south to meet the base of the ridge *a*, but which is cut off from it by the little stream. A part of this talus is shown in fig. 2, Pl. X, to the right, and its position at the base of the north bluff will be made clearer by reference to *d*, Pl. VIII, and fig., 1, Pl. XI. If at any time the talus *d* had been pushed across the narrow creek-bed to the ridge *a*, the waters of the little streamlet would have formed a pond. If this had occurred when the talus at the base of *a* reached only to the dotted line at *c*, the horizontal distribution of the thin silt layer which has created so much comment, would be exactly accounted for. This damming of the tributary, and the subsequent slipping of the talus might have occurred very recently, and even at low water in the Missouri river.

With the exception of this thin silt-layer, the Lansing deposit seems to be a talus, and hence of but little value in determining the age of the human remains. It certainly is not loess, unless under that term we are to include practically all the pleistocene deposits consisting of more or less incoherent materials.

LOESS AND THE IOWAN DRIFT.

It has been customary in very recent years to associate the greater part of the loess with the Iowan drift, and because of the alleged correlation, in some of the discussions of the Lansing man the loess was employed as a measure of the age of the human remains. In a previous paper* the writer attempted

*Am. Geol., vol. xxxii, pp. 362–4, Dec., 1903; also this Bulletin, pp. 337–40.

to show the unsatisfactory character of such reference, but since its first publication, Mr. Frank Leverett reiterates and emphasizes the reference of loess to the Iowan drift period.* The reference of loess to any drift period must be objected to, and not the least on account of the frequent presence of numerous land-snails, which indicate also the existence of a vigorous vegetation.† The several loesses represent interglacial and post-glacial periods during which conditions could not have been materially different from those which exist at present, and nothing has yet been presented which would shake their evidence. Leverett himself recognized this when he stated‡ that the fossils "bear clear evidence of having lived during its deposition." It may be true, as Leverett says in the *American Geologist*, that "the study of fossils alone will be insufficient to fully clear up the question of the mode or modes of deposition of the loess,"—and so far as the writer knows no one has attempted this,—but neither can the question be cleared up by disregarding entirely, or distorting the evidence which the fossils offer, as has been done by several of those who have recently taken part in the discussion of the loess question.

It is interesting in this connection to scan the evidence which Leverett offers in his published papers in support of the contention that the loess is Iowan.§

In the proceedings of the Iowa Academy (l. c.) he defines loess as "that sheet of loess which connects at the north with Iowan the Iowan till sheet," and refers to it a number of times

*Am. Geol., vol. xxxiii., pp. 56–7, Jan., 1904.

†The writer has repeatedly called attention to the fact that these molluscs are herbivorous. See: Proc. Ia. Acad. Sci., vol. iii, p. 85, 1896; vol. v, p. 39, 1898; vol. x, p. 46, June, 1903. Bull. Lab. Nat. Hist. S. U. of Ia., vol. v, p. 212, May, 1901.

‡Monographs U. S. Geol. Sur., vol. xxxviii, p. 165, 1899.

§The following are the most important: Geol. and Nat. Hist. Sur. of the Chicago Acad. Sci., Bull. no. II, pp. 16–17, 1897; Proc. Ia. Acad. Sci., vol. v, pp. 74–5, 1898; Monographs U. S. Geol. Sur., vol. xxxviii, pp. 153–187, 1899; Am. Geol., vol. xxxiii, pp. 56–7, Jan., 1904.

without, however, submitting any evidence of its contemporaneousness with the Iowan.

In the monograph of the Illinoisan Glacial Lobe he says (p. 131): "The sheet of drift to which the name Iowan is here applied, is referred to the Iowan stage of glaciation, not because of direct connection with the Iowan drift of eastern Iowa, but because of an apparent similarity with the Iowan drift of eastern Iowa in its connection with the great sheet of loess in the Mississippi Basin." On p. 143 he argues that the presence of loess-like silt "brings strong support to the view that the ice-sheet, at the Iowan stage, did not fall short many miles of reaching the line occupied at a later date by the Wisconsin ice-invasion." In both these cases, as well as in the discussion on p. 133, he seems to take it for granted that the loess *is* Iowan, and uses it to determine the age of the drift sheet!

His reference to the relation between the loess and the Iowan drift on p. 153 is much more cautious than his later utterances, for he says: "Deposits of silt, tentatively classified with the loess and supposed to be of Iowan age, cover the entire surface of the Illinoisan drift so far as it lies outside the limits of the Iowan and Wisconsin drift sheets." Indeed, he seems to question the identity of the drift in Illinois with the Iowan, as is shown in the citation from p. 131, and on p. 141, where he says that "there is some evidence suggesting a slight extension of ice from Iowa into northern Illinois at the Iowan stage." Similar doubt is expressed in the discussions on pp. 141–2, 148–9, 151, 154, etc.

The writer does not here raise the question of the identity of the deposits in question with the Iowan drift, but refers to the citations merely to call attention to the doubt which existed in Leverett's own mind at a time when the supporting field observations were still fresh in mind. He also recognizes the fact that a field-worker might have legitimately changed his views in the period of five years which has elapsed since the publication of the work cited, but so far as he is aware, Mr. Leverett has published no additional observations to fortify such a change, and certainly none appear in the recent contribution in the *American Geologist.*

So far as the writer has been able to determine, no one has yet presented direct evidence of such lateral blending of loess and Iowan drift as would prove their contemporaneousness. According to Leverett's own testimony the loess is sometimes above and sometimes below the Iowan drift. Referring to the Iowan on p. 131 (l. c.), he says that "the loess overlaps the drift sheet only a short distance," and on p. 147 he reports a drift, evidently Iowan, at the base of a thick loess deposit. On p. 137 he states that "in places the Iowan till is covered to a depth of several feet by loess," and on p. 138, that low Iowan drift knolls at Polo "are capped by 4 feet of loess-like silt." In the foregoing cases the loess caps the Iowan drift, but in other sections Leverett found the loess under the Iowan. On p. 138 (l. c.) he says: "At the village of Stratford, . . . the railway exposes a bed of fossiliferous silt at the base of the Iowan drift, resting on an old land surface formed on the Illinoisan. . . . In two other localities fossiliferous silts have been found at the base of the Iowan, one being . . . west of Irene, . . . and another . . . one mile east of Belvidere. Here as at Stratford, the fossils are mainly one species." *

This fact, that loess is found both above and below the Iowan, suggests that in the territory under discussion there were two non-glacial periods of loess deposition, the one preceding and the other following the advance of the Iowan glacier.

Leverett evidently placed some reliance upon the greater thickness of the loess along the Iowan drift-border in concluding that the two deposits were contemporaneous, for on p. 155 he says: "On the margin of the Iowan ice-sheets, especially the one which occupied eastern Iowa, there is a thicker deposit

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*The species is *Succinea avara*, a common loess land-snail, of which Leverett says (l. c., p. 165):—"a form which is now found in swampy places as a rule, but which occasionally occurs in dry places. Shimek regards this as strictly terrestrial rather than a semi-aquatic form." *Succinea avara* is *not* found in swampy places as a rule, a fact which the writer will demonstrate to anyone who will go to the field with him.

of loess than in districts remote from the ice margin." But he continues, "the ice-lobe which extended southwestward into northern Illinois has a less marked thickening of the loess near its border," and then points out on pp. 155-6, the well-known fact that there is a similar thickening along the main drainage lines of our larger rivers! These thickenings along the Missouri and Mississippi rivers extend in some cases to points several hundred miles from the border of the Iowan drift-sheet, and no direct connection between them and the latter has yet been shown. It is true, as has been repeatedly noted, that there is an accumulation of loess without the border if the Iowan drift in Iowa which thins out more or less in the outlying sections, and fades out in large part within the Iowan drift area. But it is not true that the heaviest deposits of loess in the state lie along the Iowan drift-border, for that distinction belongs to the loess in the Missouri river drainage, which is not directly associated with the Iowan.

The writer has already expressed the opinion* that the greater thickness of the loess along the Iowan border is due in large part to the fact that it follows the larger streams in the eastern half of the state,† especially along those portions of their courses which have broad valleys. In such valleys the winds had, and now have, free sweep over the numerous mud and sand bars which abound at low water; and the bordering highlands were then, as now, clothed with a vigorous vegetation which retained the dust. This would be possible only after the glacier had wholly retreated and the climate was sufficiently tempered to support such a vegetation. After the recession of the glacier the surface which had been ice-covered was no doubt barren for a time, and even after vegetation appeared it was probably at first tufted like that of sand-dunes and sand-bars, leaving comparatively large bare areas.

Hence wind and water easily shifted the finer materials, removing them from the higher Iowan areas to the river-valleys,

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*See p. 338 of this Bulletin.

†See map, Pl. III, showing position of Iowan border, in Iowa Geol. Sur., vol. viii.

where they formed extensive bars, and whence they were carried to the adjoining slopes, where vegetation had already secured a foothold.

That more or less extensive sand-dunes were also formed before the deposition of the loess along this border, appears in the fact that finer sands underlie this loess very commonly along the greater part of the border. The fact that these sands are so commonly present was emphasized by McGee for the northeastern part of the area, and has been observed by all the Iowa geologists who have worked in the Iowan border territory.*

These sands suggest a sand-dune origin rather than water-deposition, by the fineness of the sand and the absence of pebbles, by the lamination characteristic of sand-dunes, by the frequent alternation of very fine and somewhat coarser sands often seen in sand-dunes, and by the vertical outlines of the deposits which, at least in the border area north of Iowa City, are like the vertical contours of ordinary sand-dunes. These sand-dune conditions have been preserved in the same region to some extent even to the present day, but after the disappearance of the Iowan ice they were at their best, and evidently formed the characteristic surface deposit just outside of the Iowan border. As vegetation gained a footing upon the dunes, soils were formed, vegetation increased, and the deposition of loess was made possible. The sand-dunes along the border of the drift, as well as the extensive bars in the streams occupying the same border territory, furnished a large amount of dust, and the immediate vicinity of the drift-border received larger quantities of this material than the outlying districts, and hence accumulated more loess. Borders of large streams, especially those flowing in broad valleys, have the same advantage and accumulate more loess than regions more remote.

As a matter of fact Leverett himself based his opinion con-

*See especially Calvin's discussion in Iowa Geol. Sur., vol. vii, pp. 88-9, 1897.

cerning the correlation of loess and Iowan drift largely upon the conclusions drawn by McGee, Calvin, and other Iowa geologists who were investigating special problems in comparatively restricted areas. McGee's discussion* of the correlation of loess and the Upper Till, now known as the Iowan, is so positive, and the numerous examples which he cites seem to be so conclusive, that it is not strange that most students of pleistocene geology accept his conclusions. That Leverett did so is evident from his statements† that "this sheet of loess seems to be intimately connected with the Iowan drift sheet, as shown by McGee, a relation while subsequent investigators fully confirm." The latter were chiefly members of the Iowa Geological Survey.

McGee correlated these two deposits chiefly because he often failed to find a sharp line of demarkation between them. On p. 442, l. c., he says: "The northern loess is never without a basal pebbly layer or sand bed . . . " and he includes this in the loess series. In the subsequent discussion of the southern loess, pp. 442-6, he includes a sandy or pebbly layer capping the Upper Till (Iowan drift) with loess. In the discussion of the "loess of the river ridges and paha," on pp. 454, 455, 459 and 460, he refers sands and gravel to loess. The same is true of his "southern loess," on pp. 462, 466, 467, etc., though here he finds the loess grading directly into drift clays.

The reference of these underlying deposits to loess is evidently erroneous.‡ McGee himself recognized the fact that loess is usually readily identified.§

The only reason, so far as appears from his discussion, which he had for including some of the basal sands and gravels in

*11th An. Rep. U. S. Geol. Sur.

†On p. 25 of the monograph on the Illinoisan Glacial Lobe.

‡Leverett makes the same error in the monograph of the Illinoisan Glacial Lobe, p. 157, etc.

§See pp. 292–3, etc., l. c.

the loess-series is found, as stated, in the fact that the line between the lower deposit and the loess is not always sharp. It should not be inferred from this, however, that there is great indefiniteness or confusion along the dividing line. This line is often quite sharp, but even in the cases in which there is a blending, the complete transition takes place usually within a vertical distance of from one to three inches. This blending does not indicate a unity of origin as has been assumed, and is entirely consistent with the æolian hypothesis of loess-origin, as has been indicated on p. 341 of this Bulletin, and as may be determined by the study of soil-accumulation in sand-dune regions. The inter-lamination of sand and loess has been observed only where fine sands underlie the loess, and suggests an original sand-dune area which would become covered with soil-retaining vegetation for a time, but in which sand-dune conditions were occasionally restored, perhaps during periods of protracted drouths, the soil (loess) and sand thus alternately occupying the surface. A fine example of inter-lamination may be seen along the Cedar Rapids & Iowa City electric line, near the north line of section 27, T. 81 N., R. 7 W., in Johnson county, Iowa. Here the alternating bands have a total thickness of several feet, six feet being exposed in the cut. The largest loess-band measures two feet in thickness, and is fossiliferous. The remaining layers of sand and loess are mostly from one-eighth to two and one-half inches in thickness. No pebbles were found, and the fossils occur only in the loess. An interesting fact in connection with this deposit is the proximity of sandy areas (low sand-dunes) bordering the broad river valley to the west and joining with the ridge through which this cut passes. In portions of this area, within the recollection of the writer, there have been such alternating changes in surface conditions, the sandy prairie being sometimes covered with soil-retaining vegetation, and again with shifting, wind-blown sands. Professor Cowles similarly reports "many fossil soil lines . . . . on the Sleeping Bear dunes at Glen Haven, Mich."*

*Bot. Gazette, vol. xxvii, p. 111, 1899.

In cases where drift underlies the loess, and once formed the land-surfaces, the gradual accumulation of soil upon plant-covered areas would usually result in such blending as may sometimes be observed between the drift and loess.

This blending, therefore, does not prove a common origin, and McGee's lowest member of the loess series, that including sand and pebbles, should be excluded from the loess. It seems to be made up, in part, of residual sands and gravels, such as in places cap *every* drift-sheet in Iowa, and evidently represents the product of post-glacial action upon superficial portions of the underlying drift, and, in part, of gumbo which quite generally overlies the Kansan drift, and probably also represents post-glacial modifications of old drift surfaces. It is evident that but for the occasional blending here discussed, McGee himself would have separated this member from his series, for, speaking of the pebbly and sandy layer, on p. 442, l. c., he says: "This structure is so unlike the mass of the loess, and so like the upper drift sheet in composition and texture, that in a taxonomy based on these characters it might with propriety be classed with the latter deposit."

The writer has made a personal examination of the majority of the sections reported by McGee to prove the intergradation of loess and drift, and has also been able to examine other sections in the same territory.* Reference to McGee's work, pp. 464–5, l. c., shows that most of the sections cited are situated in the southwestern part of Johnson county, and in Iowa county, and that in connection with but one of these, is it specifically stated that the fossils extended beneath the pebbly layer, namely the well-section in sec. 15, T. 79 N., R. 7 W. For obvious reasons this section could not be examined, but in no other one of the many sections examined in that part of the county, were fossils found beneath the upper line of pebble-bearing clay. The fact is the loess does not blend with

*In a paper now in preparation, the writer will give the exact location of all the significant sections which were examined in this territory.

drift in this part of the territory, and is not only itself divided into two more or less distinct divisions, but is separated from the Kansan drift either by a layer of Buchanan gravel, including a ferretto zone, or by gumbo, or by both gumbo and the gravel. Where the loess rests directly upon the ferretto, as in the lower part of an exposure on the north side of the road in the southwest quarter of section 11, T. 79 N., R. 7 W., the line is quite sharp. Where gumbo and the gravel separate the loess from the drift, as in the middle slope of the same section, the line between the gumbo and the loess is less distinct, the intergradation occurring chiefly within one to three inches of thickness. The same is true of cases in which gumbo directly separates the loess from the drift, as in the first exposure east of the foregoing section, where there is but one loess, passing within three to six inches into a gumbo-like layer containing a few small pebbles and coarse grains of sand, chiefly in its lower part. In none of the exposures examined in that part of the county were fossils found below what is clearly loess.

The three remaining sections, mentioned on p. 464, l. c., as containing fossil shells mingled with pebbles, are here considered separately:

The section on Sixth street, west of Harrison, in Davenport, is still much as McGee found it. The only fossils found in the loess of this section are *Succinea avara.* The writer found none of these below the line between the loess and the underlying drift, but McGee reports that they "extend to and just within the pebbly horizon." This might be true without proving the identity of the two deposits. *Succinea avara*, judging from its present occasional occurrence upon exposed rocky slopes, might have lived among plant-tussocks when some of these pebbles still projected above the old surface, and when the whole was buried under loess dust the shells and pebbles were apparently mingled in a very narrow horizon near the line of division.

The writer was not able to find the exposure described as being on the Princeton road near the middle of section 20, near Davenport, Iowa. Even the upper Princeton road is at least one-half a mile from the center of section 20, and fossil-bearing exposures were found neither along this road, nor along the road leading north through the middle of section 20. The second exposure along the latter road north of the south line of section 20, however, showed two distinct loesses, separated from each other by an oxidized band, and the lower resting on a buried soil grading below into a gumbo-like layer, which in turn rests upon Kansan drift. Neither of these loesses here showed any trace of fossils, but the lower, light-bluish loess contained iron-tubules and a few lime-nodules, the latter extending also into the buried soil (Yarmouth), and the gumbo below it.

The Green street cut in Muscatine is no longer available for study, as the banks have been sodded, but an excellent similar section has been made recently about two blocks farther west, facing Hershey avenue. In this section a light-bluish fossiliferous loess, with tubules and nodules, lies between Kansan and Illinoisan drift-sheets. In several places there is loose sand under the loess, and in such pockets, near the loess, occassional fossil shells are found. Several facts which may throw light on this case here deserve special consideration. This kind of loess has nowhere been found at the very top of the hills. The presence of a relatively large number of shells of *Limnæa*, as well as the somewhat peculiar mucky texture of parts of this loess, suggest the presence of ponds, or of seepy, soggy places, such as are not uncommon on hill-sides. In such places springs often carry drift-sand out over the muck of the surface, and produce a similar mixture of materials. There are also in this loess numerous land-shells, such as exist on hillsides, often near such soggy places, and whose shells could be carried out over them, and finally buried in further accumulations of loess. In the deposit under discussion the mixture of shells and sand was noticed only for a short distance below the loess, and this suggests the possibility that underground streamlets, or those occupying deep gullies, undermined some of the loess, washed the shells out, and mingled them finally with sand brought from a higher drift, the cavity finally being filled with such sand and loosened loess.

An additional possibility is also suggested by the fact that this region lay in the path of the Illinoisan glacier, and that much of the frozen loess was probably displaced, and in its basal parts mingled with the underlying drift. As the Illinoisan drift lies over this loess, there is no question that the ice-sheet passed over it.

The occurrence of fossils in the sub-loessial gravelly belt might make the reference of this belt to loess appear more plausible, but would not absolutely prove its correctness. Such cases are exceedingly rare, and may be due wholly to local disturbances. Occasionally gullies are cut through loess into the underlying drift. In such cases fossils are sometimes washed out of the loess, and mingle at the bottom of the gully with sand and gravel washed from the drift. If such a gully should again be filled by slumping, and perhaps further covered by subsequent deposition of loess, a misleading mixture of fossiliferous loess and drift would result. Some such local cause may account for the very rare cases in which fossiliferous mixtures of the kind have been observed. In any event the conditions here discussed are very unusual, and as proof of the intergradation of loess and drift, are certainly of little value. It should also be noted that McGee placed more or less emphasis on the occurrence of loess-kindchen and iron-tubules in his gravelly member of the loess series* and it is probable that this also influenced him in referring this layer to loess, but it is not uncommon to find lime-nodules and iron-tubules in both gumbo and undoubted drift, and their presence offers no absolute measure of the identity of the deposit.

In his communication to the *American Geologist*, Leverett positively states that "the part in eastern Iowa has been clearly

*See l. c., pp. 465, 492, etc.

shown by Calvin and his associates on the Iowa survey to be a correlative of the Iowan drift, for it connects definitely with the border of that drift sheet." It is a matter of some interest however, that neither Professor Calvin nor his associates ever considered the evidence as absolutely conclusive, and that Calvin now holds an opinion contrary to that which this reference implies.

The contention that the loess is coeval with the drift is not well supported by facts in the field, and must face the objection that much of the loess contains numerous fossils which required an abundant vegetation for their maintenance, a fact which precludes glacial conditions, and that the loess and drift after all occupy a definite vertical relation entirely inconsistent with contemporaneousness. Especially is there excellent evidence to show that all the loess is not associated with Iowan drift. Not only are there enormous deposits of loess along the Missouri and the Mississippi rivers, which can in no way be connected with the Iowan drift, but in the drift-border areas of Iowa there is direct stratigraphic evidence (which therefore ought to appeal to Mr. Leverett) that a very large part of the loess is not even immediately post-Iowan. That more than one loess exists in Iowa has already been shown,* but during the past year so many conclusive evidences of this fact have been observed by the writer that the wide extent of their occurrence can no longer be questioned. A few of the most striking cases are here noted.

The Hershey Ave., exposure in Muscatine, in which there is a distinct fossiliferous loess between the Kansan and the Illinoisan drifts, has already been noted, as has that in section 20 near Davenport, in which two sharply defined loesses overlie gumbo.

A very similar section, showing only the two loesses however, may be seen opposite Crescent Ave., in East Davenport. The loesses are separated by a well-defined oxidized band, and the lower, pale bluish loess is very fossiliferous.

*See p. 340 of this Bulletin.

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Similar loesses occur at a number of points west and southwest of Iowa City. Some of the striking examples are the following:

In the southwest quarter of section 7, T. 79 N. R. 6 W., a yellow loess (post-Iowan) caps a fossiliferous pale bluish loess (post-Kansan) which is exposed to a depth of six or eight feet. The gully in section 12, T. 79 N., R. 7 W., noted by McGee, shows similar loesses, the line between them being quite distinct, and the lower resting on a gumbo-like clay which overlies Kansan drift.

In the southwest quarter of section 23, T. 79 N., R. 7 W., about three feet of yellow loess overlie about three feet (all that is exposed) of pale bluish loess containing nodules and tubules, but no fossils.

A cut along the diagonal road in the northeast quarter of section 20, T. 79 N., R. 6 W., exposes seven feet of yellow loess resting on pale bluish-gray fossiliferous loess. In the southwest quarter of the same section an exposure shows yellow loess resting directly on gumbo.

Near the north-central part of section 30, T. 79 N., R. 6 W., the two loesses are very distinct.

A cut along the road north of the church in the northeast quarter of the northwest quarter of section 27, T. 79 N., R. 7 W., shows Kansan drift, or Buchanan gravel, at the base, then about a foot of gumbo, then the pale-blue post-Kansan loess, one to one and a half feet in thickness, then yellow loess four to five feet. A long cut along the road near the center of section 17, T. 79, N., R. 6 W., shows yellow, post-Iowan, loess resting directly on gumbo, but the upper slope shows a

CORRECTION

P. 364. The following words were accidentally omitted after the word "conclusive" in the fifth line:

"at least so far as the whole body of the loess is concerned."

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ence implies.

The contention that the loess is coeval with the drift is not well supported by facts in the field, and must face the objection that much of the loess contains numerous fossils which required an abundant vegetation for their maintenance, a fact which precludes glacial conditions, and that the loess and drift after all occupy a definite vertical relation entirely inconsistent with contemporaneousness. Especially is there excellent evidence to show that all the loess is not associated with Iowan drift. Not only are there enormous deposits of loess along the Missouri and the Mississippi rivers, which can in no way be connected with the Iowan drift, but in the drift-border areas of Iowa there is direct stratigraphic evidence (which therefore ought to appeal to Mr. Leverett) that a very large part of the loess is not even immediately post-Iowan. That more than one loess exists in Iowa has already been shown,* but during the past year so many conclusive evidences of this fact have been observed by the writer that the wide extent of their occurrence can no longer be questioned. A few of the most striking cases are here noted.

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A very similar section, showing only the two loesses however, may be seen opposite Crescent Ave., in East Davenport. The loesses are separated by a well-defined oxidized band, and the lower, pale bluish loess is very fossiliferous.

*See p. 340 of this Bulletin.

In Iowa City, in the brickyard east of Lucas and north of Ronalds streets, a yellow fossiliferous loess streaked more or less with pale bluish-gray, fifteen feet in thickness, overlies a fossiliferous pale bluish loess, two to six feet in thickness, which is evidently post-Kansan and pre-Iowan. The latter rests on somewhat sandy gumbo.

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In the northeast quarter of section 4, T. 79 N., R. 6 W., a fossiliferous bluish loess lies below a non-fossiliferous yellow loess.

In a number of exposures southwest from Iowa City the upper loess only is present, and is sometimes fossiliferous. That the lower, bluish loess is pre-Iowan is shown in the exposures along the Cedar Rapids and Iowa City Electric railway in Jefferson township, Johnson County, Iowa.

In the first exposure north of the river about seven feet of Kansan drift is exposed at the base; upon this rests an irregular band of Buchanan gravel, over which lies a bed of bluish fossiliferous loess (post-Kansan), twelve feet in thickness, and over this a layer of sand, probably Iowan. In the third cut north of the river* six feet of bluish fossiliferous loess appear at the base; upon this rest four or five feet of sand, in places with pebbles, and evidently Iowan drift, and over this a newer loess about two feet in thickness. The third, fourth, seventh and eighth cuts north of the river, in sections 21, 16 and 17, show pale bluish loess covered by from two to four feet of Iowan drift, largely sand and gravel, over which lies a foot of newer loess.

With the exception of the Muscatine cut all these exposures are near the Iowan drift border, and show that all the loess of this region is not Iowan or post-Iowan, for the bluish loess is certainly pre-Iowan and shows much greater age. Its bluish materials were probably derived directly from the Kansan blue clays when they formed the old land surfaces.

At the "Quarry" west of West Amana, Iowa County, Iowa, four feet of Kansan drift rest directly on the carboniferous sandstone; above this are four feet of Iowan drift, and

*See Plate XII, fig. 2.

on the latter ten feet of yellow loess, the lower five or six feet being fossiliferous. Other exposures along the same road show the Iowan drift capped with loess.

An exposure east of Greenwood Park, Des Moines, Iowa, shows fossiliferous loess between the Kansan and Wisconsin drifts, and several similar examples were reported by McGee and Call.*

In the first Chicago Great Western Railway cut northeast of Carroll, Iowa, the following succession of strata is clearly shown: Kansan-drift at the base, overlaid by a foot of gumbo the upper part of which grades into a layer of black mucky soil (the Yarmouth), also about a foot in thickness; next a pale bluish fossiliferous loess (post-Kansan), six feet in thickness, separated from the yellow (post-Iowan) fossiliferous loess above by an oxidized band, the whole being capped with one to five feet of Wisconsin drift. In several cuts along the Chicago Great Western Railway between Carroll and Lanesboro a thin loess-like veneer appears on the Wisconsin, the latter often showing a distinct band of pebbles and boulders along its upper line. The first Chicago Great Western cut south of Carroll, represented in Pl. XI, fig. 2, shows Kansan drift below, a sharply defined layer of bluish fossiliferous loess above this, and over it a deposit of yellow loess. This is outside of the Wisconsin drift border, and no Wisconsin appears in the section. Of the more than twenty cuts between Carroll and Manning fully half the number show essentially the same relative arrangement of drift and loesses.

All the foregoing exposures in which the two loesses occur together, lie outside the Iowan drift-border, and the loesses are uniformly separated by a more or less distinct oxidized band.

The cut at Loveland, showing two loesses which are not so clearly differentiated, has already received attention. It is more remote from the Iowan border. The foregoing, and other similar sections indicate the following succession of de-

* Am. Jour. Sci., vol. xxiv, pp. 202, *et seq.*, 1882.

posits above and including the Kansan drift: 1.) Kansan drift; 2.) Kansan residual sands and gravels (Buchanan); 3.) Gumbo; 4.) Black soil (Yarmouth); 5.) Post-Kansan loess; 6.) Illinoisan drift; 7.) Illinoisan residual sands and gravels; 8.) Black soil (Sangamon); 9.) Post-Illinoisan loess; 10.) Iowan drift; 11.) Iowan residual sands and gravels (Peorian); 12.) Black soil; 13.) Post-Iowan loess; 14.) Wisconsin drift; 15.) Wisconsin residual sands and gravels; 16.) Post-Wisconsin loess. The post-Kansan loess is widely distributed, very compact, of a pale bluish gray color, with numerous iron-tubules and some lime-nodules, and it is frequently fossiliferous, the fossils being uniformly very fragile ("rotten"), and closely imbedded so that it is often difficult to remove them entire.

The post-Illinoisan loess is restricted to the southeastern part of the state, and is not as prominent as the following.

The post-Iowan loess is yellow or brownish, partially leached only in its lower part in thick deposits, often fossiliferous, the fossils usually being well-preserved and firm, and it is best developed near the Iowan drift margin.

The post-Wisconsin loess is not a conspicuous member of the series, appearing in patches, and as a thin veneer, in the northern and northwestern parts of the state.

These several loesses are quite distinct near the drift borders, but the distinction grows less clear as we recede from the drift-margins, especially southward, and finally practically disappears, probably in the regions in which plant-life was not wholly destroyed by the advances of the several ice-sheets succeeding the Kansan.

Manifestly, however, there were several periods of loess formation, and they appear to have been interglacial and postglacial. Far beyond the border of the newer drift sheets, however, the sharp lines of distinction between them disappear, and there the deposits of loess probably represent the combined accumulation of several interglacial and later drift periods.

EVIDENCES(?) OF WATER-DEPOSITION OF LOESS.

The *American Geologist* for April, 1904, contained two papers* portions of which were presented for discussion before the Geological Society of America, at the St. Louis meeting, by Professor Wright. In these papers an attempt is made to sustain the theory that loess was deposited in water. Both papers show a complete misconception of the arguments which in recent years have been offered in support of the æolian origin of the loess.

In the opening portion of his paper† Professor Wright attempts to present the writer's views on this question, and summarizes them under four heads. He quotes a list of the writer's papers, giving the results of studies of the loess, and in this list includes two‡ in which practically no reference to fossils is made, and omits several in which detailed studies are reported.§ This is perhaps a matter of no great concern, but it indicates carelessness, which perhaps extended to other portions of the paper.

Before passing to the discussion of Professor Wright's chief arguments it is necessary to notice these four conclusions as reported by him. The first one is substantially correct, for no "distinctively water species," at least such as occur in large

* Wright, G. Frederick, "Evidence of the Agency of Water in the Distribution of the Loess in the Missouri Valley," pp. 205–222.

Owen, Miss Luella A., "The Loess at St. Joseph," pp. 223–8.

† P. 205, l. c.

‡ "Additional Observations on Surface Deposits in Iowa," Proc. Ia. Acad. Sci., vol. iv, pp. 68–81. "The Distribution of Forest Trees in Iowa," l. c., vol. vii, pp. 47–59.

§ "Is the Loess of Aqueous Origin?" Proc. Ia. Acad. Sci., vol. v, pp. 32–45, 1899; Jour. Geol., vol. vii, pp. 122–140, 1899. "The Loess of Iowa City and Vicinity," Bull. Lab. Nat. Hist., St. Univ. of Iowa, vol. v, pp. 195–210, 1901; Am. Geol, vol. xxviii, pp. 348–58. "Report on Loess Molluscs of Pottawattamie county," Ia. Geol. Sur., vol. xi, pp. 261–5, 1901.

streams or lakes, have been found in the loess. The second observation,—on "the presence of land-shells of species that live on the shores of ponds,"—is not correct, and the writer has repeatedly called attention* to the fact that the vast majority of loess fossils are those of species which inhabit high, comparatively dry grounds, and this statement has been substantiated by detailed lists. The third conclusion is also in part incorrect. The writer's arguments have applied not only to a "permanently standing body of water," but to any large body of water, and more particularly to large bodies of moving water.†

Moreover, the loess fauna shows a total absence of the molluscs inhabiting large streams,—i. e., the strictly fluviatile forms,—and this fact indicates that there were no such streams where the loess was deposited.

Professor Wright's comment on the fourth conclusion concerning the influence of vegetation as a dust retainer is also likely to lead to a misconception. His reference to this as an "ingenious reversal of a former opinion" would make it appear that this was merely an opinion,—a device for supporting a theory. As a matter of fact it is the result of long-continued field observations in plant-ecology. It is evident that Professor Wright here entered an unfamiliar field, or he would

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* "A Theory of the Loess," Proc. Ia. Acad. Sci., vol. iii, pp. 83, 85. "Is the Loess of Aqueous Origin?" l. c., vol. v, pp. 33, 39. "The Distribution of Loess Fossils," l. c., vol. vi, p. 103; Jour. of Geol., vol. vii, pp. 127–132. "The Loess of Iowa City and Vicinity," Bull. Lab. Nat. Hist., St. Univ. of Ia., vol. v, pp. 206, 212; Am. Geol., vol. xxviii, p. 353. "The Loess of Natchez, Miss.," Am. Geol., vol. xxx, pp. 289, etc. "The Loess and the Lansing Man," l. c., vol. xxxii, p. 367. This Bulletin, pp. 312–13, 343.

†Viz: "A Theory of the Loess," l. c., p. 86. This Bulletin, pp. 315–6, 366–7, etc.

have known that the importance of plants on soil- and sand-accumulation is recognized by plant ecologists.*

This most important phase of the subject has already been briefly discussed by the writer† in its relation to loess-formation, but a much more detailed presentation of the subject is now in preparation.

In his paper Professor Wright presents what he considers certain objections to the æolian theory.

1. He says that "at Omaha the bluffs of loess on the west side of the river are scarcely, if any, less in dimensions than those of Council Bluffs on the east side.... As the prevailing wind in this region is from the southwest, it would be hardly possible for it to pile up such deposits of loess upon the west side of the river, and especially upon the southwest side, as at Kansas City." As a matter of fact if Professor Wright will examine the bluffs of the Missouri from Sioux City to Kansas City, he will find that they are, as a rule, higher, more abrupt, and with thicker loess deposits on the east side, and the same is true of the Mississippi.‡ Where deviations from this rule occur they may usually be readily explained by local topographic features, and by meanderings in the river-valley,

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*Those who are interested in the plant ecology of wind-deposits will find the following incomplete list of references of use:

Cowles, H. C., "The Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan," Bot. Gazette, vol. xxvii, pp. 95, *et seq.*, 1899. "The Physiographic Ecology of Chicago and Vicinity," l. c., vol, xxxi, pp. 73, *et seq.*

Rydberg, P. A., Cont. U. S, Nat. Herbarium, vol. iii, p. 135, 1895.

Gifford, John, "The Control and Fixation of Shifting Sands," The Engineering Magazine, Jan., 1898.

Schimper, Dr. A. F. W., Plant Geography, trans. by Wm. R. Fisher, revised ed., pp. 654–5, 1903.

King, F. H., "Destructive Effect of Winds on Sandy Soils and Light Sandy Loams," 11th An. Rep. Ag. Ex. Sta., Univ. of Wisconsin, 1895.

Udell, Geo., The Strand Magazine for March, 1904, p. 176.

†See especially "Living Plants as Geological Factors," Proc. Ia. Acad. Sci., vol. x, pp. 44–48, 1903.

‡This fact is also reported by Leverett, Monograph U. S. Geol. Sur., vol. xxxviii, p. 156.

and were probably also affected by inequalities in forest and plant distribution during the deposition of the locss, to say nothing of the variation in the winds themselves. Strong winds carry the dust over the entire valley, and its final settling and accumulation may be affected by various local causes.

2. He further states that "the exclusive dependence upon wind for the distribution of the loess finds it difficult to account for the extensive level-topped terraces which frequently occur." This statement conveys an exaggerated idea of the extent and frequency of such terraces. They represent a very small part of the loess-area even along the Missouri river, and where they do occur their vertical contour is determined largely by the underlying deposits on which the loess accumulated. In any event they are too insignificant when compared with the extent of loess deposits, to form a safe basis for generalizations.

3. He criticises the writer's explanation, which is consistent with the æolian hypothesis, of the fact that locss is thickest near the streams, and that its particles are here somewhat coarser, but he evidently failed to grasp its significance. It is not here a question of moving sand upon the lower heights. The particles of which the loess is composed are all sufficiently fine to have been sustained in the air as dust. They are not uniformly fine, but the differences between them are not to be compared with the differences between particles carried by water-currents, and those sustained in sluggish waters. Naturally the coarser particles would usually be deposited nearer the chief source of supply,—namely the bars of the streams,—and their retention would be favored by the usually greater, though unequal, extent of forest growth, or at least plant growth, in such places. But Professor Wright signally fails to explain why under his hypothesis of great floods *land*-snails, favoring high, comparatively dry grounds, should be most abundant in the portions of the deposit nearest the thread of the streams, and where the greatest amount of mud was deposited.

In this connection it may be well to notice also the objections to the writer's conception of the source of material, presented in Miss Owen's paper. She asks: " . . . . where could there have been river bars of sufficient extent to yield the supply for the deep mantle covering the region about St. Joseph ?" Miss Owen might look out, at St. Joseph, across the Missouri to the west, and she can see some of them.*

Here there are extensive bars and sand-dune areas, and the writer has seen great volumes of dust and sand raised from these bars, the sand being soon dropped, while the dust was widely diffused. Such bars are common at low water not only in the Missouri, but in all streams with wide valleys, and each succeeding flood brings new fine material to be again transported to the uplands. Loess is evidently a deposit which required a long period for its formation, and consequently accumulated only a little at a time.

It is surprising, however, that a resident of the Missouri valley familiar with these bars, and with the dust-storms which are so common, should resurrect this question.

Miss Owen further says: "Then too, it might be asked, by what law of nature did the winds confine their energy wholly to the flat, low-lying river bars while the higher and, supposedly, dryer mantle of till and beds of residual clay remained undisturbed to be gently but deeply covered?" In reply it may be said that it is the same law as that which today prevents winds from raising quantities of dust from plant-covered slopes and hills, while great clouds of it are carried upward from barren sandbars. During dry seasons, or in barren places, even the highlands yield dust, but so long as vegetation holds its own not only is there no wind-erosion, but the covering of plants retains much of the dust brought to it from other sources.

But Professor Wright's chief objection to the writer's explanation of these phenomena is contained in the statement that the explanation "notably fails to account for numerous

*See Pl. XIII, fig. 2.

facts mentioned in Miss Owen's paper concerning the composition and stratification to which Professor Winchell has called attention." The "numerous facts" referred to are practically embodied in the statement that at a number of points lamination and stratification appear in the loess, and it is assumed that this proves water-deposition. This is submitted as one of the most important "evidences" contained in the papers under discussion,* but it is neither new nor unusual, for the writer can point out a large number of exposures in which lamination may be observed. But he desires here to protest against the further perpetuation of the error that lamination or stratification are in themselves proof of water-deposition. While water deposits are often laminated, not all laminated deposits were formed in water. The writer has already called attention to this fact as illustrated in the road-cut near the Bohemian cemetery in West Cedar Rapids,† where distinctly laminated sand was found covering a fence. This cut is about 100 feet above the river, and there can be no question that the deposit was formed by winds. The "White Sands," an extensive gypsum sand-dune formation west of Alamogordo, N. Mex., often clearly show lamination, yet there is no question that these dunes were formed by winds, as ranches have been overwhelmed by them within the memory of old settlers. West of Missouri Valley, Iowa, there is an extensive sand-dune area along the Missouri river. The writer has made sections of some of the dunes, and invariably found them laminated and sometimes stratified, more or less parallel to the surface. Yet they are undoubtedly æolian. One of the largest of these (see Pl. XIV, fig. 2) rises more than 40 feet above the Missouri, and the testimony of old settlers shows that it has been formed since the year 1883, and that the waters of the Missouri have never covered it, even during the flood of 1903. Yet even its uppermost portions distinctly show lamination, especially if moist lumps of the cohering sand be broken (not cut) vertically.

*It is also emphasized by Professor Broadhead in Am. Geol., vol. xxxiii, p. 39.

†Proc. Ia. Acad. Sci., vol. iv, p. 70, footnote.

It is an interesting fact that most loess, especially where there has evidently been rapid deposition, shows similar lamination if broken vertically. Such lamination is shown in Plate XIII, fig. 1, and also in Plate VII, fig. 1 of Professor Wright's article, and is wholly unlike water-lamination, as may be determined by comparing it with sections of pond-mud which has cracked and scaled off on drying. The writer has seen a few exposures in which what appears to be water-lamination (which is much more regular and much less like cross-bedding on a minute scale than wind-lamination) may be observed, but these bands appear only between different loesses, as if the older loess had been over-washed for a short time, or at intervals, by water from the melting glacier which had interrupted the formation of the loess. Another possibility is well illustrated by the C. G. W. Ry. cut east of Lanesboro, Iowa. Here there is evidently a buried pond, into which loess-materials had been carried by winds and erosion from higher parts of the ridge, until this portion of the pond was completely filled. The loess material in this old pond is very distinctly stratified, and contains numerous bands of iron oxide.* Its only fossils are shells of a *Pisidium*, a small bivalve which now inhabits prairie pools and streamlets. The same ridge still retains what appears to be a part of the same bog, and such bogs and ponds are common in Iowa on both drift and loess ridges. But these cases are rare and purely local, and the lamination here observed is wholly unlike that which loess usually reveals when broken vertically. They furnish no warrant for the general conclusion that the whole deposit was formed in great bodies of water, and it could be drawn from this evidence only in utter disregard of the processes which may be observed in the same region today.

Professor Wright's additional evidence in support of the theory of water-deposition of loess, contained in pp. 210–222 of his paper, is equally unsatisfactory. Stripped of its verbiage it may be briefly summed up in the statement that 1.)

*See Pl. XIV, fig. 1.

he found boulders about 40 miles south of what has been considered the limit of drift, and 15 to 60 feet above the Osage; and 2.) that the Missouri could discharge the amount of water necessary to flood the bordering loess-covered highlands. These propositions are here considered separately:

1. In the first place Professor Wright should not have been "startled" by the occurrence of the boulders in the Osage region, for a similar boulder had previously been found by Professor L. C. Wooster* near Eureka, Kas., at a point still farther south than Tuscumbia, Mo., and farther removed from the recognized drift border. Professor Wright found one boulder at a point "from fifty to sixty feet above highwater mark in the river," and a number of others on a sedimentary terrace "from fifteen to twenty feet above high-water mark," and from this he argues that the river must have been dammed sufficiently to account for the water deposition of loess on its bluffs. The weight of this argument will be appreciated, even when allowance is made for the fall to the mouth of the Osage, when it is considered that in Iowa, for example, the hills and bluffs a ong the Missouri rise to a height of 300 to 400 feet above high water, and that even in Missouri they are frequently much more than sixty feet high,† and that in all this territory their top-most bulk consists of loess!

Both Professor Wright and Miss Owen rejoice that, now that they have found evidence of a barrier so far south, the deposition of loess along the Missouri can easily be explained by the aqueous hypothesis. But they have yet to show how they would account for the deposition of the great sheet of loess which continues on down the Missouri and Mississippi rivers for several hundred miles, and which at Vicksburg and Natchez rises more than 200 feet above the Mississippi!

2. Professor Wright and Miss Owen, and Professor Broadhead who comes to their assistance in a reminiscent letter in

*Reported in Science, vol. xii, p. 132, Sept. 14, 1888.

†Miss Owen herself reports, l. c. Pl. x, some of the loess at St. Joseph 270 feet above the river!

the *Am. Geologist*, l. c., argue that the Missouri could have discharged the amount of water necessary for these vast floods. Their arguments only demonstrate that powerful currents would be necessary to accomplish this. They underestimate, however, the volume of water which would have been moved during each great flood if the loess was deposited in this manner. Manifestly every part of the area covered by loess would have to be flooded. Professor Broadhead says that "it is very rarely that the loess is found more than six miles from the Missouri river. . . ." This is not correct even for Missouri as the writer knows from personal observation, and as Professor Marbut reports,* but it is entirely wrong for Iowa, where the loess extends from the Missouri to the Mississippi, passing over the divide between the two drainage-systems! Therefore, these floods would have formed an enormous body of water, and not only would more time have been required to move them, but the necessary strong currents would not have left fine material such as loess on the bluffs which border the main streams, and which, therefore, would have been exposed to these strong currents. Professor Wright argues that the fact that loess-particles nearer the main stream are somewhat coarser than those in outlying districts, supports his contention, but this difference is entirely too insignificant for his purpose, for the particles of the çoarsest loess are still very much finer even than Miss Owen's building-sand (see p. 227, l. c.). In their anxiety to prove that the Missouri could discharge these floods and carry enough material to form the loess deposits, these authors have called into existence conditions which would result in the distribution of material much coarser than appears in the loess. Excepting where it is covered by the newer drifts the loess uniformly forms the surface deposit. In no part of the vast loess-covered area is there any deviation from this rule. If we examine the valley of any larger stream after a flood, we find masses of sand and gravel moved out over at least some of the higher ground

*See map opposite p. 80 in Williams' "The State of Missouri," 1904.

which was flooded. South of the Iowan drift-border the loess is uniformly the superior member, and whatever amount of sand and gravel may appear is uniformly beneath it. The writer repeats: Under what conditions could flooded streams have produced these results? Professor Wright's answer to this question is entirely inadequate. He is confronted by two horns of a dilemma: Either there were strong currents, and somewhere there ought to be evidences of them in coarser deposits; or the currents were not strong and the vast volume of water was moved too slowly to accomplish the desired result.

But there is another feature of the case to be considered. Professor Wright reports that it would take 96 days to carry off 500 cubic miles of water under his hypothesis. If all the loess area in the Missouri drainage was flooded, it required a much larger volume than this, but assuming this as correct, we still have to consider that the combined time required for the rise and fall of this vast volume of water would take out of each year the greater part of the season suitable for the growth of plants and snails. It would leave only the very highest areas exposed for a sufficient period to develop a flora and a fauna, and we ought to find fossils only (or at least very much more abundantly) in the highest deposits. That this is not true is known to everyone who has collected these fossils extensively. But if Professor Wright would take the trouble to investigate the subject in the field he would know that the species which predominate in the loess do not live on areas subject to overflow, and that the condition which he pictures would be unfit for such species. Professor Broadhead's comments on the snails are quite as unfortunate. On p. 394, l. c., he says: "On every wreck heap I would find among the trash hundreds of land shells, mostly Helices, and sometimes the small Pupa, all being landshells, and rarely did I find a Planorbis or Lymnea. The Succinea I could also find. These shells are also found with the loess. Those in the river were washed down from the hills by the rains, and the shells in the loess came the same way." In the first place it is fair to call upon Professor Broadhead for a bill of particulars. The term

"Helices" is very comprehensive, and includes forms which vary very much in habit. Species of the genera *Pupa* and *Succinea* exhibit the same variation in habits. Is Professor Broadhead quite sure that he found the *same species* throughout in both the wreck-heaps and the loess? The writer has collected thousands of shells along the Missouri river from both sources, and among them he frequently found shells that were evidently washed from the near-by highlands, mingled with those of lower grounds. Will Professor Broadhead explain where such shells developed when the *highest* loess-bearing ridges were covered with water, as he assumes? But the shells of the "wreck-heaps" are not identical throughout with those in the loess. A comparison of a list of modern shells from Nebraska City and Sioux City, collected in river drift, with the shells of the lcess, may be of interest:

	NEBRASKA CITY	SIOUX CITY	LOESS
Land-shells:			
Vallonia gracilicosta	Very common	Not common	Com. westward
Vallonia parvula	Common	Common	———
Polygyra leai	Not common	Not common	Not common
Strobilops virgo	Not rare	———	Quite rare
Leucholcheila fallax	Not rare	Not rare	Quite rare
Bifidaria armifera	Very common	Very common	Not rare
Bifidaria contracta	Very common	Very common	Rare
Bifidaria holzingeri	Very common	Very common	1 spec. known
Bifidaria pentodon	Common	Not common	Very common
Bifidaria procera	Not common	Not common	———
Vertigo milium	Not common	———	———
Vertigo ovata	Common	Common	Not common
Vertigo tridentata	Not common	———	Rare
Cochlicopa lubrica	Not common	Not rare	Not common
Vitrea hammonis	Not common	———	Not rare
Vitrea indentatus	Rare	———	Rare in north
Euconulus fulvus	Rare	———	Rather common
Zonitoides arboreus	Common	Common	Not rare
Zonitoides minusculus	Rare	Not rare	Very rare
Pyramidula alternata	Not rare	Not common	Not rare
Pyramidula striatella	One	Rare	Very common
Helicodiscus lineatus	Common	Common	Rather rare
Punctum pygmæum	Rare	Rare	None north
Succinea ovalis (obliqua) . . .	Rare	Rare	Common
Succinea retusa (semi-aquatic) .	Not rare	Not rare	Very rare
Succinea avara	Rare	———	Very common
Carychium exiguum	Very common	Not rare	———
Pond-snails (Pulmonates):			
Limnæa caperata	Common	Common	Local
Limnæa humilis	Common	Common	Local
Limnæa palustris	———	Not common	———
Physa gyrina	Common	Common	Very rare
Planorbis exacutus	Rare	———	———
Planorbis dilatatus	Not rare	Not rare	———
Planorbis parvus	Common	Common	Very rare
Planorbis trivolvis	Not rare	Not rare	———
Segmentina armigera	Not rare	Not rare	———
Prosobranchs (aquatic):			
Amnicola cincinnatensis . . .	Not common	———	———
Bythinella obtusa	Rare	———	———
Valvata tricarinata	Not common	———	Very rare

It will be seen that a large part of these species do not occur in the loess, or are exceedingly rare, and that 12 are aquatic,—a much larger percentage than can be found anywhere in true loess, notwithstanding the fact that the Missouri river is poorer in aquatic forms than any other river within the loess-covered territory. There is also a striking absence or scarcity of such characteristic loess forms as *Succinea grosvenorii*, *S. avara*, *Pyramidula striatella*, etc. The list includes only forms which were found in the "wreck-heaps," and does not include other aquatic forms which are sometimes found in somewhat different situations along the river. In such cases as this the upland shells were carried down for short distances, and their distribution is wholly unlike that of the loess fossils, for they are more or less banded and heaped together, a condition which is very rare in the loess, and entirely local.

But the most peculiar objection to the value of fossils is made by Miss Owen on p. 227, l. c. It is so absurd that but for the fact that it was published in a scientific journal, and hence might be credited by others who are unfamiliar with the subject, it would go unnoticed. In order that comments may be properly appreciated its most interesting parts are here reproduced in full: "Professor Shimek asserts with much positiveness that 'there is not a single well authenticated species of fluviatile mollusks known from clearly undisturbed loess in this country.' Such a statement leaves no doubt as to personal conviction, but carries no proof of its correctness, so it may be asked if the loess fossils can be positively identified. On the subject of identification of snails Theodore Gill, supporting his conclusions by those of Professor Huxley, says: 'The same kind of shell may be common to forms that are radically different in their organization, and there is no *a priori* reason why the modifications of the shell should be of any greater value than those of any other single part of the organism .... It is thus seen that the form of the shell, and even the presence or absence of a shell, are of very inferior systematic significance . . . .' If this is true, we are at liberty to assume that the loess fossils from the water-tower hill, identified for Professor Winchell by Professor Shimek as Polygyra multilineata, Pyramidula alternata, and Succinea obliqua, may with equal certainty be referred to the genera Planorbis and Limnea of the family Limnæidae, and Paludina integra of the family Paludinidæ. The æolian theory would accordingly suffer the loss of its best support."

Of course those who have studied the subject, know that Dr. Gill had reference to classification of molluscs, and not to specific identifications. *Pyramidula alternata*, for example, will always be readily recognized as a distinct species even by the beginner, whether it be placed in the genus *Pyramidula* of the family *Endodontidæ*, or, as formerly, in the genus *Helix* of the family *Helicidæ*. Miss Owen is not familiar with molluscs, and it is to be regretted for her sake that her statement was published, as it is sure to invite the ridicule of all who have even the most rudimentary knowledge of shells. The efforts made by these latest critics to discredit the "best support" of the æolian theory are certainly not a success.

Explanation of the Map.

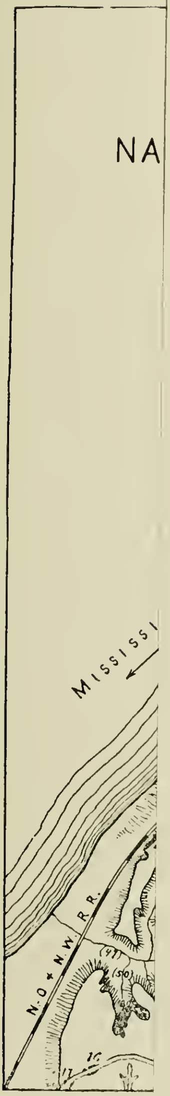
The figures in the parentheses represent altitudes above low water mark (O) in the Mississippi river.

The bridge across St. Catherine's creek on the Liberty road, not shown on the map, is 75 feet above low water.

The remaining numbers mark the exposures, the numbers corresponding to those employed in the table of fossils.

The following exposures lie beyond the limits of the map:

- No. 26, along Liberty road, east of St. Catherine's creek. Its altitude is about 105 feet above low water.
- No. 30, made by a deep gulley in a mass of loess lying considerably lower than the bluffs, some distance north of no. 29. Like no. 28, it contains broken fossils, which suggest possibilities of land-slides from the bluff above.
- No. 31, north of no. 30, forming a high bluff facing the river, and very similar to no. 29.
- No. 32, an exposure high up on a hill north of the National cemetery, at an altitude of about 210 feet above low water.
- No. 33, an exposure about half-way down the bluff along the road leading to the river bottom north of the National cemetery.
- No. 34, along the road just north of no. 35, and somewhat higher.


NA
MISSISSI
N.O + N.W. R.R.
(47)
(50)

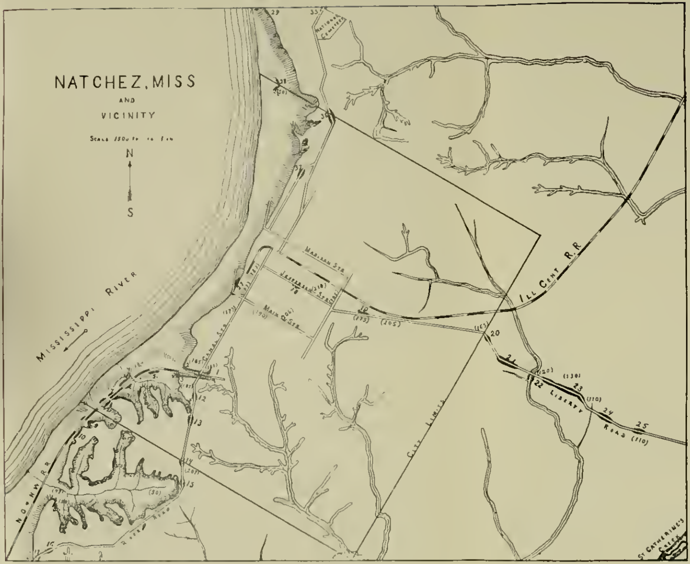

NATCHEZ, MISS
AND
VICINITY
N
S
MISSISSIPPI RIVER
Madison Str.
Jefferson Str.
Main Str.
Canal Str.
Ill Cent. R.R.
Liberty Road
City Limits
National Cemetery
St Catherine's Creek

PLATE I.

Explanation of Plate II.

A small "gulf" southeast from exposure no. 6. The stratified orange sands show in the bluff. The loess is not very distinct. The bottoms of most of the broader gulfs are quite flat, and contain no permanent streams.

PLATE II.

Explanation of Plate III.

Looking southeast from a point east of exposure no. 7. The upper vertical portion is loess. Below it is an irregular, rather narrow layer of dark brown loam, and below that the orange sands and gravels are covered largely by a loose talus.

PLATE III.

Explanation of Plate IV.

Looking west along the N. O. & N. W. R.R., from a point near its eastern terminus. The excavation to the right is exposure no. 1. The over-head bridge in the back ground is on Canal street.

PLATE IV.

Explanation of Plate V.

The figures are all natural size. Numerous large nodules were found, but none contained a greater number of shells than those figured.

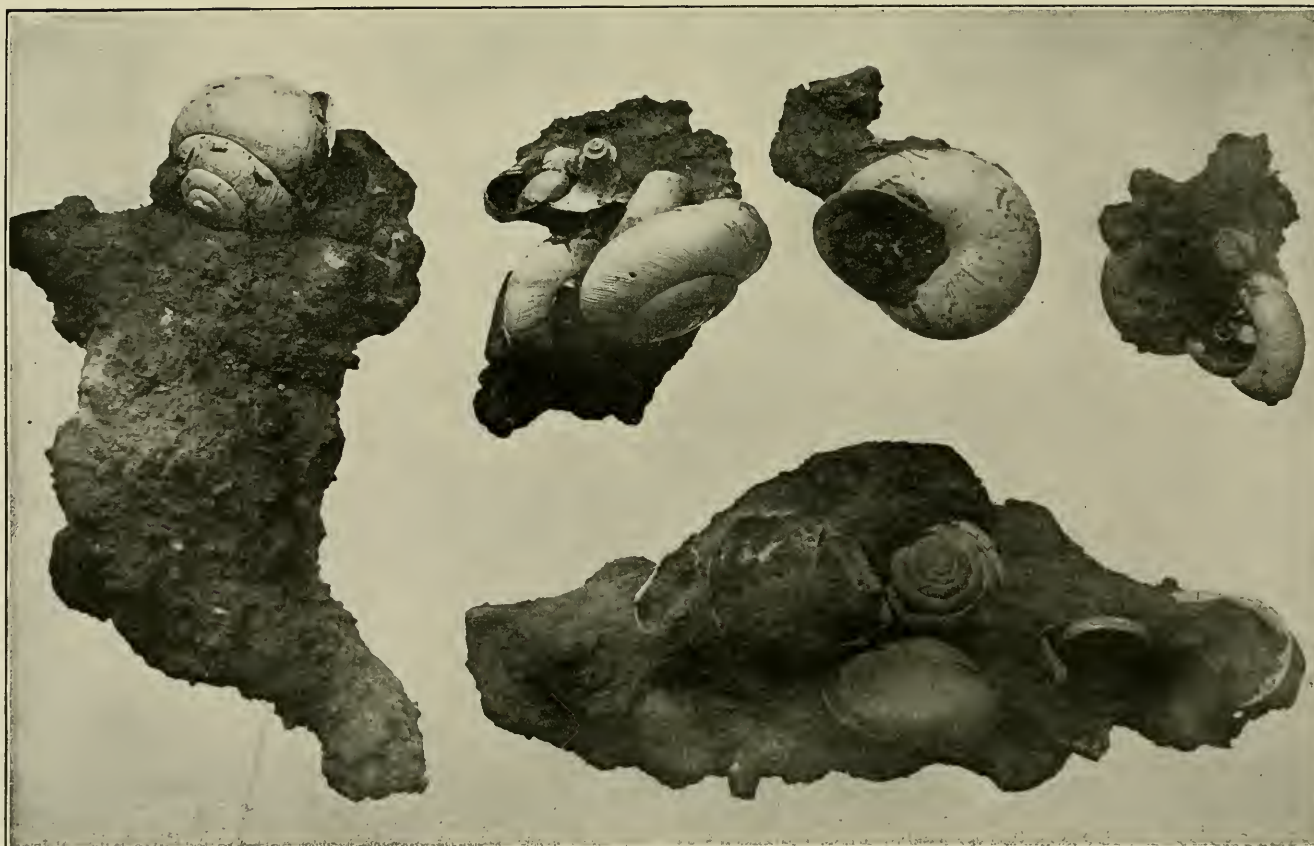


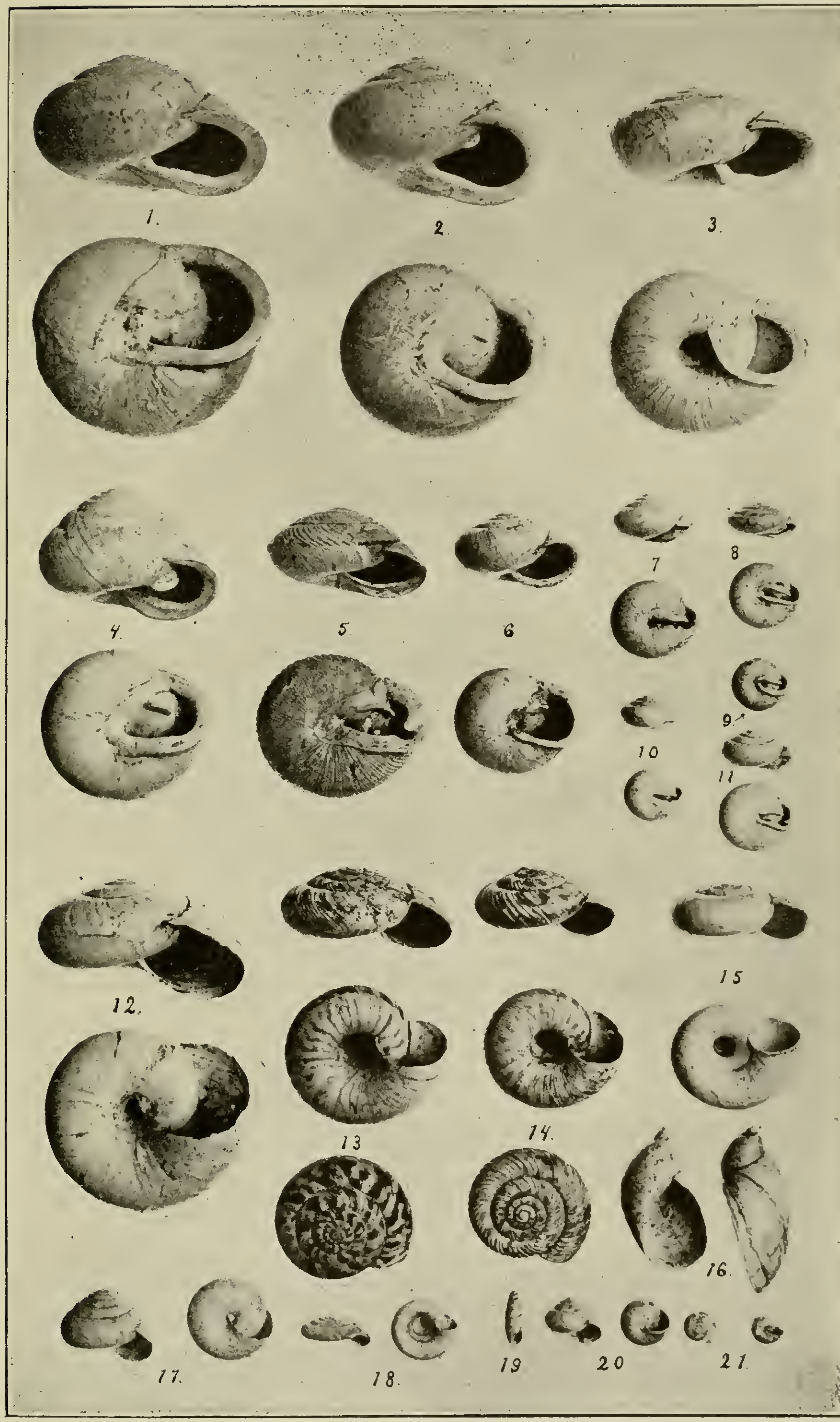
PLATE V.

Explanation of Plate VI.

Fig. 1. Polygyra albolabris (Say) Pils.
2. Polygyra exoleta (Binn.) Pils.
3. Polygyra profunda (Say) Pils.
4. Polygyra elevata (Say) Pils.
5. Polygyra obstricta (Say) Pils. The upper specimen has lost the parietal tooth.
6. Polygyra thyroides bucculenta (Gld.) Pils. The upper specimen without parietal tooth.
7. Polygyra stenotrema (Fer.) Pils.
8. Polygyra monodon fraterna (Say) Pils.
9. Polygyra monodon (Rack.) Pils.
10. Polygyra hirsuta (Say) Pils.
11. Polygyra inflecta (Say) Pils.
12. Omphalina kopnodes (Binn.) Pils.
13. Pyramidula alternata (Say) Pils.
14. Pyramidula alternata (Say) Pils.
15. Circinaria concava (Say) Pils.
16. Succinea ovalis Say.
17. Gastrodonta ligera (Say) Pils.
18. Pyramidula perspectiva (Say) Pils.
19. Cochlicopa lubrica (Müll.)
20. Helicina orbiculata Say.
21. Vitrea indentata (Say) Pils.

Two views of each species are given, front and lower surface, excepting in figs. 9 and 19, of each of which only one view is given, and 13 and 14 which show three views each. The figures are natural size.

PLATE VI.



Explanation of Plate VII.

View of Natchez bluffs, looking southwestward. At low water the water in the foreground recedes and exposes extensive mud-bars. Exposure no. 26 is just visible near the top of the hill along the road in the foreground. The deep cut in the projecting point of the bluff in the background shows exposure along the N. O. & N. W. R. R. Exposures 5, 6, 7 and 8 also show indistinctly.

PLATE VII.

Explanation of Plate VIII.

The plat roughly represents the vicinity of the Concannon house, and was made from sketches taken in the field.

a) The ridge which rises southward from the Concannon house, and is shown also in Pl. IX.

b) The ridge which rises northward and is also shown in Pl. XI., fig. 1, to the right.

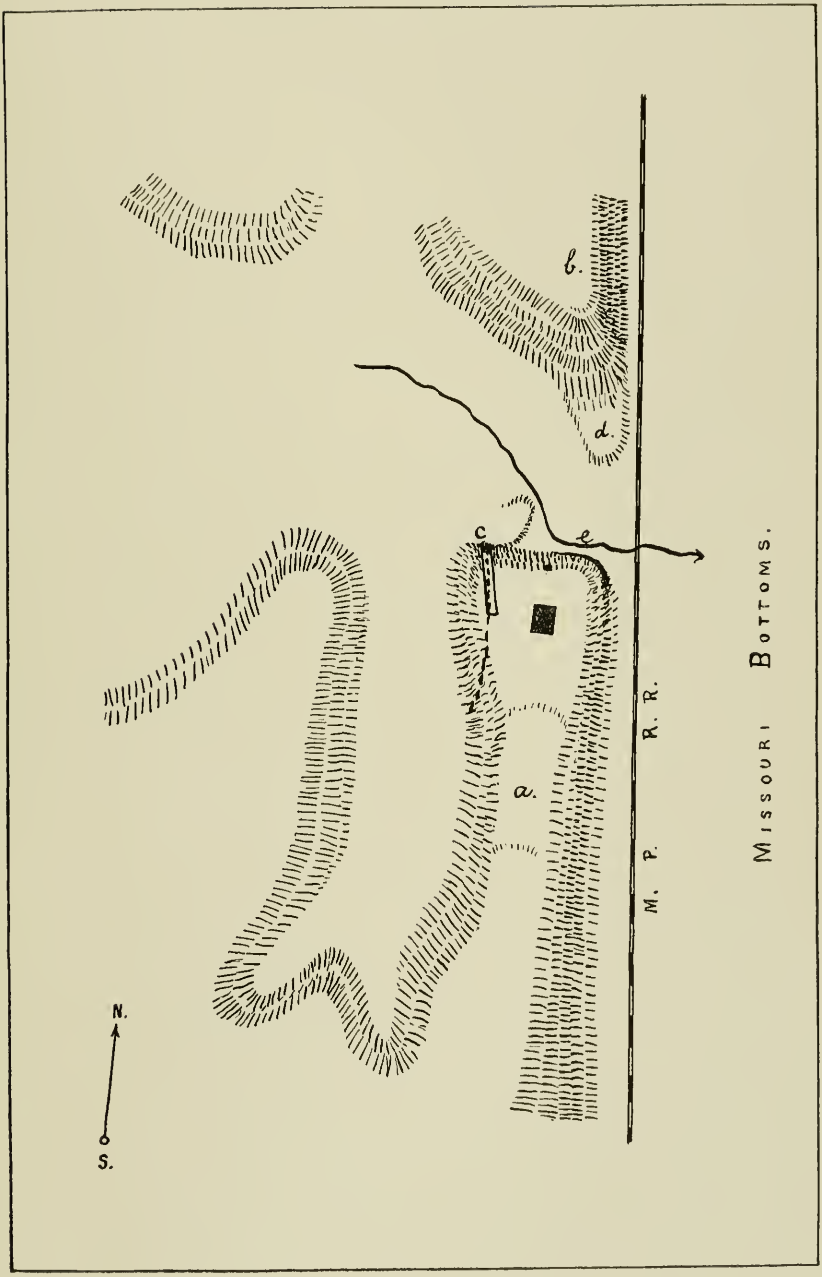
c) The entrance to the cave, from which the cave extends southward to a point west of the Concannon house.

d) The talus, low and of limited extent, which was evidently formed by slipping from *b*.

e) Carboniferous exposure at base of bank, along south side of streamlet.

The position of the R. R., the tributary streamlet, the Concannon house, etc., is also shown.

PLATE VIII.



Explanation of Plate IX.

Fig. 1. A view of the Concannon ridge looking southeast. The entrance to the cave is just to the left of the tree, which shows against the bank below the northwest (or nearest) corner of the house. The highest point on this ridge toward the south is about 180 feet above the mouth of the cave. (See p. 350).

Fig. 2. A view along the Concannon ridge, looking west of south. The cave is at the northern base of the ridge to the right. (See p. 350.)

FIG. 1.

FIG. 2.

Explanation of Plate X.

Fig. 1. The entrance to the Concannon cave is shown at the right. Extending from it toward the left is an artificial embankment made of material taken from the cave. In 1903 the Missouri river floods covered the basal portion of this embankment. The bed of the streamlet is shown in the foreground. Looking east of south. (See pp. 351–2.)

Fig. 2. Looking west of south. The entrance to the cave, and the artificial embankment show to the right. In the right foreground is a portion of the talus *d*. (See p. 352.)

PLATE X.

FIG 1.

FIG 2.

Explanation of Plate XI.

Fig. 1. The ridge *b* shows to the right. The talus *d* appears indistinctly at its base. The Concannon house is on the basal part of the ridge *a*, to the left. Looking west of north. (See p. 351).

Fig. 2. The first cut along the C. G. W. Ry. southwest of Carroll, Iowa, looking north.

The topmost layer is yellow non-fossiliferous loess. The whitish band is pale bluish loess with abundant fossils, iron - tubules and lime-nodules. Below that is Kansan drift. (See p. 367).

PLATE XI.

FIG. 1.

FIG 2.

Explanation of Plate XII.

Fig. 1. Shows the two loesses in section 3, near Decorah, Iowa. (See p. 340). The two markers indicate the line of separation, here quite sharp.

The lower is bluish (post-Kansan) loess, and the upper is yellow (post-Iowan).

Fig. 2. The third exposure north of the Iowa river in Jefferson township, along the Cedar Rapids and Iowa City electric line. The two upper markers indicate the line of division between the uppermost loess layer, and the Iowan sands below. The whitish band below this is only a moisture band. The two lower markers separate the lower, fossiliferous loess from the Iowan sand. There is a strongly oxidized band below this, extending into the lower loess, and the latter is exposed to the base of the cut. The portion of the surface with markers was scraped to show the position of the several parts. (See p. 366).

PLATE XII.

FIG. 1.

FIG. 2.

Explanation of Plate XIII.

Fig. 1. Laminated loess in cut on the north side of M. street, east of Thirteenth street, So. Omaha, Neb. This is very unlike water-lamination. (See p. 375).

Fig. 2. Sand-bars along the Missouri river, opposite St. Joseph, Mo. (See p. 373). Clouds of dust were being swept from these bars at the time the picture was taken.

PLATE XIII.

FIG 1.

FIG. 2.

Explanation of Plate XIV.

Fig. 1. The laminated and stratified deposit, evidently a buried pond-bed, in first cut east of Lanesboro, Iowa, along the C., G. W. Ry. There are strongly oxidized bands, alternating with loess-like material, which is compact, and contains shells of *Pisidium*. (See p. 375).

Fig. 2. A large sand-dune, with cotton-woods, west of California Junction, Harrison county, Iowa. Sections of this dune showed laminated sand clearly. (See p. 374).

PLATE XIV.

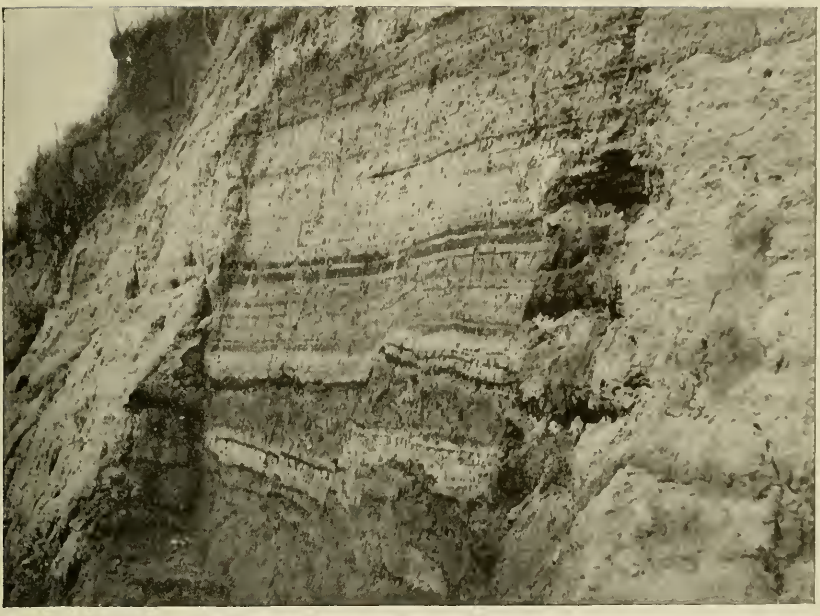


FIG. 1.

FIG. 2.