THE OHIO JOURNAL OF SCIENCE

(CONTINUATION OF THE OHIO NATURALIST)

Official Organ of the

OHIO ACADEMY OF SCIENCE

and of the

OHIO STATE UNIVERSITY SCIENTIFIC SOCIETY

VOLUME XVII, 1916-17

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THE

OHIO JOURNAL OF SCIENCE

PUBLISHED BY THE

OHIO STATE UNIVERSITY SCIENTIFIC SOCIETY

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CYTOPLASM AND HEREDITY.*

A. FRANKLIN SHULL.

It is too much to say that the days of controversy in biology are past. Yet most of us are now content to play the role of judge and jury, and abandon the less dignified role of advocate. I shall not, therefore, attempt to refute the arguments of my predecessors as a necessary preliminary to advancing evidence of exceptions. It may be granted that the work of Morgan, Bridges, Sturtevant, Muller and others, upon the fruit fly Drosophila, has demonstrated that differential factors of heredity lie in the chromosomes. Those who take comfort in the thought that these factors *may* lie in other bodies (perhaps cytoplasmic), which behave like chromosomes, but which can not be observed, and about which nothing is known, not even that they exist, may take that comfort without injury to any one but themselves. They are in the position of that famous student of heredity who, after a lifetime of biometric work, naively remarked that he saw nothing in the Mendelian work of the present century which refuted a single jot or tittle of his conclusions, but who did not think it worth while to admit that not a few of those conclusions, while still true, had, in the light of the newer work, become practically useless. They are putting new wine in old bottles.

*The concluding paper of a symposium on the mechanism of heredity, held by the Biological Conference of the Michigan Schoolmasters' Club, March 31, 1916.

It may be granted that the cytological work of the past fifteen years has established an undoubted connection between chromosomes and sex. One may even magnanimously neglect to point out that in some cases, for example, in the phylloxerans and probably the rotifers, the sex-determining event, as shown by differences in the size of the eggs, precedes the differential behavior of the chromosomes, and that the chromosomes are therefore not players, but pawns. It may be admitted that the experimental work of Baltzer, Gates, Lutz, Stomps, and others, has fixed upon the chromosomes the responsibility of producing certain hereditary features of the organisms they studied.

Yet, after making all these admissions, it is possible to accept as demonstrated certain facts which plainly indicate an influence upon hereditary processes, of something else than chromosomes. It is my purpose first to point out a few of these facts; and second to show how we may cherish this evidence, without spewing the chromosomes out of our mouths, like the angel of Laodicea, and likewise without straddling.

Among the foremost evidence of the importance of cytoplasm in heredity is that derived from cases of inheritance only through the mother. Inheritance only through the mother is in strong contrast to one of the earliest evidences in favor of the nucleus as the bearer of hereditary factors. It was long ago pointed out that father and mother shared equally in fixing the nature of the offspring; but that the spermatozoa carried little or no cytoplasm, while the egg was, from the standpoint of volume, *chiefly* cytoplasm. The chief difference between egg and sperm is that the former is lumbered down with a mass of passive cytoplasm and yolk, from which the sperm is practically free. When, then, we find a case of inheritance only through the mother, there is left little room for any conclusion but that this inheritance depends upon the cytoplasm of the egg, or upon something included in the cytoplasm.

The facts in one such case are these. In the old-fashioned four o'clocks of grandmother's garden, *Mirabilis Jalapa*, there is a variety named *albomaculata*, which has variegated leaves. The structural basis of the variegation is the fact that the chromatophores in the yellowish white patches are not bright green, but more or less blanched. The amount of green and white varies greatly in different plants. Furthermore, whole branches may be green, other whole branches white.

Flowers borne upon green branches, if self-fertilized, give seed that produces only green offspring. Flowers upon white branches if self-fertilized, give seed that produces only white offspring, which soon die because unable to carry on photosynthesis. Flowers on variegated branches yield offspring some of which are white, some green, some variegated.

Crosses between flowers upon green branches and flowers upon white branches yield the important result that only the mother determines the chlorophyll character of the next generation. Correns found that when, in such crosses, the flower used as a female was on a green branch, the offspring were all green. If the flower used as a female was on a white branch, the offspring were all white. A flower on a variegated branch yielded seeds that produced variegated plants, regardless of whether the pollen came from a green, a white, or a variegated branch. As regards this color character, the offspring are always like the mother. Even in subsequent generations, there is no reappearance of the paternal character. Domination by the female is even more rigid in these garden plants than in human families.

What causes this peculiar course of heredity may be questionable; but Correns suggests that it is due to a disease transmitted only through the cytoplasm of the egg. No generalization can be made in regard to variegation, for in other plants this character is found to be inherited through the sperm also; but there appears to be no doubt that in Mirabilis it is a cytoplasmic character.

Similar evidence of cytoplasmic influence in heredity is to be found in what are called matrocline hybrids. When two crosses are made between two races or varieties, the mother coming from race A in one case, from race B in the other, these crosses are called reciprocal crosses; and the first generation hybrids from these crosses are known as reciprocal hybrids. In ordinary Mendelian cases, the two reciprocal hybrids are theoretically equal. If the chromosomes are the bearers of hereditary factors, and if there is no disturbance in the normal chromosome behavior, the reciprocal hybrids *should* be equal. But in certain cases they are not equal, each reciprocal being more like the mother which produced it. Unequal reciprocal hybrids which resemble the mother more than the father are described as matrocline hybrids.

The earliest cases of matrocline hybrids appear to be those between different orders or genera of echinoderms. These were not always reciprocal crosses. Such crosses have been made possible largely by the work of Loeb and others on the induction of artificial parthenogenesis, through chemical changes in the sea water. Loeb himself fertilized sea-urchin eggs with the sperm of starfishes and ophiurans. The larvæ were purely of the maternal (sea-urchin) type. Godlewski fertilized sea-urchin eggs with crinoid sperm. The larvæ were again purely maternal. The most obvious explanation in each case is that the type of larval development is determined by the cytoplasm of the egg. Too much stress is not to be laid upon this evidence, however, for recent work of Baltzer has shown that there may be irregularity of the behavior of the chromosomes in the two reciprocal hybrids; so that these matrocline hybrids may some day become most excellent evidence of the importance of chromosomes in heredity. This objection can hardly be urged against other experiments of Godlewski, in which fragments of sea-urchin eggs that contained no nuclei were fertilized with crinoid sperm. Even if irregularities in the behavior of the chromosomes occurred, and some of the chromosomes were lost, whatever chromosomes remained must have been paternal. Yet larvæ from these egg fragments were purely maternal in type. This result is not the universal one, it is true, for Boveri obtained precisely the reverse effect in another cross. But for those cases in which the larva produced by merogony (that is, the fertilization of egg fragments) is maternal, there seems little room for any other conclusion than that the cytoplasm of the egg is responsible.

Not all matrocline hybrids, be it pointed out in leaving this type of evidence, are evidence of cytoplasmic influence. There are matrocline hybrids in the evening primrose, Oenothera. But there are also patrocline hybrids in the same genus, that is, reciprocal hybrids that resemble the father more than the mother. Oenothera is probably not a lawless being, but so far its laws have baffled all its students. When patrocline hybrids are finally explained in Oenothera, the explanation may well be such as will also explain matrocline hybrids without an appeal to the cytoplasm. But this anticipated defection of the evening primrose from the ranks of matrocline hybrids which owe their maternal resemblance to the cytoplasm of the egg, will not weaken the evidence which other undoubted cases of cytoplasmic influence afford.

Further arguments against the chromosomes as holders of patent rights in heredity is found in the polarity of eggs. All eggs have differentiated regions, even when these are not visibly different. In most cases the animal pole becomes the aboral pole of the later gastrula, while the vegetative pole becomes the interior of the digestive tract. This polarity can be traced back, in some cases, into the early oogonial stages, and it is not improbable that it is continuous from one generation to the next. It is scarcely conceivable that this polarity is due to anything else than the cytoplasm.

Symmetry in many animals is likewise apparently independent of the chromosomes. This is particularly true of the insects and the cephalopods. In the back swimmer Notonecta, the last part of the egg to emerge in oviposition always forms the same part of the larva, and there is a bilaterality of the body that corresponds to a bilaterality of the egg. Since in the development of the insect egg the nucleus divides repeatedly before the daughter nuclei are shut off in separate cells, it is scarcely conceivable that a selective distribution of chromatin can occur with such minute regularity as to account for the regular location of the organs. Perhaps the mere shape of the egg, acting mechanically, may produce this symmetry; but in any case, it is not the chromosomes.

And finally, the case of the ascidian egg is important. These eggs contain various localized metaplasmic substances which can be traced into the muscles, the notochord, and the nervous system of the larva. If that part of the egg which contains one of these substances be removed before development begins, the corresponding part of the larva is missing. The cytoplasmic inclusions may not be organ-forming substances, but in that case the cytoplasm itself must exert a determinative influence.

The foregoing facts indicate a probable, in some cases almost necessary, influence of cytoplasm in heredity. They are not intended, however, to disprove the chromosomes hypothesis. It seems to me possible to hold the view that both chromosomes and cytoplasm have their influence; but they play different roles. Let us examine anew the facts we have cited to show the hereditary influence of cytoplasm. There was one case (variegation in Mirabilis) which may be explained as due to a disease transmitted by the cytoplasm of the egg alone. If the disease is due to an infection to the germ of which chromatin has so far proven immune, the transmission of variegation is no more heredity, it seems to me, than is intrauterine transmission of syphilis. But if by disease we mean merely a defect, then this defect is found only in the cytoplasm. Perhaps the results can be explained by assuming that the defect lies in the chromatophores themselves, that these are autonomous bodies arising only from other bodies like themselves, and that they are handed on to new generations only in the cytoplasm of the egg. This is clearly not opposed to inheritance through the chromosomes as a general phenomenon.

All the other phenomena listed above in support of cytoplasm as an agent in heredity involve only developmental stages. Polarity directly traceable to polarity of the egg has reference only to an early larval stage. The symmetry referred to differences of the cytoplasm, applies only to the embryo. The ascidians from which muscles or notochord were missing, due to removal of part of the egg, were observed only in larval stages. The matrocline hybrids among echinoderms have been observed only as larvæ. Unfortunately, it has been found impracticable to rear them to the adult stage. No one knows whether the reciprocal hybrids would or would not be dissimilar as adults.

In view of the fact that much of the evidence that the cytoplasm influences heredity comes from embryonic stages, may we not harmonize the once conflicting views regarding chromosomes and cytoplasm in the following manner? Barring such characters as variegation in Mirabilis, for which there is a special explanation, it may be assumed that the cytoplasm often (perhaps usually) determines the type of cleavage, the early course of development, and in large measure the larval characters, while the adult characteristics are determined by the chromosomes. With the developmental stages the student of heredity using the usual breeding methods has little to do. He may be pardoned a bias in favor of the chromosomes because he rarely studies larval characters. To the physiologist and morphologist, on the other hand, the rigid conviction of the geneticist that the chromosomes contain all the tools of his trade has not unnaturally been viewed with skepticism.

I claim no originality for the above attempt at harmony. The idea I have expressed was first propounded, I believe, by Conklin in 1908. I am, however, able to advance in favor of Conklin's view evidence which was not available when Conklin wrote. In my own work on rotifers I have discovered a case of matrocline hybrids which, unlike those of the echinoderms, were easily reared to the adult stage, at which time they were wholly alike. The facts of this case are as follows: The rotifers are one of the groups of animals that lay both parthenogenetic and sexual eggs. The former hatch regularly in 14 to 18 hours after laying, the latter remain in the egg a week or longer. Moreover, whereas all the parthenogenetic eggs usually hatch, only a fraction of the young developed in sexual eggs ever emerge. The proportion of sexual eggs hatching varies greatly in different lines. In line A, in the experiments above referred to, about fifty per cent of the sexual eggs hatched. They began to hatch about a week after they were laid, and two weeks later practically all had hatched that would hatch at all. The time spent in the egg was thus fairly uniform. Line B was strongly contrasted with line A both in the total number of sexual eggs that hatched and in the length of time spent in the egg. Only five per cent of the eggs of line B ever hatched. Morover, their hatching was spread irregularly over a period of five or six weeks.

The reciprocal hybrids obtained from crosses between these two lines were very unequal. When line A furnished the mother, line B the father, the eggs laid by the females hatched in one to three weeks, like line A, and about fifty per cent of them hatched, also like line A. When line B furnished the mother, the hatching of the eggs occupied four or five weeks, and the total number hatching was about thirty per cent. In both respects the hybrid eggs in this cross were intermediate between the parent eggs.

Here the reciprocal hybrids are very unlike, each being much nearer the maternal condition. But when new lines were obtained from these hybrid eggs, and these lines produced sexual eggs of their own, the two reciprocal hybrid *lines* were fully equal. Doubtless the inequality of the reciprocal hybrid eggs was due to the cytoplasm furnished by the mother; but when adults were developed from these eggs, and new cytoplasm was produced under the influence of the paternal as well as the maternal chromosomes, the eggs containing this cytoplasm were alike in the length and uniformity of the time of development, and in the total number hatching.

Whether the matrocline hybrids of echinoderms, so far observed only as larvæ, would on becoming adults show any less the characters of the mother than in the developmental stages, can only be conjectured. But the demonstration of such a change between embryonic and adult life in the rotifers supports Conklin's suggestion that it is the larval characters which, in animals in general, are influenced by the egg cytoplasm. When, however, in writing of the function of the chromosomes, Conklin states that they have only to do with the *details* of adult structure, I am unable to follow him. Nor, it seems to me, are some of the larval features which are conditioned by the cytoplasm, for example, the form of the larval skeleton of echinoderms, to be regarded as anything else than details. Geneticists, it is true, usually deal only with details; but that is because no mutations which involve radical changes in fundamental processes, and still leave the organisms capable of breeding with the parent form, have occurred. It seems much more probable that even the fundamental features of the adult are products of chromosome determination.

Cytoplasmic influence in heredity may appeal more to a certain type of mind if there is a mechanism through which it operates. That type of mind (or some other) has already found the mechanism. Hereditary importance is attributed by some to those bodies, found in the cytoplasm of many cells, called chondriosomes. One of the leading cytologists of America (who be it said is an ardent advocate of the chromosome hypothesis) admits that "probably" the chondriosomes have something to do with heredity. But I suspect that his admission was made chiefly to clear his conscience of any bias in the opposite direction. The only evidence that chondriosomes play any role in heredity seems to be that the cytoplasm plays such a role—and the chondriosomes are in the cytoplasm.

Zoological Laboratory, University of Michigan.

SOME NEW SPECIES OF NEARCTIC TINGIDAE.*

By Herbert Osborn and Carl J. Drake.

In working up the material for the "Tingitoidea of Ohio"† we found a few new forms from other states that were not included as they were not likely to be found in Ohio. Since the publication of this paper, we have received a few specimens from other states for identification, including a few new forms. We believe that a description of these forms will prove useful to other workers in this group and in view of this fact we are publishing a description of these new species.

Acalypta ovata spec. nov. (Fig. 1.)

With new material received and with specimens already in hand of *Acalypta lillianis* we have concluded that the supposed dimorphic forms as given by Bueno are not one species, but two distinct forms. The striking differences in the head and antennal characters make the association of the two forms unwarranted unless it can be definitely proven by mating or reared specimens. We have ♂ and ♀ specimens of the brachypterous form and only ♀ specimens of the macropterous form; the short-winged form we describe herein as new. *A. ovata* can be readily separated from *lillianis*‡ (macropterous form) by its longer head and face, the curved basal segment of the antennæ, and the much larger and longer processes or tubercles between the eyes and antennæ.

Head long, narrow, armed with two diverging spines; vertex quite long. Rostrum reaching the middle of the first abdominal segment. Antennæ moderately long, beset with a few short hairs; first segment considerably swollen, curved; second segment slightly swollen, shorter than the first; third segment longest, slender, three times the length of the fourth; fourth segment fusiform, about equal to the first and second

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*Contribution to Department of Zoology and Entomology, No. 49.

†Ohio Biological Survey Bulletin 8, 1916.

‡Westwood in "Introduction to the Modern Classification of Insects," Vol. II, "Generic Synopsis," page 121, gives the generic description of the genus Acalypta as follows: "Prothorax with the sides slightly dilated, 3-carinated; antennae long, clavate, hemelytra meeting in a straight suture; wings wanting." In the Ohio Biological Survey Bulletin, No. 8, Vol. II, No. 4, p. 220, we slightly amplified Westwood's original generic description so as to include *A. lillianis* (the long-winged form) and we do not now feel warranted in placing it in another genus. In this species the sutural area is broad and rounded and the inner margins do not meet in a straight suture; true wings are also present.

conjoined. The process or tubercle between each eye and antenna rather large and curved inwardly. Pronotum coarsely punctate; the three median carina slightly sinuate. Hood extending over the base of the head. Membranous pronotal margins subquadrate, with two rows of areolæ. Elytra short, inner margins meeting in a straight suture. Length, 2.35 mm.; width, 1.2 mm.

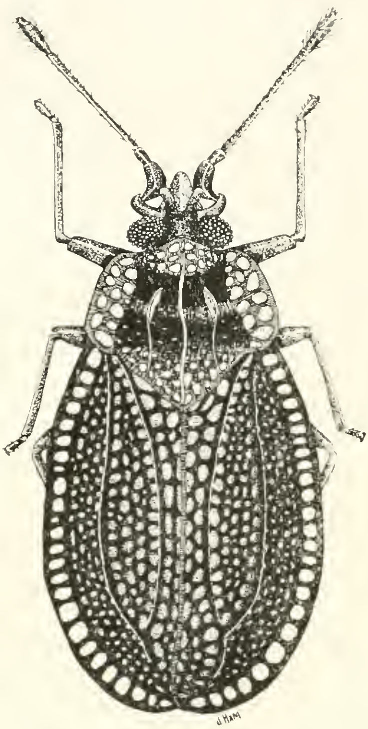


FIG. 1. ♀ *Acalypta ovata* n. sp. (From drawing by J. I. Hambleton).

The ♂ agrees with the ♀ in size, head characters, etc. The ♂ genital segment is tumid and transversely rugose; the ♀ genital segment is longitudinally striate and convex on the posterior border.

Color: General color dark-gray. Antennæ griseus, first, second, and fourth segments blackish. Pronotum dark-gray; disc blackish. Elytra dark-gray. In one specimen that seems to be a teneral form, the color is much lighter.

Described from two ♀ specimens, the type taken at Durham, New Hampshire (C. M. Weed), and the paratype at Ottawa, Canada, by Mr. W. H. Harrington.

Corythucha immaculata spec. nov.

Antennæ beset with a few long bristly hairs; first segment slightly more than twice the length of the second, moderately swollen; second segment short, less swollen than the first; fourth segment swollen toward the apex. Rostrum reaching between the posterior coxæ. Membranous pronotal margins broad, kidney-shaped, bullate about the middle, slightly turned up at the posterior margins, entire outer margins armed with rather small, closely set spines. Hood closely reticulated, abruptly constricted about the middle; anterior portion long and narrow; posterior portion subglobose. Pronotum more or less indistinctly reticulated; sides of posterior triangular process rather strongly raised anteriorly, with five or six distinct areolæ. Median carina foliaceous, with two nearly complete irregular series of unequal areolæ. Wings a little longer than the abdomen. Elytra quite closely reticulated, outer margin slightly sinuate; costal area rather coarsely and unevenly reticulated, with three complete and a partial series of areolæ; subcostal, discoidal, and sutural areas (except row of large cells on inner margin) closely reticulated. Length, 4.1 mm.; width, 2.15 mm.

Color: Body beneath black. Legs and antennæ testaceous. Nervures of hood, membranous pronotal margins, posterior triangular process of pronotum, and elytra yellowish. Areolæ translucent.

Described from two specimens, taken at Alameda, California, by Mr. Albert Koebele. We have one specimen from Santa Cruz Mountains, California, that has a few nervures slightly tinged with testaceous.

Corythucha obliqua spec. nov.

Antennæ beset with a few long, stiff hairs; first segment moderately swollen, about twice the length of the second; second segment less swollen, shortest; third segment very long, cylindrical; fourth segment considerably swollen towards the apex. Rostral groove rather broad; rostrum reaching the intermediate coxæ. Pronotum coarsely and regularly punctured; membranous margins broad, kidney-shaped, quite closely reticulated, strongly bullate about the middle, slightly reflected behind, the dorsal surface armed with a few erect spines; posterior, triangular portion reticulated at the apex, the sides raised anteriorly, with five or six distinct areolæ; median carina considerably raised, with one complete row and two divided areolæ about the middle forming double cells. Hood moderately raised, rather closely reticulated, armed with a few short spines on the sides, quite abruptly constricted about the middle, globose behind. Wings a little longer than the abdomen. Elytra broadly rounded at the apex, outer margin slightly sinuate; costal area with three complete series and a partial row of areolæ near the base. Length, 3.45 mm.; width, 1.44 mm.

Color: Antennæ yellowish. Legs dusky-yellow; tarsi somewhat embrowned. Body beneath black. Hood dark-fuscous, except a few areolæ yellowish. Pronotum dark-fuscous; apex and raised sides of triangular process yellowish. Expanded margins of pronotum mostly dark-fuscous; centers of areolæ hyaline. Elytra yellowish, a rather broad band near the base, a slightly narrower, oblique band near the apex, a few transverse nervures of costal area, and more or less of sutural areolæ dark-fuscous; areolæ of costal area hyaline. Nervures of apical areolæ dark-fuscous; areolæ hyaline, a few slightly infuscated.

Described from a single specimen, taken at Dutch Flats, California, by Mr. Chas. Dury.

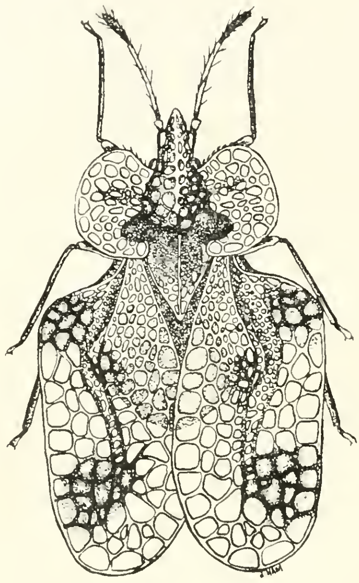


Fig. 2. *Corythuca mollicula* n. sp.

Corythucha mollicula spec. nov. (Fig. 2).

Differs from the other northern and eastern species in having the lateral spines on the pronotum (except anterior border) and elytra almost entirely wanting.

Antennæ with a few long bristly hairs; first segment swollen, twice as long as the second; second segment slightly less swollen, very short; fourth segment swollen toward the apex. Rostrum reaching between the intermediate coxæ. Membranous pronotal margins very broad, slightly bullate about the middle, slightly turned up at the posterior end, anterior margin only armed with a few small spines. Hood rather evenly reticulated, moderately elevated, not very abruptly constricted about the middle; anterior portion rather long, not very narrow.

Pronotum coarsely punctate; posterior triangular process reticulated, the sides raised anteriorly with a few distinct cells. Elytra quite broad, considerably longer than the abdomen, spines on outer margin almost entirely obsolete; costal area coarsely reticulated, with three complete series of areolæ; sutural area broad, coarsely reticulated. Wings longer than the abdomen. Length, 3.4 mm.; width, 2.16 mm.

Color: General color light gray marked with brown; centers of areolæ hyaline. Body beneath black. Anterior portion of hood light gray and the posterior part brown; center of areolæ semitransparent. Membranous pronotal margins light gray, a few veinlets near the border slightly embrowned. Pronotum brown; posterior triangular portion light gray. Elytra light gray; basal area, part of bullate area, and a subapical area chestnut brown; the veinlets are widely opaque with only the centers hyaline. Antennæ dirty white; fourth segment infuscated. Legs brownish-gray.

Described from a single specimen, labeled "June 12, 1890, Agricultural College, East Lansing, Michigan."

Corythucha distincta spec. nov.

Readily separated from allied species by the angular upper line of the hood, the outer convex margin of the elytra, the lack of spines on the outer and posterior margins of the membranous pronotal margins and outer margin of the elytra.

Antennæ with a few long bristly hairs; first segment moderately swollen, about twice as long as the second; second segment very short, less swollen than the first; third segment very long, cylindrical; fourth segment swollen toward the tip. Rostral groove moderately wide, very deep; rostrum reaching between the intermediate coxæ. Membranous pronotal margins broad, rather long and narrowing posteriorly, reniform, bullate about the middle, rather closely and evenly reticulated, slightly bent up posteriorly, anterior margin only armed with a few small spines. Hood abruptly constricted about the middle, quite evenly reticulated; anterior portion long, narrow, the sides depressed; posterior portion somewhat angular, a median line forming a distinct angle with the anterior portion of the hood. Dorsal surface of the membranous pronotal margins and elytra, and sides of hood armed with a few spines. Pronotum rather closely and evenly punctured; posterior triangular process reticulated, the sides strongly elevated anteriorly, with five or six distinct areolæ. Median carina moderately raised, with a double series of areolæ about the middle. Wings about as long as the abdomen. Elytra considerably longer than the abdomen, narrowed posteriorly, outer margin slightly convex, the basal reflected outer margin only armed with short spines; costal area with three complete and a partial series of areolæ; sutural area with a row of large areolæ on the inner margin. Length, 4 mm.; width, 2.41 mm.

Color: Body beneath black. Antennæ pale brown; apical segment infuscated. Legs pale brown; tips of tarsi blackish. Hood, pronotal margins, and elytra yellowish-gray. A rather large spot on each side of the hood, an anterior and posterior area on each pronotal margin, a basal and an apical band on the elytra (also bullate portion) fuscous-brown. Pronotum olive-brown.

Type specimen labeled "Colo.," received from Prof. C. P. Gillette, Fort Collins, Colorado. A second specimen from the same state agrees in size and form, but is uniformly a trifle lighter.

Corythucha associata spec. nov.

This species is quite like *C. aesculæ*, the buckeye Tingid, it being about the same size and of a similar color; but differs from that insect by its shorter and narrower anterior portion of the hood and the posterior portion is considerably more globose. The position of the strongly deflected hood is between *aesculæ* and *bulbosa*.

Moderately large and broad. Antennæ beset with bristly hairs; first segment swollen, three times as long as the second; second segment short; fourth segment swollen toward the apex. Rostrum reaching between the intermediate coxæ. Membranous pronotal margins broad, bullate about the middle, slightly turned up posteriorly, rather evenly reticulated, entire margins armed with closely set spines. Hood more highly elevated than in *aesculæ*, very abruptly constricted near the middle; anterior portion short and narrow; globose portion high and quite large. Pronotum punctate; triangular process reticulated, the sides raised anteriorly, with a few distinct areolæ. Median carina considerably raised. Elytra broad, considerably longer than the abdomen, broadly rounded at the tip, the outer margin slightly concave and the inner apical margin obliquely rounded. Length, 4.1 mm.; width, 2.4 mm.

Color: General color brownish. Body above and beneath blackish. Antennæ yellowish; terminal segment slightly embrowned. Legs yellowish; tips of tarsi brownish. Membranous pronotal margins hyaline, with one or two spots embrowned. Hood infuscated, the center of a few areolæ hyaline. Elytra hyaline, with a broad band near the base, another at the tip (except the distal part of the apical series of areolæ and two large cells within the band) and more or less of sutural area fuscous.

Described from a very long series of specimens, taken during August and September at Clarksville, Tennessee, by Messrs. Louis Stearns and E. H. Vance, on wild cherry, *Prunus serotina*. We have another specimen, taken June 25, 1915, at Lexington, Tenn., by Mr. D. M. DeLong. This species differs greatly from *C. pruni* by the larger hood, longer basal segment of the antennæ, etc.

Melanorhopala duryi spec. nov. (Fig. 3d.)

Somewhat allied to *M. uniformis* Stal, but easily distinguished from that species by the shorter and more swollen third segment of the antennæ and its much smaller size.

Antennæ rather stout, short, closely beset with short decumbent hairs; first segment a little longer and stronger than the second; second segment very short; third segment moderately long, quite stout, more strongly swollen toward the tip; fourth segment short, slender, conical.

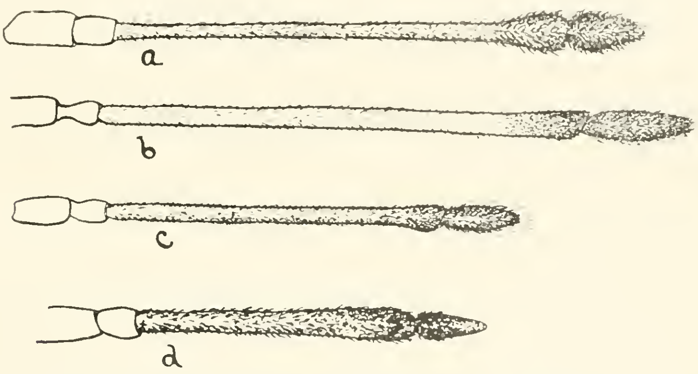


FIG. 3. Antennæ: a, *Melanorhopala clavata* Stal; b, *M. lurida* Stal; c, *M. clavata* Stal; d, *M. duryi* n. sp. (Drawings by J. I. Hambleton).

Rostrum very long, reaching between the posterior coxæ. Head with five long deflected spines. Pronotum narrowed in front, with three longitudinal carinæ; membranous pronotal margins narrow, reflected back against the surface of the pronotum. Elytra extending a little beyond the apex of the abdomen; discoidal area extending beyond the middle of the elytra; boundaries between discoidal, sutural, and subcostal areas strongly raised. Length, 3.45 mm.; width, 1.9 mm.

Color: General color, dull yellow-brown; apex of third and fourth antennal segments infuscated.

Described from a single ♀ specimen, taken at Brownsville, Texas, by Mr. Chas. Dury.

A MONSTROSITY IN TRILLIUM GRANDIFLORUM.

William H. Weston.

The genus Trillium seems to be especially subject to deviations from the normal structure. This tendency is mentioned both in Gray's Manual and in Britton and Brown's Flora, while in the botanical periodicals there are references to structural abnormalities in practically all species of the genus. Mr. Walter Deane, of the New England Botanical Club, who has collected extensively throughout the eastern United States, has reported a number of monstrosities. In the common Painted Trillium (*T. undulatum* Willd.) he has described several anomalous forms (*Rhodora*, Vol. 10, '08, p. 21–24 and p. 214–216; Vol. 12, '10, p. 163–166) from Massachusetts, Maine, New Hampshire and New York, some with flowers on the plan of four rather than three, others with as many as four superposed whorls of leaves, and others showing even greater irregularities of structure. The same author has described (*Rhodora*, Vol. 13, '11, p. 189–191) a specimen of *T. ovatum* Pursh. from Washington in which sexual organs were lacking and petals were multiplied to twenty-four; and also an abnormal *T. erectum* (*Rhodora*, Vol. 12, '10, p. 165) from the White Mountains which showed a numerical plan of four in all parts of the flower except the sepals which curiously enough were five in number. *T. sessile* L. has also furnished instances of departure from the normal type. One specimen was described by L. S. Hopkins (*Plant World*, '02, p. 182–183) with three whorls of leaves and an abnormal flower, and another was recorded by Prof. F. M. Andrews (*Plant World*, '06, p. 101) from near Bloomington, Ill., with fourteen petals and no sexual organs. Moroever in *T. recurvatum* Beck. Prof. Andrews (loc. cit.) described a most remarkable specimen with twenty-three petals.

In the species with which the present paper is concerned, *T. grandiflorum* (Michx.) Salisb. at least three instances of teratological formation have been recorded. A case of multiplication of the petals was described by Mrs. W. A. Kellerman in a plant collected in Jefferson County, Ohio (*Asa Gray Bul.* Feb., '98, p. 18–20) the figure showing a flower with the astonishing number of thirteen whorls of petals; a double flowered specimen of the same species with about fourteen parts to the perianth was collected by Prof. William R. Dudley in New York State (*The Cayuga Flora*, '86, p. 99); while Britton and Brown (Vol. 1, p. 437) refers to a plant collected in Michigan by Dr. Pitcher which showed the peculiar abnormality of two long-petioled leaves.

The purpose of the following note is to describe a form of monstrosity not as yet recorded for the species as far as the writer knows with the hope that interest in phenomena of this nature may be aroused among botanists of this region.

On May 10, 1916, Dr. F. W. Hitchings brought into the laboratory at Adelbert College three specimens of *T. grandiflorum* which through the kindness of Prof. F. H. Herrick were turned over to the writer for examination. One of these specimens was quite typical, the other two were distinct monstrosities. All three had been gathered in woods in the neighborhood of Cleveland from a large patch of flowers several of which had caught the attention of the collector because of their peculiar appearance. One of the abnormal flowers showed three superposed whorls of sepal-like structures; but since a caterpillar had involved the floral parts in its cocoon, this flower was rejected. The other abnormal flower, however, was a vigorous and uninjured one, consequently its structure was examined in detail. The leaves of this plant were normal in shape, size, and position; and there was nothing unusual in the position of the floral parts, since they were borne on a short peduncle 4 cm. above the leaves. In structure however, the flower differed markedly from the normal. Instead of showing the usual succession of a whorl of three sepals followed by three large white petals, the perianth consisted of three successive whorls of sepal-like structures surmounted by a whorl, the members of which partook of the nature of petals and sepals as shown in Fig. 2.

The first or lowest whorl consisted of three sepal-like structures similar in color, venation, and texture to sepals but more elongate-lanceolate in shape, 5.5-6 cm. long by 1.8-2 cm. wide at the widest part, (Fig. 2 and 3). In the second whorl, which alternated with the first, the members were smaller, being 4.5-5 cm. long and 1.2-1.5 cm. wide, and slightly paler in color, (Fig. 2 and 3.) The members of the third whorl were alternate to those of the second, but with a slight twist to the right so that they were not directly above the first, (Fig. 2 and 3).

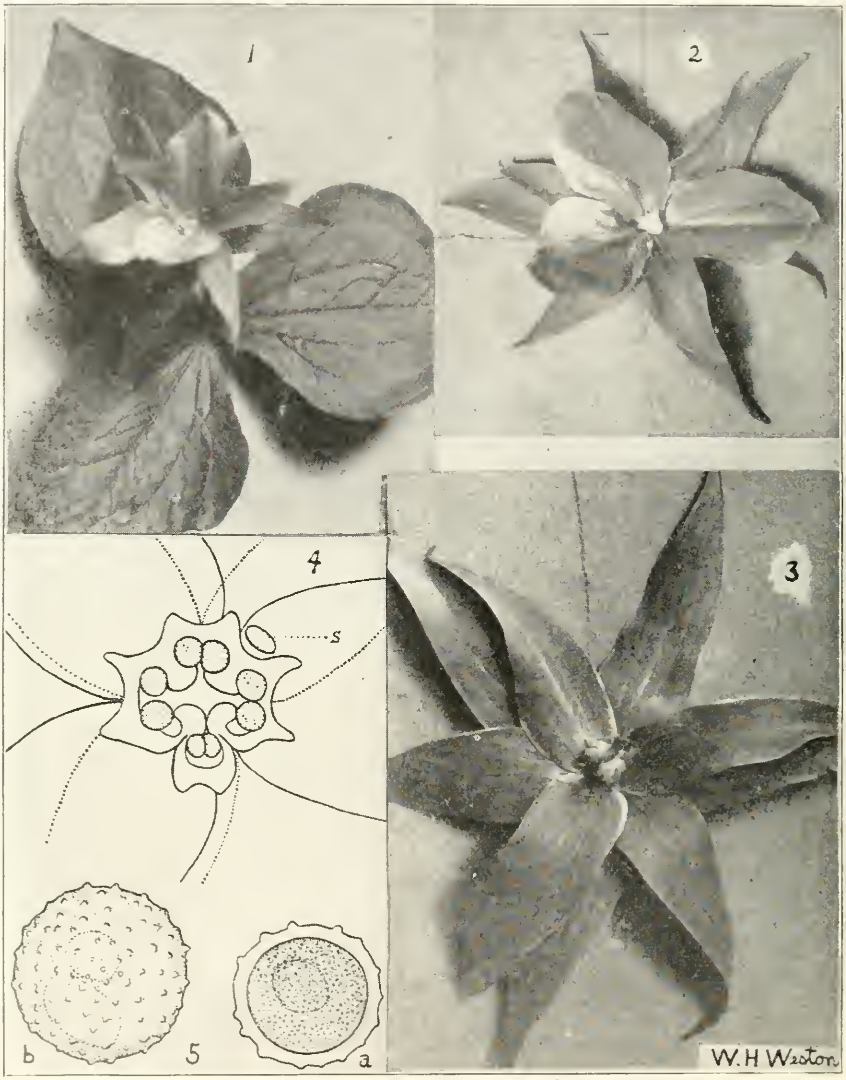
The parts were similar to those of the second whorl, but smaller, 3.5–4 cm. long by 1.1–1.5 cm. wide, and paler in color. The fourth whorl was in appearance far more petaloid than the first three, (Fig. 2). In shape the parts were obovate and rounded similar to the normal petals; but the texture was softer, and the size smaller, the dimensions being 4 cm. long and 2.5–3 cm. wide. One member was pale green with a splotch of white on one end, and with a median streak of white; the next was about two-thirds green, with the remainder white; while the third was nearly one-half white.

Not only was the perianth abnormal but the sexual organs of the flower also showed a very unusual structure, (Fig. 3). Only one stamen was present, there being no trace of the other five usually present in Trillium. On comparison with a stamen from a normal flower, the structure was found to be perfectly regular; and a microscopic examination of the pollen showed nothing exceptional in its appearance, (Fig. 5). Furthermore, both in pure water and in water with the addition of a very little cane sugar, the pollen grains from this single stamen germinated readily, indicating that they were potentially functional. In contrast to the trimerous arrangement of the parts of the normal flower and also of the perianth of this flower, the pistil showed 4 divisions, (Fig. 3). The pistil was somewhat smaller than is customary; and consisted of 4 spreading styles with the well known shape and characteristic stigmatic surface, surmounting the 4 lobed ovary containing 4 placentæ. The structure of the ovary can best be shown by a diagram of the cross section, (Fig. 4). It will be noted at once that the fourth lobe is smaller than the other three, and somewhat deeply constricted from them. Ovules were borne in all 4 divisions of the ovary, however, and were perfectly normal as far as could be seen although their functionality was not determined.

Perhaps the most remarkable thing about the flower is the persistence of the single functional stamen. Forms have been found with the number of sepals increased or with a tetramerous arrangement of the essential parts; but the combination of characters seen in this form, and especially the existence of the single stamen renders this flower rather an unusual one even as a monstrosity.

The interpretation of abnormal forms is a matter of considerable interest. At first the writer was inclined to regard the flower as diseased, the abnormal structure representing a response on the part of the plant to the stimulating effect of some fungus or insect injury. In spite of the most careful examination however, no evidence of any infection was found; and the writer was forced to regard the flower as a typical instance of monstrous growth. Such an abnormality can be regarded either as reversion to an ancestral type, or as a morphological translocation, or as a mutation. To those interested in the interpretation of these forms a very able discussion of the matter in a paper by Leavitt (*Rhodora*, Vol. 7, '05, p. 13–19 and 21–31) will undoubtedly prove of interest. The writer is not satisfied himself as to the true explanation of an abnormality such as this; and prefers merely to record the case here as one of interest, leaving the interpretation thereof to those more competent for the task. In connection however, with the possibility that such forms as these are mutations it is of interest to note that the abnormal *T. undulatum* described by Mr. Deane from Squam Lake, N. H., seemed to remain constant for years under natural conditions, while the double flowered *T. grandiflorum* from Ohio reported by Mrs. Kellerman remained constant under cultivation for ten years always producing an excessive number of petals. It is unfortunate that none of the ovules of the plant described by the writer had matured so that they might be planted to determine whether this abnormality also was one to which the offspring would breed true. One can only conjecture what the result would have been had the pollen of this plant been made to fertilize a normal flower; and the writer very much regrets that no growing plants were available so that this most interesting experiment could be attempted. Next season the writer hopes to visit the spot from which this specimen came; and make a further study of the inheritance of this abnormality. In the meantime he would be very glad to receive from botanists of this region data on any unusual forms of this unstable genus.

Adlebert College, Cleveland, Ohio.



EXPLANATION OF PLATE I.

Figs. 1-3 photographs of living plant. Figs. 4 and 5 drawings made with camera lucida, slightly reduced in reproduction.

FIG. 1. Flower and leaves (one-third natural size) showing position and arrangement of parts.

FIG. 2. Flower seen from above (one-half natural size) showing the parts of the perianth with the pistil in the center; the single stamen at the right.

FIG. 3. Flower with petaloid structures removed (natural size) showing three superposed whorls of sepals, with 4-lobed ovary in the center and single stamen at right.

FIG. 4. Diagram of cross section of ovary (x 4) showing tetramerous structure, placentæ, and ovules. Position of petaloid structures shown by solid lines; position of uppermost whorl of sepals shown by dotted lines; position of stamen indicated at *s*.

FIG. 5. a, Pollen grain, just shed, seen in optical section, x 640. b, Pollen grain about to germinate, surface view, x 640.

DESCRIPTIONS OF ROBBER FLIES OF THE GENUS ERAX.

James S. Hine.

The predatory habits of robber flies are of distinct value from the standpoint of one interested in economic entomology. A study of the genus Erax has resulted in bringing together nearly all the North American species. As a number of these are undescribed the following descriptions are published so that the names will be available in future work in the genus.

Erax plenus n. sp. A large, robust species, varying in length from 23 to 30 millimeters.

Male. Total length, 27 millimeters, antennæ black, style nearly twice as long as the third segment, palpi black and clothed with pale yellow hair, face and cheeks with abundance of pale yellowish hairs, ocellar bristles and several bristles on the upper part of the occiput black. Thorax yellow pollinose with most of the hairs and bristles black; wings with a very pale yellowish tinge, costa not thickened near the tip of the auxiliary vein, furcation of the third vein far before the base of the second posterior cell and with a distinct appendage, posterior branch of the third vein reaches the costa distinctly before the tip of the wing; legs clothed with pale yellowish hairs and black bristles, black, except the tibia which are largely reddish. First three abdominal segments dark, mostly with black hair above and white hair beneath, four white with long white hair parted in the middle and directed outward, five, six and seven white, hypopygium dark in color, short and somewhat tumid.

Female unusually robust for an Erax. Abdomen, except the ovipositor, uniformly pale yellowish pollinose, ovipositor shining black, about as long as abdominal segments five, six and seven combined. Otherwise colored as in the male.

Type male from Douglas County, Kansas, 900 feet elevation. (F. H. Snow).

Several specimens of each sex from the same locality, from Onaga, Kansas, and from Osborne County, Kansas, 1557 feet elevation, collected August 3, 1912. (F. X. Williams.)

A male from Onaga, Kansas, taken August 20, 1901, is like the other males except that abdominal segment seven is black instead of silver white. This gives the specimen quite a different appearance, but since similar variations have been observed in other species of the genus it is not considered specific here.

Erax auripilus n. sp. A medium sized species characterized by abundance of rather bright yellow hair on all parts of the body.

Male. Total length, 22 millimeters. All the hairs on the various parts of the head yellow, sternum and sides of the thorax with yellow hair, dorsum with black hair, wings clear hyaline, furcation of the third vein distinctly before the base of the second posterior cell and with a long appendage, costa not enlarged near the tip of the auxiliary vein, posterior branch of the third vein meets the costa distinctly before the tip of the wing; legs with yellow hair and black bristles, in most part black in ground color but the basal half or more of each tibia is bright yellow; abdomen with yellow hair, segments two to five black above with light colored lateral and hind margins, segments six and seven silver white, hypopygium of medium size, shining black in ground color and clothed with yellow hair.

Type male taken at Clifton, Texas, May 29, 1907, by E. B. Williamson. A male in the collection of the Academy of Natural Sciences was taken at Round Mountain, Texas.

Erax canus n. sp.

Male. Total length, 24 millimeters. General body color rather hoary white produced by white pollen and hair, dorsum of the thorax with black hair and bristles, legs with black bristles, mystax and beard pale yellow, bristles of the front black, palpi black with pale yellow hair and bristles, wings hyaline, costa uniform throughout, furcation of the third vein distinctly before the base of the second posterior cell and with a distinct appendage, the posterior branch of the third vein bends forward to meet the costa plainly before the apex of the wing, legs black with the basal third of each tibia reddish; abdomen uniformly hoary white, segments two, three and four on the dorsum with long white hair parted at the middle and directed outward; hypopygium of medium size, black and clothed with white hair.

Female colored like the male, but abdominal segments two, three and four devoid of the peculiar long hair described for the male. Ovipositor shining black, slightly longer than abdominal segments six and seven combined.

Male type from Claremont, California, sent in by Carl F. Baker; females from the same locality. The smallest female measures only 17 millimeters in total length.

NEWS AND NOTES.

At the May meeting of the Ohio State University Scientific Society the following officers were elected:

President—JAMES R. WITHROW.
Vice President—DANA J. DEMOREST.
Secretary—RAYMOND J. SEYMOUR.
Treasurer—FREDERICK H. KRECKER.

Charles S. Prosser, a member of the editorial board of this Journal and head of the Department of Geology, Ohio State University, died suddenly on September 11, 1916. The cause of his death is unknown but was probably due to some unexplained accident.

William R. Lazenby, head of the Department of Forestry, Ohio State University, and an active supporter of the Ohio Academy of Science and of this Journal died September 15, 1916.

THE LIFE OF INLAND WATERS, an elementary textbook of fresh-water biology for American students, by James G. Needham and J. T. Lloyd, of Cornell University, has been recently published by the Comstock Publishing Company, Ithaca, New York. The price of the volume is $3.00.

This work, which is a well printed and illustrated book of 438 pages, will be a valuable addition to the texts and reference books available for students in the Aquatic Biology Courses of Summer Schools and Laboratories. It discusses the nature of the aquatic environment, the aquatic organisms and societies, both plant and animal, and contains practical suggestions as to the economic uses to which our swamps and inland waters may be put. The subject material is well selected and the book should do much in stimulating an interest in the life of fresh-waters and the study, protection, and utility of our acquatic resources.

J. H. S.

Two new textbooks of General Botany have recently been issued. The one, "Fundamentals of Botany," by C. Stewart Gager, published by P. Blakiston's Son & Co., Philadelphia, is a book of 640 pages, which presents the general subject of Botany from a somewhat new and very interesting point of view.

The other, "A Textbook of Botany for Colleges," by Wm. F. Ganong, published by the MacMillan Company, New York, consists of two parts, the first part alone being issued at the present time. This consists of 390 pages devoted to Morphology and Physiology. The second part which is to deal with a description of the groups of plants will appear later.

This text also presents the subject of general botany from a distinctive point of view, each section giving the essential morphology followed by the physiology of the tissues and organs involved.

These two books occupy a field which has received little attention by American botanists, namely, the preparation of suitable texts for the general introductory courses of botany given in the numerous colleges and advanced normal schools. A text presenting a science to a freshman or sophomore college student must evidently present the subject from a different point of view than one prepared for university students. Heretofore, most of the available English texts were of entirely too advanced a nature to be satisfactorily used in introductory classes. The present texts are a valuable addition to botanical pedagogics, whether one can agree entirely with the method of presentation or not.

J. H. S.

Date of Publication, November 20, 1916.

THE

Ohio Journal of Science

PUBLISHED BY THE

Ohio State University Scientific Society

Volume XVII DECEMBER, 1916 No. 2

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THE RELATION OF THE PROFUNDUS AND GASSERIAN GANGLIA IN THE EMBRYO OF THE URODELE, PLETHODON GLUTINOSUS.

Katherine W. Okey,
Department of Anatomy, Ohio State University.

Introduction.

In such lower fishes as the Selachians both a profundus and a Gasserian ganglion are present as separate ganglia in the adult form. Many ganoids and all teleosts, with the single recorded exception of Trigla, show modifications of the condition in Selachians, by the apparent loss of the profundus ganglion or by its fusion with the Gasserian in the adult. (Allis. '97). Likewise in every adult form of Amphibia so far described the Gasserian is the only ganglion on the trigeminus nerve. No separate profundus ganglion is present, although rami from the Gasserian ganglion are homologized with all or portions of the ramus opthalmicus profundus found in Selachians.

The assumption has been made that the profundus ganglion has in the Amphibia fused with the Gasserian to form what Coghill ('02) calls "a fused ganglionic complex" in which rami representing both of the ganglionic components have their origin. Evidence for the proof of this specific assumption is wanting, although in the study of Rana embryos by Landacre and McClellan ('12) and of a Plethedon embryo by Kostir in an unpublished paper summarized in Fig. 29, it was found that certain ganglia, other than these two, which form complexes in the adult stand out separate and distinct in the embryo.

The results of these studies of embryonic conditions indicate a process of fusion in the ontogenetic development of certain ganglionic complexes other than that of the trigeminus. As stated above, it has been assumed that fusion takes place in the phylogenetic development of the profundus and Gasserian ganglia. So far as I know, however, the ontogenetic development of these two ganglia has not been studied in a form where they are separate in the embryo and form one complex in the adult.

The profundus ganglion has been found separate from the Gasserian in an early embryo of Lepidosteus, (Landacre '11) and distinct but not detached from the Gasserian in Rana (Landacre '12) and in the 11.5 mm. embryo of Plethedon glutinosus referred to above, but the exact relations of the profundus and Gasserian in the ontogeny of a favorable form have not been followed in detail. The present study was, therefore, undertaken with the purpose of determining the exact relations of the profundus and Gasserian ganglia in the early ontogeny of a typical urodele amphibian, Plethedon glutinosus.

This study was preceded by that of Kostir in an unpublished work on the 11.5 mm. embryo of Plethedon gl. and is an endeavor to trace the profundus and Gasserian ganglia from the condition in this 11.5 mm. embryo to earlier stages where the ganglia are separate and to describe their exact relation at critical stages.

This problem has definite limitations and no final conclusions concerning the phylogenetic relations of these two ganglia can be drawn from the results of this study, but if similar studies were made on a sufficient number of types in the vertebrate series, light would undoubtedly be thrown on the fate of the profundus and Gasserian in phylogeny.

I wish to express my gratitude to Professor Landacre for the help, constant encouragement and inspiration he has given me during the progress of this study.

Material and Methods.

The material used consists of a series of embryos of Plethedon taken from four lots of eggs collected at the same time. There are thirty-eight stages taken at intervals of from 3½ to 7½ hours, or an average of 4 hours. These range in length from 6 mm. to 11.5 mm. All were killed and fixed in Zenker's fluid, cut in transverse sections 10 micra thick and stained with Daelafield's hæmetoxylin and orange G.

No 30 of this series closely corresponds to the 11.5 mm. embryo studied by Kostir. Of the present series three stages were chosen for detailed study. These are:

Series:

M.—9 mm. in length.
G.—7 mm. in length and 26½ hours younger than M.
B.—6 mm. in length and 28½ hours younger than G.

Three flat reconstructions at a magnification of 150 diameters, detailed drawings at magnification of 520 diameters, and outlines at magnification of 80 diameters were made of the selected stages with the aid of a camera lucida.

The methods of study were in brief as follows:

After an examination of all 38 stages of the series, three stages as mentioned above, uniform in fixation and staining and exactness of transverse section, were selected as representing the most critical phases in the progressive development of the ganglia in question. The method of reading from later to younger stages was observed and the descriptions of the specific stages are given in this order. The histological characteristics of the ganglia were determined in the later stages since recognition of the ganglia at younger stages depends on a knowledge of the distinguishing features of their nuclei and cytoplasm, as well as of their position.

In the selection of sections for detailed drawing, care was taken to choose, when possible, comparable levels from the different stages in order to make simpler the comparison of the ganglia at different stages.

The aim was to choose from each stage one section: (a) near the anterior end of profundus; (b) at the level of the optic stalks; (c) through the roots of the ganglion; (d) through the main portion of the Gasserian, and any other sections necessary to make clear the description.

In the course of the study a count was made of the nuclei in the ganglia at each stage. In making this count the principle was adhered to of counting every nucleus visible in cross section. Many nuclei were thus recounted, but the error is apparently constant for all stages and would not effect the ratio in the results.

General Features.

The profundus and Gasserian ganglia which together form the trigeminus complex lie in front of the auditory vesicle and are the most anterior of all the pre-auditory ganglia in this form, except the ganglion of the nervus terminalis. Their general position is anterior to the facial ganglia and the auditory vesicle and in the region of the optic vesicle.

The profundus may, however, extend as far anterior as the region of the nasal capsule and the Gasserian as far posterior as the first visceral pouch of the pharyngeal region.

The ganglia are usually more or less completely surrounded by the loose mesenchyme, which fills the head region. The mesenchyme cells have rather large, light staining nuclei and unpigmented cytoplasm containing very large yolk granules and seems to be composed of mesentoderm. The cells of the ganglia have the opposite characters of small, darkly staining nuclei, like the ectoderm and small, obscure yolk granules.

This contrast in histological character makes it possible to determine the limits of the ganglia and the mesenchyme at any stage.

Description of the 9 mm. stage.

In the 11.5 embryo of Plethedon gl. described by Kostir, the Gasserian ganglion (Fig. 29, Gass. G.) is a large mass, oblong in cross section lying wedged between the brain and the optic vesicle. The anterior end of the profundus portion extends for some distance forward between the brain and the optic vesicle. From the ganglionic complex arise three nerve trunks: (a) The opthalmicus V from the anterior end; (b) the maxillaris V, and (c) the mandibularis V which fork over the temporalis and masseter muscles.

The trigeminus ganglion is attached to the medulla by a fibrous root, long antero-posteriorly. The nuclei of the ganglia have the usual dark staining properties and at this stage are very closely packed together.

The 9 mm. embryo (Fig. 30 and Fig. 1-6) is the oldest stage of my series. It shows a fused condition of the profundus and Gasserian ganglia and at the root it is impossible to distinguish between the two portions of the ganglionic complex.

At the anterior end, anterior to the level of the optic stalks, the profundus ganglion consists of a small mass of pigmented cells dorso-mesial to the optic vesicle and in contact with it (Fig. 2 and 3 Prof. G). At the level of the optic stalks the profundus is a larger oval and compact mass (Fig. 3, Prof. G), in about the same position as in the more anterior sections. At a point about one-half of the total length of the ganglion from the anterior end, the ganglion becomes larger and round in cross section, and lies mesially towards the ventro-lateral border of the medulla. Just posterior to the optic vesicle the profundus and Gasserian ganglia are joined and attached by a fibrous root to the medulla at its ventro-lateral border. In these sections the first visceral pouch of the pharynx is beginning to appear as an evagination of the endoderm (Fig. 5, Ph. P. I) accompanied by condensation of mesenchyme.

Posterior to the root of the ganglionic mass the Gasserian portion forks over the first visceral pouch in about the position where the maxillary V and mandibular V nerve trunks arise in later stages (Fig. 6, Gass G.). These trunks are entirely cellular at this stage. Near its posterior end the Gasserian ganglion becomes loose in texture. The dorsal lateralis ganglion on VII appears dorso-lateral to the Gasserian in the most posterior sections of the Gasserian. (Fig. 6, D. L. VII). No histological differences between the two ganglia are apparent at this stage (9 mm.) although in the 11.5 mm. stage the nuclei of cells of the lateral line ganglia are larger and lighter staining.

Description of the 7 mm. stage.

At this stage the profundus ganglion is very large and more prominent than the Gasserian. It is in contact with the Gasserian at its proximal end, but enters the medulla by a separate root. The profundus projects anteriorly from its point of contact with the Gasserian and lies dorsal to the optic vesicle. The Gasserian consists of a mass in contact with the medulla and of a ventro-lateral projection. The dorsal lateralis ganglion on VII lies lateral to the distal part of this extension. The general relations are shown in the flat reconstruction. (Fig. 31).

The extreme anterior end of the profundus ganglion lies between the ectoderm and the fore brain dorsal to the anterior end of the optic vesicle. Figure 7, (Prof. G.) shows the character of the ganglion near its anterior end. It is a small, ragged mass of pigmented cytoplasm containing nuclei of moderate size and dark staining properties. Mesially and ventrally it is in contact with mesenchyme and laterally it is separated from the ectoderm by a thin layer of mesenchyme, in which some darkly staining nuclei appear.

An interesting feature observable in this figure (Fig. 7) is the relation of the profundus ganglion (Prof. G) to the large ectodermal thickening (Pl.) lateral to it. This thickening is a placode, which farther posterior shows more noticeably the radial arrangement of cells characteristic of the lateral line organs and is identified as a supra-orbital lateral line placode. This placode is apparently formed by proliferation of cells in both layers of ectoderm. The cells of the outer non-nervous layer have no definite arrangement but those of the inner nervous layer lie with their long axes at right angles to the surface. Cell boundaries may sometimes be clearly made out in the placode. Mitotic figures such as seen in Figure 7 (Pl.) are numerous in the placode. Both of these facts are in contrast to the condition in the profundus ganglion. (Prof. G.).

Posterior to the level of figure 7 the ganglion becomes rounder and more compact and definite. Posterior to the optic stalks it lies slightly farther from the ectoderm. Figure 9 (Prof. G) shows a transverse section of the ganglion at the point of evagination of the optic stalks and the middle of the crystalline lens invagination. (C. L.)

At this level (Fig. 9) the profundus ganglion lies, as before, (Fig. 7) very near the supra-orbital lateral line placode. The boundaries of the ganglion are clean cut and its limits are readily distinguishable from the surrounding mesenchyme (Fig. 10, Prof. G). The nuclei seem to vary a good deal in size.

From a point posterior to the level shown in figure 9, to its root in the medulla the profundus ganglion appears to move mesially. It retains its compactness, but is smaller in transverse section than in preceding sections. Gradually it becomes looser in structure and shows a mesial projection until at the level of Figure 11, the profundus is attached to the ventro-lateral region of the medulla by a small, necklike cellular root (Rt. Prof. G). It is noticeable that the boundaries of the profundus at this level are uneven and irregular. The outline (Fig. 12) shows that the supra-orbital lateral line placode (Pl.) persists at this level, which is near the posterior end of the optic vesicle (O. V.).

Immediately posterior to the beginning of the root of the profundus the Gasserian ganglion increases in size and 10 micra posterior to the level of figure 12 it comes to lie in contact with the profundus. The profundus forms the dorso-mesial portion of the ganglionic mass and the Gasserian the ventro-lateral portion. Just posterior to this first contact with the profundus the Gasserian enters the medulla by a large, cellular root. (Fig. 13 Rt. Gass. G.)

The Gasserian portion remaining consists of a small, triangular mass in contact with the medulla and a larger rectangular mass extending ventro-laterally to the region of the first visceral pouch. As one reads posteriorly the ganglionic mass dorsal to the gill pouch increases in size and comes to lie as an irregular oblong near the supra-orbital placode and dorso-lateral to the first gill pouch. It is connected by a narrow neck with the proximal portion. The neck portion then drops out, leaving the condition shown in Figures 15-16, where the two parts of the ganglion are entirely separate. Only the larger portion (Fig. 15, Gass. G.) is figured in detail. Its close relation with the first visceral pouch (Ph. P. I) is shown in the outline (Fig. 16) while the detail drawing (Fig. 15) shows its slight lateral contact with the supra-orbital lateral line placode (Pl). At its ventro-lateral border the ganglion is irregular in outline and is at one point in close contact with the ectoderm just ventral to the placode. At its extreme ventro-lateral edge the ganglion comes into contact with the ectoderm of the first visceral pouch (Ph. P. I).

Slightly posterior to this level the proximal portion of the Gasserian drops out, leaving only the part over the gill pocket. At this same level a few nuclei of the dorsal lateralis ganglion on VII appear as a loose mass dorso-lateral to the Gasserian (not figured). The dorsal lateralis ganglion of VII is very near the ectoderm and dorsal to the gill pouch. It retains this position for several sections. The Gasserian becomes gradually smaller and more vaguely marked out and drops out just posterior to Fig. 15.

Description of the 6 mm. stage.

The profundus ganglion is in the 6 mm. stage a loose mass extending for about one-fifth its length anterior to the optic vesicle and for four-fifths of its length is in contact with the lateral ectoderm. The Gasserian at this stage is hard to define. It has no root entering the medulla, but lies close to it. A ventro-lateral extension projects to the region of the first visceral pouch. At this stage the Gasserian and the profundus are isolated from one another by a distance of three-eighths the length of profundus, as may be seen in the flat reconstruction of this stage. (Fig. 32).

The anterior end of the profundus ganglion lies in the region of the fore brain just anterior to the optic vesicle. Near its anterior end it consists of a loose mass of pigmented cells attached to the ectoderm (Fig. 17, Prof. G.).

The anterior portion of the ganglion lies in contact with the ectoderm throughout most of its dorso-ventral diameter. The greater part of this contact is immediately anterior to the supra-orbital lateral line placode. This contact continues to a point just anterior to the crystalline lens invagination. Posterior to its loss of connection with the ectoderm the profundus becomes very indefinite. There are only a few nuclei and these are separated from each other by cytoplasm and yolk granules (Fig. 21). The profundus retains its position dorsal to the optic vesicle until it drops out. At the level of the open optic stalks no trace of a ganglionic mass is found. None appears until the level of the anterior end of the Gasserian. (Fig. 23-24 and Fig. 32, Sec. 76). This mass consists of a few ganglion cells lying between the medulla and the ectoderm just posterior to the open optic stalks (Fig. 24, Gass. G.). In this group the ganglion cells have many cytoplasmic processes and large yolk granules are mingled with them. For the next ten or more sections the Gasserian ganglion is an irregular triangular mass with its base in contact with the lateral part of the medulla and its apex extending ventro-laterally to the region of the first gill pouch.

At the level of figure 25 and figure 32 the Gasserian (Gass. G.) is diffuse and has many strands of cytoplasm running parallel to the long axis of the ganglion. A few sections posterior to this point the Gasserian has two nucleated portions, one a small triangular part near the medulla and the other a large distal part lying over the gill pocket, as in the 7 mm. stage. These two portions are connected by pigmented cytoplasm.

At the level of figure 27, Plate IV, almost at the posterior end of the optic vesicle the Gasserian is restricted to a few cells over the first gill pouch. The supra-orbital lateral line placode (Pl) is large and shows a radial arrangement of cells. For a few sections posterior to Figure 27, the cells of the Gasserian are mingled with the ectoderm at the apex of the first gill pouch. They are apparently continuous with the inner layer of the ectoderm lateral to the endodermal pouch.

The Fusion of the Profundus and Gasserian Ganglia.

The form relations of the profundus and Gasserian ganglia in the specific stages described above furnish abundant evidence for the fusion intact of these ganglia. However, in order to determine whether there is other evidence bearing on this question aside from that of form relation, a count of the nuclei in the ganglia was made according to the principle stated on page 27.

Table 1. Showing the number of nuclei in the profundus and Gasserian ganglia before and after fusion.

Stage	*Length*	*No. of Nuclei*
B	6 mm.	Gass. 480, Prof. 570.
G	7 mm.	Trigeminal Complex 1330
M	9 mm.	Trigeminal Complex 1350.

In the 6 mm. stage the Gasserian has only 480 nuclei, at 9 mm. the trigeminal complex has 1350. It is obvious that this increase in number of nuclei is due mainly to the fusion of the profundus portion with the Gasserian. The number of nuclei in the trigeminal complex in the 9 mm. stage is a little more than the sum of the number of nuclei in the gasserian and profundus at the earlier stage where the two ganglia are separate.

The increase in number of nuclei from 1050, the sum of the nuclei of profundus and Gasserian in the 6 mm. stage before fusion, to 1350 in the 9 mm. stage may be partly accounted for by mitosis. Although the mitotic figures in the ganglia at any stage are extremely scarce, the maximum is 10 in the ganglion at any one stage. The difference is 200 nuclei. At the maximum rate of 10 for every stage between 6 mm. and the 9 mm.

stage, i. e., for 12 stages, the increase by mitosis during this period would be 120 nuclei. This leaves a margin of 80 nuclei for error and possible increase in rate of growth during the stages.

This count of the nuclei seems to fully confirm the other evidence for the fusion intact of the ganglia in question and leave no doubt of its certainty.

The question, however, of the possible disintegration of the Profundus portion in later stages where its identity is in part lost deserves attention. The evidence for disintegration is slight for the boundaries of profundus becomes more and more definite from early stages up to the time of fusion and there is slight evidence of shelling off of cells into the mesenchyme.

If the profundus disintegrated one would expect to find an increasing looseness in the mass and increasing difficulty in determining its boundaries up to the time of fusion. So far as I have observed the opposite is true, during its development. The profundus never behaves as a disintegrating structure, but in fact always contains some mitotic figures which are proofs of continued growth. The comparative rate of growth of the Gasserian and profundus through all stages in their development has not been determined, but the comparative rate at the selected stages furnishes significant proof that the profundus is not breaking down.

In the 6 mm. stage there is one figure in profundus and there are two in Gasserian. The rate of growth is slow for both ganglia at this stage, which is soon after their formation, and for several series the chief characterisitc of their behavior is the aggregation of cells. In the 7 mm. stage there are 10 figures in the two ganglia combined and seven of these are in the profundus. This is a period of comparatively rapid growth and the rate of growth is much higher in the profundus than in the Gasserian. The profundus is evidently the more active of the two ganglia. In the 9 mm. stage there are only four figures in the ganglionic complex. This is the beginning of a period of differentiation and of the formation of fibrous roots and nerve trunks and is marked by a slowing up in the growth process. Even at this stage, however, the profundus is as active as the Gasserian.

Aside from the facts just cited there are other evidences of the persistence in the trigeminal complex of the profundus.

(1) It forms a root which enters the medulla and during development this root shows no signs of disintegration. (2) Although the ganglionic mass is at every stage a syncytium in which the cell boundaries are not easily discerned, there is no indication of the breaking down of nuclear material at any stage. This, if present, might indicate disintegration. The nuclear boundaries become, in fact, more definite from early to late stages.

Summary of the Relations of the Profundus and Gasserian Ganglia From the 6 mm. Stage to the 11.5 mm. Stage.

A comparison of the flat reconstructions of the selected stages of the development of the profundus and Gasserian ganglia makes evident the following points: (Figs. 29, 30, 31, and 32).

(1) The anterior end of the profundus ganglion shifts from early to late stages. It moves from a point at the anterior end of the optic vesicle (Fig. 32) where it is in contact with the lateral ectoderm to a position mesial to the optic vesicle at a level half way between the optic stalks and the anterior end of the vesicle (Fig. 29). In this position it has of course no contact with the lateral ectoderm.

(2) Roots appear in the 7 mm. stage (Fig. 30) as development proceeds and there is a slight shifting ventrally of the roots from the position in earlier stages.

(3) There is a change in the shape of profundus from an irregular oval mass over half as long as broad at its widest point and tapering at both ends in early stages to an elongated tongue-like projection, broad at the proximal and narrow at the distal end in later stages. The level of the greatest dorsoventral breadth of profundus moves progressively posterior with reference to the position of the proximal end of the Gasserian. (Fig. 29-32).

(4) There is a change in the form of the ventro-lateral projections of the Gasserian ganglion from younger to older stages. It changes from a single large, rectangular projection extending to the first visceral pouch to a comparatively slender projection forked over the temporalis muscle.

(5) There is an absence of the close relation with D. Lat. Gang. on VII in the younger stages which is present in the older stages.

A comparison of comparable levels of the specific stages described, for instance, a comparison of the section at the level of the optic stalks in the 7 mm. stage with the section at about the same level in the 9 mm. stage, confirms the general features observable from flat reconstructions and in addition shows the following characteristics:

(1) Both Gasserian and profundus increase markedly in compactness and definiteness of boundary from early to late stages. The proportion of cytoplasm to nuclei appears to decrease.

(2) Mitotic figures or other evidence of growth by this method are rare in both ganglia at any stage, although they are numerous in surrounding structures.

(3) The ganglion cells can always be distinguished from those of the surrounding mesenchyme because of their pigmented cytoplasm and small yolk granules, and small, quite uniformly darkly staining nuclei. In the youngest stage large yolk granules are sometimes seen in the ganglion, but in the older stages there seems to be no evidence of the mingling of the mesenchyme with either ganglionic mass, i. e., either profundus or Gasserian, nor of the shelling off of ganglionic cells into the surrounding mesenchyme.

(4) The anterior end of profundus in the 6 mm..and the 7 mm. stages lies close to a supra-orbital placode.

(5) The ventro-lateral projection of the Gasserian is closely associated with the first visceral pouch.

The relation of the anterior part of profundus to the supra-orbital placode is a very striking one. Until however the origin of the profundus ganglion and of the lateral line system have been described for this type, one is not justified in attempting to explain the significance of this relation. The same may be said for the relation of the ventro-lateral extension of the Gasserian ganglion to the first visceral pouch.

The Phylogenetic Relations of the Ramus Opthalmicus Profundus.

In order to make clear the bearings of the results of this ontogenetic study on the phylogenetic history of the profundus, it will be necessary to summarize the relations of the profundus ganglion and its nerves in the vertebrate phylogenetic series. Table 2 is a synopsis of the conditions in great part as given by Allis '97.

TABLE II—Showing the Phylogenetic Relations of the Profundus Ganglion and its Nerve Trunks.
(In part after Allis, '97.)

Phylum—Chordata
Class—Pisces
Sub Class—Elasmobranchii
Order—Selachii

Genus	*Prof. G.*	*Rt. Prof. G.*	*Rami Prof.*	*Innervation*
Laemargus (Ewart '89, '96) (See Allis '97, p. 535)	Separate from trigeminus in adult.	Fairly separate from trigeminus some communicating branches.	(1) r. op. prof. which divides into (a) small branch above rectus superior muscle, (b) main branch under rectus internus.	Cutaneous and subcutaneous tissue of the snout.
Raja (Ewart '89) (See Allis '97, p. 535-6)	Separate from trigeminus in adult.	Root more intimately connected with root of trigeminus.	r. op. prof. below superior and inferior recti and obliquus, superior; below trochlaris and superior branch of oculomotor. (Schwalbe '79) (See Allis, p. 537).	
Torpedo (Ewart '90)	Separate from trigeminus in adult.			
Acanthias vul. (Mitrophanow by Allis) (See Allis '97, p. 537)	Mesocephalic ganglion, (homologized with the profundus ganglion of Amia) separate from trigeminus in the embryo.	A prolongation of the posterior root of the trigeminus.	r. op. prof. porto prof.	
Sub Class—Ganoidii	Separate ganglion in adult.	Separate in 12 mm. embryo but somewhat fused in adult.	A large portio op. prof. which runs above all the muscles of the eye and joins op. sup. V several ciliary nerves and a small degenerating r. op. prof. from ganglion between dorsal and ventral angle.	
Genus				
Amia (Allis '97) pp. 593, 532.				

TABLE II—Continued.

Genus	*Prof. G.*	*Rt. Prof. G.*	*Rami Prof.*	*Innervation*
Lepidosteus (Schneider) (See Allis '97, p. 540) (Landacre '12)	Separate ganglion in adult.		10 mm. embryo. R. op. prof. from anterior end of Prof. G. dorsal to optic vesicle Associated with R. O. S. VII (Landacre '12, Fig. 1). *Adult.*—portio op. prof. probably No. r. op. prof.	
Sub Class—Teleostomi				
Menidia (Herrick '99) (pp. 362-66)	Not isolated in adult. A portion of Gasserian ganglion isolated and fused with most cephalic ganglion of sym. system.	Fused with root of trigeminus.	Portion of cutaneous fibres from isolated Gasserian ganglion, which are fused with radix longa of ciliary ganglion tentatively homologized with r. op. prof. No. portio op. prof.	
Trigla (Stannius '49) (See Allis '97, p. 538)	Sep. from trig. in adult.	Arises from trig. root.	No. r. op. prof., two ciliary rami.	
Class—Amphibia Order—Urodela				
Genus				
Spelerpes (Bowers '01)	Fused in adult.			
Ambylstoma (Coghill '02)	Fused with Gass. gang. and the ganglion of the anterior division of the Lat. VII root in adult.	Fused with trig. root.	r. op. prof. has 3 branches and performs function of R. op. and r. max. in frog tadpole. Passes below rectus superior and above rectus inferior and rectus internus.	

Amphiuma (Norris '08, p. 533)	Fused with gass. in adult.	Fused with trig. root.	r. op. prof. from anterior end of Gasserian 5 branches.
Order Anura			
Genus			
Rana (Strong '95)	Adult—Fused with trigeminus and Facial in 21 mm. embryo. Antero-ventral and middle portion of Gass. gang. particularly separate. No profundus described.		R. opthalmicus trigeminus r. opthalmicus trig. supraorbital but deep. From antero-ventral part of Trig. ganglion. Passes between rami of oculomotor.
(Landacre and McClellan '12, p. 463)	8 and 10 embryo, distinct but not detached from Gasserian.		r. opthalmicus seems at this time to come entirely from the profundus portion.
Class—Mammalia			
Guinea Pig (Chiarugi '94) (See Allis '97, p. 545)	Distinct opthalmic gang. but soon fuses with the trig. (unquestionably prof. ganglia of Amia (Allis '97, p.545).		r. opthalmicus.
Man (Streeter '08) (pp. 287-296)	Fused with Trig. in the adult, called semi-lunar ganglion (Wilder '09, p.456), 10 mm. embryo. No. prof. gang. described only a gang. semi-lunar.		10 mm. embryo. r. opthalmicus divides into frontal and naso-ciliary just dorsal to eye stalk.
(Ewart '90) (See Allis '97, p. 545)	5 mo. embryo vestiges of a profundus ganglion lying under cover of the inner portion of the Gasserian ganglion.		

In the Elasmobranchs the profundus ganglion is separate from the Gasserian and usually has a separate root even in the adult form. From this profundus ganglion arises the ventral ramus opthalmicus profundus which innervates the cutaneous tissues of the rostrum, and carries ciliary nerves and in one case noted (Acanthias) gives rise to the portio opthalmici profundi, which represents the dorsal branch of the primitive profundus nerve. (See Herrick '99, p. 364).

In the ganoids several different conditions exist. The Gasserian and profundus ganglia are usually separate in the adult, but a true ramus opthalmicus profundus is seldom present. According to Allis "a small, delicate, apparently degenerate nerve from the profundus ganglion" is in Amia the only remnant of the ramus opthalmicus profundus. There is a large portio opthalmicus profundus which fuses with the ramus opthalmicus superficialis V to form the supra-orbital trunk.

In teleosts the profundus ganglion is not isolated in the adult (Herrick '99) and no ramus opthalmicus profundus is described for any form so far as I know. Herrick homologizes cutaneous fibres which arise from the Gasserian ganglion and are fused with the radix longa from the ciliary ganglion with the ramus opthalmicus profundus of the Elasmobranchs. Allis takes the position that the ramus opthalmicus profundus is probably entirely wanting in Teleosts (p. 539) and that the ramus op sup V, probably contains the portio op. prof. The ramus opthalmicus profundus, whatever its relation to the muscles of eye (Allis '97, p. 536) always lies under the superior branch of the oculomotor and over the inferior branch of that nerve. In teleosts and ganoids a small branch of the trigeminus which is found dorsal to the oculomotor nerve must undergo a special development, i. e., become enlarged, as the rest of the profundus nerve disappears and become the portio opthalmicus profundus, which may be a separate nerve as in Amia, or be fused with the ramus opthalmicus superficialis V, as in Teleosts, according to Allis ('97, p. 539).

In the Amphibia the profundus ganglion is partially or entirely separate from the Gasserian in the embryo, but is always fused in the adult. In the adult Anura the trigeminal complex is also fused with the facial complex, but in the Urodeles the facial is separate. A ramus opthalmicus profundus is present and so named in almost every adult form of Urodele described (e. g. Coghill '12, Amblystoma).

Strong ('95) does not designate the opthalmic trunk arising from the Gasserian ganglion in Rana, as r. oph. profundus. He calls it the r. opthalmicus trigeminus. In discussing the problem of the profundus however, he seems (p. 193) to partially agree with Wilder ('92) who took the position that in Amphibia and the higher vertebrates the r. op. sup. V is fused with the r. op. profundus of the Elasmobranchs to form the r. op. trigeminus or supra-orbital trunk. Landacre ('12) finds that in the 8 mm. Rana embryo the r. opthalmicus comes almost entirely from the profundus portion of the ganglion, but in later stages derives some fibers from the Gasserian.

In higher terrestial vertebrates neither the r. opthalmicus profundus nor its ganglion are distinct in adult forms. A separate profundus ganglion has been found in the cat and the guinea pig embryos and Ewart ('90) found vestiges of it in the 5 mo. human embryo. The name ramus opthalmicus is the common term for the anterior trunk from the trigeminal or semi-lunar ganglion in higher vertebrates. The word profundus has dropped from the terminology of this complex and no hint is given that some fibers of this opthalmic trunk may have their origin in the profundus portion of the ganglion. The real morphology and origin of this nerve trunk is not known for the higher vertebrates and such forms as these would logically be the next to study after such a form as the Urodele where a r. opth. profundus is present and so named. The difficulty of obtaining a close series of embryos of the higher vertebrates makes the problem a serious one. The results of such studies would throw light on the question of what happens to the region innervated by a nerve when the ganglion on that nerve disappears or fuses with another. Such studies would also help to clear up the question of the fate of the profundus ganglion in phylogeny. It is evident from the summary given above that the urodeles occupy an intermediate position between types with a separate profundus ganglion and a distinct r. oph. prof. nerve in the adult and those types with neither profundus ganglion nor nerve in the adult; in that the urodeles have both structures separate in the embryo and in the adult have a distinct r. oph. prof. but fused Gasserian and profundus ganglia. The results of this study show that for Plethedon at least the ganglia of the adult are formed by an actual fusion of the profundus with the Gasserian without loss of cells by the profundus portion. This would not warrant the conclusion that the same process occurs in types where there is a loss of the r. oph. prof. nerve, but it throws an interesting light on the mode by which the process of reduction ending in loss of both profundus ganglion and nerve began in phylogeny.

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ABBREVIATIONS.

Gal. E, Journ. Science, Dec.—(D)
Aud. G.—Auditory ganglion.
Aud. Ves.—Auditory vesicle.
B. B.—Base of the brain.
C. L.—Crystalline lens invagination.
Dien.—Diencephalon.
D. L. VII.—Dorso-lateral portion of the lateralis VII ganglion.
Ec.—Ectoderm.
Ec. Con.—Contact of the profundus ganglion with the lateral ectoderm.
En.—Endoderm.
En. D.—Endolymphatic duct.
Gass. G.—Gasserian ganglion.
Gen. G.—Geniculate ganglion.
Inf.—Infundibulum.
Med.—Medulla oblongata.
M. B.—Mid-brain.
Mes.—Mesenchyme.
N. C.—Nasal capsule.
O. V.—Optic vesicle.
Pal. VII.—Palatine branch of VII.
Ph.—Pharynx.
Ph. P. I.—First visceral pouch of the pharynx.
Pl.—A supra-orbital placode of the lateral line series.
Prof. G.—Profundus ganglion.
R. aveolaris VII.—Ramus aveolaris VII.
R. Bucc. VII.—Ramus buccalis VII.
R. Max. V.—Ramus maxillaris V.
R. op. Prof. V.—Ramus opthalmicus profundus V.
R. op. Sup. VII.—Ramus superficialis VII.
Rt. Gass. G.—Root of the Gasserian ganglion.
Rt. Prof. G.—Root of the profundus ganglion.
Tel.—Telencephalon.
V. L. VII.—Ventro-lateral portion of the lateralis VII ganglion.

Explanation of Figures.

All sections were cut 10 micra thick and all reconstructions and drawings were made from transverse sections. Flat reconstructions at 150 diam., detailed drawings at 520 diam. and outlines at 80 diam. were made with a camera lucida. All figures were reduced to one-third and the magnification after reduction is given after the description of each figure. Figures 1 to 6 inclusive are from the same embryo. (Plethedon gl. stage m. 9 mm.) from which the flat reconstruction Fig. 30 was made.

Plate II.

Figure 1 is a detailed drawing of the profundus near the level of the middle of the crystalline lens and seven sections posterior to the anterior end of the profundus. (See Fig. 2). Large yolk granules appear as light areas in the mesenchyme. The pigmented cytoplasm of the ganglion is shown by darker, solid stippling. Sec. 62 × 175.

Figure 2 is an outline of the section of which a portion is detailed in Fig. 1. ×27.

Figure 3 is an outline of a section at the level of the optic stalks and just posterior to the crystalline lens. Sec. 69. × 27.

Figure 4 is a detailed drawing of the trigeminal complex at the level of the root. (See Fig. 5). The fibrous root of the Gasserian ganglion is shown (Rt. Gass. G.). A profundus root cannot be distinguished in the figure nor identified in the section from which it was drawn. Sec. 90. × 175.

Figure 5 is an outline of the section of which a portion is detailed in Fig. 4. Sec. 90. ×27.

Figure 6 is an outline of a section through the main portion of the Gasserian ganglion half way between its root and its posterior end. The D. L. VII is shown lateral to the Gasserian ganglion which shows the characteristic forking over the first visceral pouch of the pharynx. (Ph. P. 1). Sec. 95. ×27.

Figures 7 to 15, inclusive, are all from the same embryo (Plethedon gl. Stage G. 7 mm.) from which the flat reconstruction of Fig. 31 was made.

Figure 7 is a detailed drawing of the profundus ganglion at the level of Fig. 8, six sections posterior to the anterior end. The irregular outline of the ganglion is shown and its position relative to a supra-orbital placode of the lateral line series (Pl). The placode appears as a thickening of the ectoderm. The nuclei in the inner layer, containing a mitotic figure, are seen to have a radial arrangement. Sec. 52. ×175.

Figure 8 is an outline of the section of which a portion is detailed in Fig. 7. × 27.

Figure 9 is an outline of the section of which a portion is detailed in Figure 10. This section is at the level of the open optic stalks and the middle of the crystalline lens. Sec. 68. ×27.

Fig. 1

Fig. 2

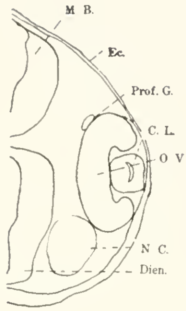

Fig. 3

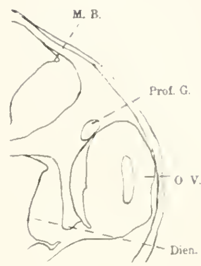

Fig 4

Fig. 5

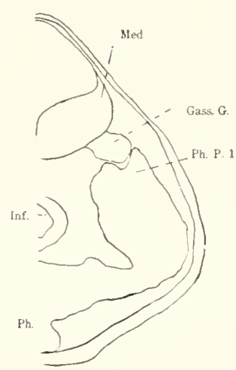

Fig. 6

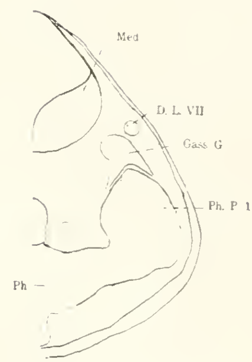

Fig 7

Fig. 8

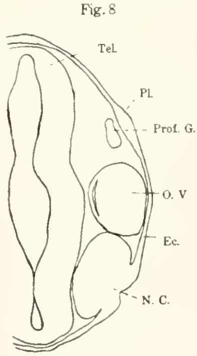

Fig. 9

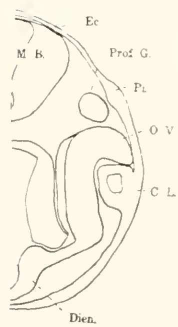

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PLATE III.

Figure 10 is a detailed drawing of the profundus at the level of Figure 9. The definite boundaries and compactness of the ganglion stand out clearly in the figure. This figure also illustrates the relation of the ganglion to a supra-orbital placode (Pl), the nuclei of which show a radical arrangement. Sec.68 ×175.

Figure 11 is a detailed drawing of the profundus at the level of its root in the medulla. The root is cellular, as the figure shows and is at this level separate from the root of the Gasserian. Sec. 86. ×175.

Figure 12 is an outline of the section of which a portion is detailed in Fig. 11. Sec. 86. × 27.

Figure 13 is a detailed drawing of the trigeminal complex seven sections posterior to the beginning of the root of the profundus. This figure is drawn from the left side of the section because it showed the double root more clearly than the right side. Sec. 93. × 175.

Figure 14 is an outline of the section of which a portion is detailed in Fig. 13. Sec. 93. × 27.

Figure 15 is a detailed drawing of a portion of the Gasserian ganglion at the level of Fig. 16. Only the part over the gill pouch is detailed. The close relation of the ganglion to a lat. line placode (pl.) is shown and also its contact with the endoderm (en) of the gill pouch. Sec. 94. × 175.

Figure 16 is an outline of the section of which a portion is detailed in Fig. 15. Sec. 94. ×27.

Figures 17 to 27, inclusive, are from the same embryo (Plethedon gl. Stage B, 6 mm.) from which the first reconstruction Fig. 32 was made.

Figure 17 is a detailed drawing of the profundus ganglion with the ectoderm (ec) is shown and also the irregular outlines of the ganglion. Sec. 45. × 175.

Fig. 10

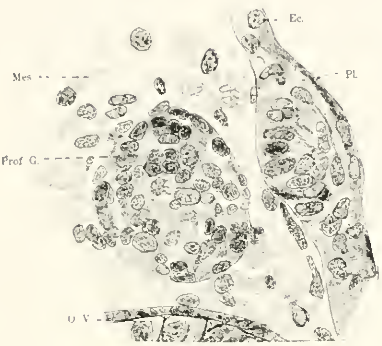

Fig. 12

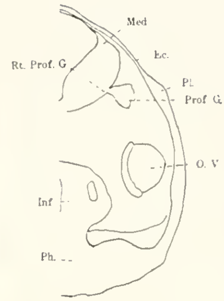

Fig. 14

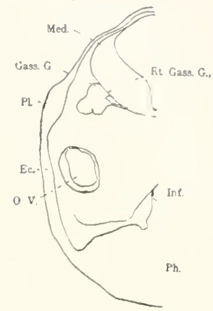

Fig. 11

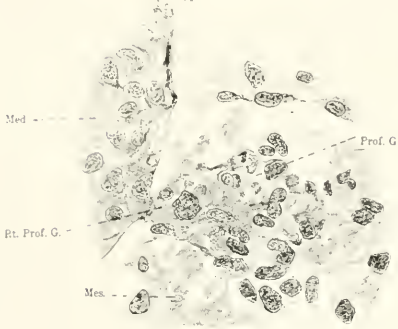

Fig. 13

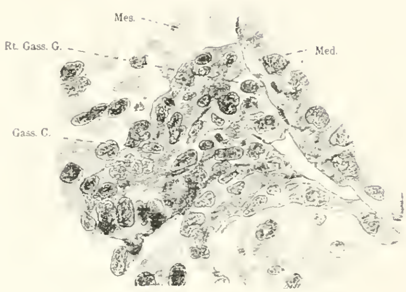

Fig. 15

Fig. 16

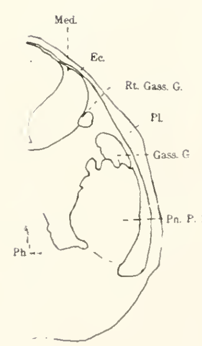

Fig. 17

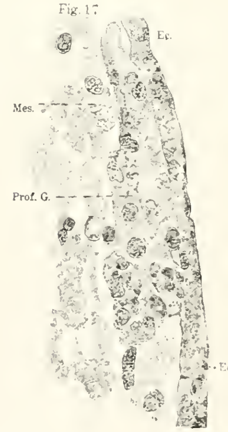

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Plate IV.

Figure 18 is an outline of the section of which a portion is detailed in Fig. 17. This section is three or four sections posterior to the anterior end of the profundus. Sec. 45. × 27.

Figure 19 is a detailed drawing of the profundus at the level of Figure 20. The ventro-lateral attachment of the profundus to the lateral ectoderm is shown. The loose structure of the ganglion and its irregular outline are also shown. Sec. 56. × 175.

Figure 20 is an outline of the section of which a portion is detailed in Fig. 19. Sec. 56. × 27.

Figure 21 shows in detail the extreme posterior end of the profundus ganglion slightly anterior to the level of the evagination of the optic stalks. The ganglion appears very small in this figure. Large yolk granules appear as light areas in the surrounding mesenchyme. (See Fig. 22). Sec. 67. × 175.

Figure 22 is an outline of the section of which a portion is shown in detail in Fig. 21. Sec. 67. × 27.

Figure 23 shows in detail the extreme anterior end of the Gasserion ganglion which appears as a small, darkly stippled mass. The level is that of Fig. 24. The anterior end of a placode is shown (Pl). Sec. 76 . × 175.

Figure 24 is an outline of the section of which a portion is shown in detail in Fig. 23. Sec. 76. × 27.

Figure 25 shows in detail the characteristic condition of the Gasserian ganglion near its middle part. The relation to the medulla is shown. No root, either cellular or fibrous, appears. Sec. 85. × 175.

Figure 26 is an outline of the section of which a portion is detailed in Fig. 25. Sec. 85. × 27.

Figure 27 shows in detail the posterior part of the Gasserian ganglion. It lies in contact with the first visceral pouch (Ph. p. 1, Fig. 28) and near a placode of the lateral line series (Pl). × 175.

Figure 28 is an outline of the section of which a portion is detailed in Fig. 27. Sec. 94. × 27.

Fig. 19

Fig. 18

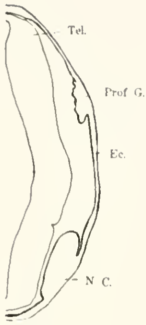

Fig 20

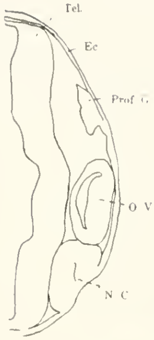

Fig 22

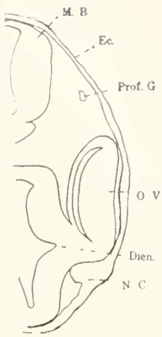

Fig 24

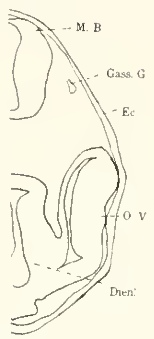

Fig. 21

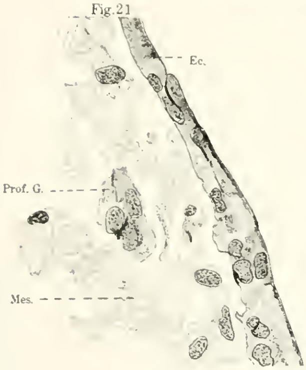

Fig 23

Fig 28

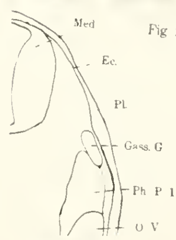

Fig. 26

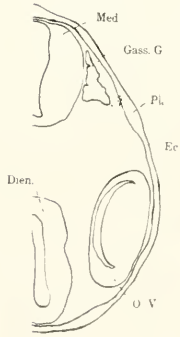

Fig. 25

Fig. 27

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Plate V.

Figure 29. A copy of a portion of a flat reconstruction by W. J. Kostir of a Plethedon embryo 11.5 mm. in length. The scale at the top of the figure indicates the number of sections 10 micra in thickness over which the plot extends. The figures indicate the numbers of the sections, counted from the anterior end of the body.

This reconstruction shows the most fused embryonic condition of the trigeminal complex so far studied. The profundus portion is not distinct; the nerve trunks are formed and the ganglion is over-lapped by the D. L. VII. × 66.

Figure 30 is a flat reconstruction of the Gasserian, profundus and a part of the D. L. VII of Plethedon gl. stage M, 9 mm. in length. This shows a well fused condition of the Trigeminal complex and a single root, which is indicated by dotted lines (Rt. Gass. G.). An outline of a longitudinal section of the head was made on coordinate paper with a camera lucida. This outline was used as a horizontal axis and guide in making the reconstructions of the transverse sections. The same method was used for the reconstructions shown in Figs. 31 and 32. The scale at the top of the figure indicates the number of sections 10 micra in thickness over which the plot extends. The figures indicate the numbers of the sections counted from the anterior end of the body. The levels of the sections detailed in Figures 1 to 6 are given. × 50.

Figure 31 is a flat reconstruction of the Gasserian and profundus ganglia and a part of D. L. VII of Plethedon gl. stage G., 7 mm. in length. The roots of profundus and Gasserian are separate at this stage. A dotted line indicates the line of contact of the profundus and Gasserian posterior to the root of profundus. × 50.

Figure 32 is a flat reconstruction of the Gasserian and profundus ganglia of Plethedon gl. stage B., 6 mm. in length. The ganglia have no roots at this stage. This shows the unfused condition of the profundus and the Gasserian and the number of sections by which they are separated. The contact of the profundus with the ectoderm is shown (Ec. Con.). × 50.

Fig 29

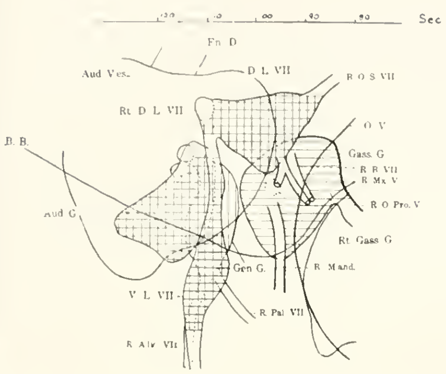


Fig 30

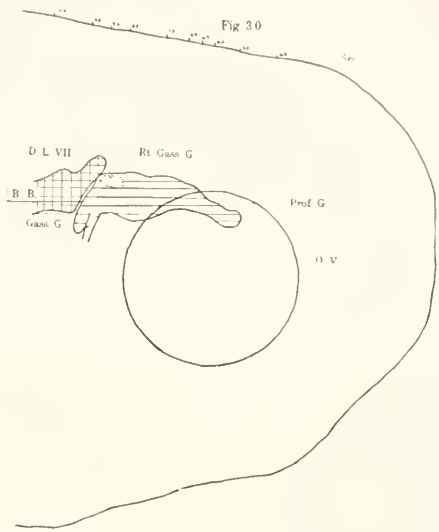


Fig. 31

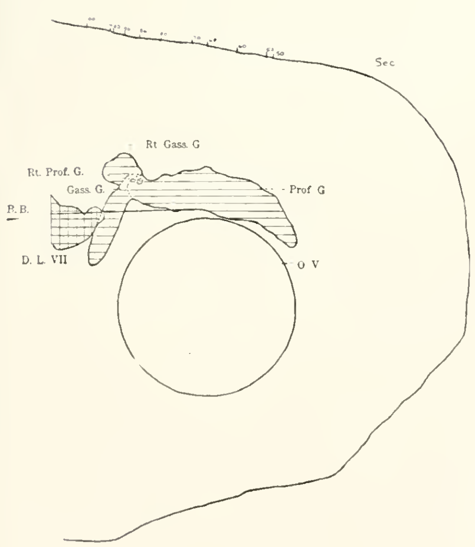
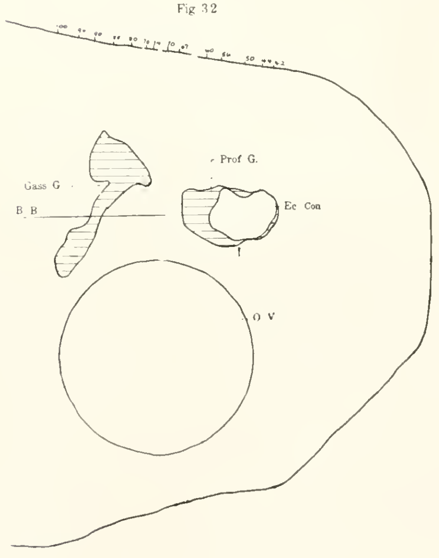


Fig 32



Katherine Okey.

A SHELF OF GEOLOGIC LITERATURE FOR THE SMALL LIBRARY, WITH A GUIDE TO THE MORE IMPORTANT REPORTS ON OHIO.*

D. Dale Condit.

The scarcity or absence of standard local and general geologic literature in many public libraries is far too frequently discovered to his sorrow by the field geologist, who is so rash as to go into a region without his "trunk-ful" of books. Recently I had occasion to visit libraries in a number of the larger towns in eastern Ohio, many of which are fine large structures of the Carnegie class. On inquiring for certain publications of the United States Geological Survey, I was informed that the library had none. "A complete set was received several years ago, but has recently been sent back, because they occupied so much space and because there was no call for them."

There was a similar scarcity or absence of reports by the State Geological Survey. I was referred to the books on geology in the general reading room. These usually would be Le Conte's Textbook, works of Lyell and Tyndall, or other writings of ancient vintage.

Certainly a town of sufficient size to own a library of any description should have all geological literature available pertaining to its vicinity, if not to the entire State. It is asking too much from them to straightway harbor formidable volumes of a highly technical character, such as rock analyses or principles of metamorphism, and when these come *en masse* they are almost sure to be stored in the musty, dusty space assigned to "Government documents." But a well selected educational set must find favor when its existence is revealed to the public, and any library, however small it may be, should be provided with a collection such as is herein suggested. The list should include one or two up to date, elementary text books on physiography and geology, State Survey publications of local and general interest, and the publications of the Federal Survey concerning local geology, together with

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a few reports of an educational nature. The entire lot should be assembled on a "geology shelf" and the librarian should provide space in the main reading room, where accessible to the public.

It is not with purely selfish motives that this plea is made, for convenient reference books to meet the needs of the geologist, but rather it is desired to place in the way of the average layman a means of access to local and general geologic information, for after all it is he whom the State and Federal Geological Surveys hope to serve.

The study of geology is a broad application of all the elementary sciences and the up-to-date practical geologist must be a mathematician, chemist, physicist and civil engineer, and should also have an intimate knowledge of zoology, botany, astronomy and other sciences. His long years of training prepare him to go forth and determine the location of undiscovered oil and gas pools, the extension of ore bodies, the depth of coal beds, the height to which artesian water will rise when the well is drilled, and other problems in applied geology. His conclusions with proofs are described in "geologic reports."

Although the geologist deals with such difficult problems, he is expected to write reports that will straightway be comprehended by the average reader. Even though the utmost attempt is made to write in simple and plain "English," the report must necessarily be of a semi-technical tone in order to state facts without greatly amplifying and encumbering the discourse with definitions and explanations which have place only in an elementary text book. It is therefore highly desirable that everyone interested in geology should make an effort to become sufficiently familiar with its fundamental principles to be able to intelligently read geologic reports.

It is believed that a collection of great value as a ready source of general and local geologic information need not include more than twenty-five to forty books that can be housed on a single "geology" shelf. It is true that even in this immature stage of geologic investigation the literature is so voluminous that a well-stocked library will contain thousands of volumes. The library of the U. S. Geological Survey, the most complete in geology in the country, has on its shelves 120,000 bound volumes and 100,000 pamphlets. The selection of a "shelf" of books of first importance for local and general geologic information is therefore an exceedingly difficult task, which is attempted with some misgivings and it is hoped that the effort will be accepted in good part by the public.

In preparing the list here compiled an effort is made to make it suited for use in public schools and small libraries. In fact, the number is so limited that it can well be accommodated in the private library. The need of keeping the list from attaining unwieldy dimensions prevents the mention of dozens of books, many of which are of equal merit with the State and Federal Survey publications that are mentioned. Persons wishing more ample information concerning books on special subjects will be given earnest attention on application to either the State or Federal Geological Surveys. Only a few of the numerous excellent modern books on geology can be mentioned here and an effort is made to hold strictly to elementary treatises. More ample lists are given in the recent announcements of the American Library Association. There are a number of geologic magazines which furnish channels for prompt publication of investigations of general interest, and in fact there is much information of prime importance which is printed only in such magazines. Some of the more important ones are given in the lists that follow.

The material suggested for the geological library falls in two classes: (1) Text books and other books of interest as a general source of geologic information and educational value; (2) Reports concerning the geology of specific areas including the most important State and Federal Survey publications and also geologic and topographic maps. The first class is useful no matter in what part of America the reader lives. The second class must necessarily consist of many lists, each of which will be appropriate for a State or, where the interests are varied, for part of a State.

The following lists include, in addition to text books and books of general interest, the more important publications of interest to people living in Ohio.

Class I. Consisting of text books, periodicals and publications of the U. S. Geological Survey and Bureau of Mines of general educational value and interest.

Text Books and Periodicals.

(a) General geology (one or more to be selected).

1. Pirsson, L. V., and Schuchert, C. Text-Book of Geology. John Wiley & Sons, Inc., New York, 1915. Part I, Physical Geology, by L. V. Pirsson. Part II, Historical Geology, by C. Schuchert. Complete in one volume. 1051 pages. Price $4.00. Also published in two parts. Profusely illustrated and contains colored geological map of North America.
2. Chamberlin, T. C., and Salisbury, R. D. Introductory Geology. A Text Book for Colleges, 708 pages. Henry Holt & Co., 1914. One volume. Price $2.00. Profusely illustrated.
3. Blackwelder, Eliot, and Barrows, H. H. Elements of Geology, 475 pages. American Book Company, 1911. Price $1.40. An excellent elementary treatise with numerous illustrations.
4. Scott, William B. Introduction to Geology, 573 pages. The Macmillan Company, 2nd ed., 1907. Price $2.60. A standard elementary text book.

(b) Physiography (one or more to be selected).

1. Salisbury, R. D. Elementary Physiography, 359 pages. Henry Holt & Co., 1910. Price $1.30.
2. Gilbert, G. K., and Brigham, A. P. Introduction to Physical Geography, 412 pages. Appleton, 1908. Price $1.25.
3. Davis, W. M. Elementary Physical Geography, 401 pages. Ginn & Co., 1902. Price $1.25.
4. Hobbs, W. H. Earth Features and Their Meaning, 506 pages. The Macmillan Company, 1912. Price $3.00.
5. Bowman, Isaiah. Forest Physiography. Physiography of United States and Principles of Soils in Relation to Forestry, 759 pages. John Wiley & Sons, 1911. Price $5.00. An interesting and highly instructive book.

(c) Economic geology (one or more to be selected).

1. Ries, Heinrich, and Watson, Thomas L. Engineering Geology, 2nd ed., 722 pages, 104 plates and 175 figures. John Wiley & Sons, 1915. Price $4.00. Describes fundamental principles of geology which relate to engineering problems.
2. Lindgren, Waldemar. Mineral Deposits, 883 pages. McGraw-Hill Book Company, New York, 1913. Price $5.00.
3. Kemp, J. F. Ore Deposits of the United States and Canada, 481 pages. The Scientific Publishing Company, 3rd ed., 1900. Price $5.00.
4. Ries, Heinrich. Economic Geology, 4th ed., revised, 856 pages, tables, plates. John Wiley & Sons, 1916. Price $4.00.
5. Hayes, C. Willard. Handbook for Field Geologists, 159 pages. John Wiley & Sons, 2nd ed., 1909. Price $1.50.

(d) Mineralogy and petrography (one of the first two and one of the second two should be selected).

1. Moses, A. J., and Parsons, C. L. Elements of Mineralogy, Crystallography and Blowpipe Analysis, 389 pages. I. Van Nostrand Company, New York, 4th ed., 1909. Price $2.50.
2. Brush, G. J., and Penfield, S. L. Manual of Determinative Mineralogy, 312 pages. John Wiley & Sons, New York, 16th ed., 1903. Price $4.00.
3. Kemp, J. F. Handbook of Rocks, 272 pages. D. Van Nostrand Company, 5th ed., 1911. Price $1.50.
4. Merrill, George P. Treatise on Rocks, Rock Weathering and Soils, 400 pages. The Macmillan Company, 2nd ed., 1906. Price $4.00.

(e) Principal periodicals devoted wholly or in part to geology, not essential to the small library, but of interest to the geologist.

1. Journal of Geology. Published semi-quarterly. The University of Chicago Press. Subscription $4.00 per year.
2. Economic Geology. Published semi-quarterly. Devoted to geology as applied to mining and allied industries. The Economic Geology Publishing Company. Subscription $3.00 per year.
3. Bulletin of the Geological Society of America. Published quarterly. Subscription $7.50 per year.
4. American Journal of Science. Published monthly at New Haven, Conn. Subscription $6.00 per year.
5. Bulletin of the American Institute of Mining Engineers. Published monthly in New York. Subscription $10.00 per year.

A Few Books of General Educational Interest Published by the U. S. Geological Survey and Bureau of Mines.

1. Professional Paper No. 60, U. S. Geological Survey. The Interpretation of Topographic Maps. By R. D. Salisbury and W. W. Atwood, 1908. 84 pp., 170 pls. Sold by the Superintendent of Documents, Washington, D. C., for $2.75.
2. Professional Paper 71, U. S. Geological Survey. Index to Stratigraphy of North America. By Bailey Willis. Accompanied by a geologic map of North America. Compiled from various sources. 1912. 894 pages, 1 pl. Sold by the Superintendent of Documents, Washington, D. C., for $2.00.
3. Bulletin 616, U. S. Geological Survey, 1916. The Data of Geochemistry. Third edition. By F. W. Clarke. 821 pages. Available for free distribution by the Survey.

4. U. S. Geological Survey Bulletins 611, 612, 613 and 614. Popular Guide Books for western railroads, containing descriptions of geology and other features of interest along several transcontinental railroads.
   Bulletin 611. The Northern Pacific Route.
   Bulletin 612. The Overland Route.
   Bulletin 613. The Santa Fe Route.
   Bulletin 614. The Shasta Route and Coast Line.
   Sold by Superintendent of Documents for 50 cents each.
5. U. S. Geological Survey Bulletins 127, 188, 189, 203, 221, 240, 271, 301, 372, 409, 444, 495, 524, 545, 584, 617, and 645. Bibliography of North American Geology, 1732 to 1915. Bulletin 127 is now only available for consultation in public libraries, the supply being exhausted. Bulletins 188, 189, 271, 301 and 617 are sold by the Superintendent of Documents, Washington, for 40, 25, 15, 50 and 15 cents respectively. Bulletins 203, 221, 240, 372, 409, 444, 495, 524, 584, and 645 are available for free distribution by the Survey.
   A cumulation bibliography of North America, which will comprise all articles and books on American geology from the earliest date to 1916, is now under way and will be published in a year or two by the Survey.
6. The more recent chapters of Mineral Resources, U. S. Geological Survey. Distributed free by the Director of the Survey.
7. U. S. Geological Survey, Water Supply Paper 122. Relation of the Law to Underground Waters. By D. W. Johnson. Available for distribution by the Survey.
8. U. S. Geological Survey, Water Supply Paper 340. Stream Gaging Stations and Publications relating to Water Resources, 1885-1913. Compiled by B. D. Wood. Available only for consultation in public libraries, the supply being exhausted.

The U. S. Bureau of Mines, although one of the youngest of the Government scientific bureaus, has published more than 130 bulletins and about the same number of "Technical Papers." Many of these, as would be expected, are of interest chiefly to persons engaged in the exploitation of coal, oil and gas, and metalliferous deposits. A list of publications can be obtained on application to Van H. Manning, Director of the Bureau of Mines, Washington. Among reports of general interest are the following:

9. U. S. Bureau of Mines, Bulletin 38, 1913. The Origin of Coal. By David White and Reinhardt Theissen, with a chapter on the formation of peat by C. A. Davis. Sold by the Superintendent of Documents, Washington, for 80 cents.

10. U. S. Bureau of Mines, Bulletin 94, 1915. United States Mining Statutes Annotated. By J. W. Thompson. Part I, Sections and Statutes relating to metalliferous and coal mining. Part II, Miscellaneous mining subjects. Sold by the Superintendent of Documents, Washington, for $2.50.

Class II. Literature concerning geology of Ohio:

The work of the Federal Survey in Ohio has consisted largely in topographic mapping and the area is practically completed. There are, however, reports on the glacial geology, the underground waters of the southwestern part of the State, recent destructive floods in the Ohio Valley, oil and gas geology of certain quadrangles in the eastern part of the State and other reports that will be listed. The Geological Survey of Ohio ranks among the most progressive of State Surveys and its publications include many valuable reports, covering nearly all phases of geology in the State. One of the most useful of these reports is a bibliography of Ohio geology.

Principal Reports of U. S. Geological Survey Concerning Ohio.*

(Classified into (a) reports of general interest, and (b) reports on small areas chiefly of local interest.)

(a) Reports of general interest.

1. Professional Paper 13. Drainage modifications in southeastern Ohio and adjacent parts of West Virginia and Kentucky. By W. G. Tight. 1903, 111 pp., 17 pls.

   Describes ancient rivers, many of which have been modified, reversed, or abandoned in the production of modern drainage, largely through the influence of Pleistocene glaciers. Distributed free by the Director, U. S. Geological Survey.
2. Monograph 41. Glacial formations and drainage features of the Erie and Ohio basins. By Frank Leverett. 1902. 802 pp., 26 pls.

   Describes in detail the striking features of glacial drift, its character in Ohio and adjacent States; the influence of the ice invasions on drainage, and also on the development of the Great Lakes. Sold by the Superintendent of Documents, Washington, for $1.75.
3. Water Supply Paper 334. The Ohio Valley flood of March-April, 1913, (including comparisons with some earlier floods). By A. H. Horton and H. J. Jackson, 1913. 96 pp., 22 pls. Distributed free by the Director, U. S. Geological Survey.

*A complete catalogue of publications of the U. S. Geological Survey can be obtained on application to George Otis Smith, Director, Washington.

4. Bulletin 552. Results of triangulation and primary traverse in Ohio, 1898-1911, inclusive. R. B. Marshall, Chief Geographer. 1914. 232 pp., 2 pls. Distributed free by the Director, U. S. Geological Survey.
5. Bulletins 411, 476, 518. Results of spirit leveling in Ohio, describing elevations of numerous localities above sea level as shown by permanent bench marks. Distributed free by the Director, U. S. Geological Survey.

Topographic Maps.—Most of the topographic maps are published in quadrangles covering areas approximately 13 by $17\frac{1}{2}$ miles, on a scale of about one inch to a mile. These maps show streams, hills and valleys, roads, houses and other surface features. Variations in elevation above sea level are represented by contours of either 10 or 20 feet interval, depending on the relief. The locations of permanent bench marks are also shown. Each quadrangle is designated by the name of some town, village, or geographic feature within it. Topographic maps are sold by postmasters or may be obtained direct from the Survey at a cost of 10 cents each, or 6 cents when ordered in lots of fifty or more maps. An index map showing the locations and names of the quadrangles can be obtained on application to the Director of the Geological Survey.

It is suggested that each library obtain maps covering its vicinity and have them mounted for hanging on the wall, where they will be brought to the attention of the public.

(b) Reports of the U. S. Geological Survey on limited areas in Ohio, chiefly of local interest.

SOUTHERN AND SOUTHWESTERN PART OF STATE.

1. Water Supply Paper 259. The underground waters of southwestern Ohio. By M. L. Fuller and F. G. Clapp. With a discussion of the chemical character of the waters by R. B. Dole. 1912. 228 pp., 9 pls. Distributed free by the Director, U. S. Geological Survey.
2. Water Supply Paper 353, Part III. Surface water supply of the Ohio River Basin, 1913. By A. H. Horton, W. E. Hall and H. L. Jackson. 1915. 264 pp., 5 pls. Distributed free by the Director, U. S. Geological Survey.
3. Folio 184. A report on the geology of the Kenova quadrangle, 938 square miles, including part of Lawrence County, Ohio, and adjacent areas in Kentucky and West Virginia. By W. C. Phalen. Sold by the Director, U. S. Geological Survey. Library edition, 18 by 22 inches, 5 cents; octavo edition, 6 by 9 inches, 25 cents.

4. Folio 69. A report on the geology of the Huntington quadrangle, 938 square miles, including part of Lawrence County, Ohio, and an adjacent area in West Virginia. By M. R. Campbell. Sold by the Director, U. S. Geological Survey, for 5 cents. Published in library edition only, 18 by 22 inches.
5. Bulletin 349. Economic geology of the Kenova quadrangle (Kentucky, Ohio, and West Virginia). By W. C. Phalen. 1908. 158 pp., 6 pls. Sold by the Superintendent of Documents, Washington, for 25 cents.

EASTERN AND NORTHEASTERN PART OF STATE.

6. Bulletin 318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, West Virginia, and Pennsylvania. By W. T. Griswold and M. J. Munn. 1907. 196 pp., 13 pls. Sold by the Superintendent of Documents, Washington, for 75 cents.
7. Bulletin 346. Structure of the Berea oil sand in the Flushing quadrangle, Harrison, Belmont and Guernsey counties. By W. T. Griswold, 1908. 30 pp., 2 pls. Distributed free by the Director, U. S. Geological Survey.
8. Bulletin 541-A. Oil and gas in the northern part of the Cadiz quadrangle, Harrison, Jefferson and Carroll counties. By D. Dale Condit, 9 pp., 1 pl. Distributed free by the Director, U. S. Geological Survey.
9. Bulletin 621-H. Anticlines in the Clinton sand near Wooster, Wayne County, Ohio. By C. A. Bonine. 12 pp., 1 pl. Distributed free by the Director, U. S. Geological Survey.
10. Bulletin 621-N. Structure of Berea oil sand in Summerfield quadrangle, Guernsey, Belmont and Monroe counties. By D. Dale Condit. 15 pp., 2 pls. Distributed free by the Director, U. S. Geological Survey.
11. Bulletin 621-O. Structure of Berea oil sand in Woodsfield quadrangle, Guernsey, Noble and Monroe counties. By D. Dale Condit. 17 pp., 2 pls. Distributed free by the Director, U. S. Geological Survey.

CENTRAL PART OF STATE.

12. Folio 197. A report on the geology of the Columbus quadrangle, 915 square miles. By C. R. Stauffer, G. D. Hubbard, J. A. Bownocker and others. Sold by the Director, U. S. Geological Survey. Library edition, 18 by 22 inches, 25 cents; octavo edition, 6 by 9 inches, 50 cents.

NORTHERN PART OF STATE.

13. Monograph 41. (Already listed as of general interest in Ohio).

Principal Reports of the State Geological Survey.*

1. Geological map of Ohio. Scale 8 miles to 1 inch. 1909. By J. A. Bownocker, State Geologist. Price 25 cents.
2. Bulletin 1. Oil and gas. 325 pp., 9 lithographic maps. 1903. By J. A. Bownocker. Describes fields in Trenton, Clinton and Carboniferous oil and gas bearing formations. Price 65 cents.
3. Bulletins 4 and 5. The lime resources and the lime industry in Ohio. 361 pp., 1906. By Edward Orton, Jr., and Samuel V. Peppel. The manufacture of artificial snadstone or sand-lime brick. 79 pp., 1905. By Samuel V. Peppel. Price of Bulletins 4 and 5 conjointly 45 cents.
4. Bulletin 6. Bibliography of Ohio geology. 332 pp., 1906. By Alice Greenwood Derby and Mary Wilson Prosser. Price 35 cents.
5. Bulletin 7. Revised nomenclature of the Ohio geological formations. 36 pp., 1905. By Charles S. Prosser. Price 6 cents.
6. Bulletin 9. Coal. 342 pp., 1908. By J. A. Bownocker, N. W. Lord and E. E. Somermeier. Part I describes Pittsburg, Pomeroy and Meigs Creek coals. Part II gives chemical analyses and calorific tests of the Clarion, Lower Kittanning, Middle Kittanning and Upper Freeport coals. Price 50 cents.
7. Bulletin 14. Geology of the Columbus quadrangle. 133 pp., 1911. By C. R. Stauffer, G. D. Hubbard and J. A. Bownocker. Price 30 cents.
8. Bulletin 18. Building stones of Ohio. About 150 pp., 1915. By J. A. Bownocker. Price 30 cents.
9. Bulletin 19. Geology of Cincinnati and vicinity, —— pp., 1916. By N. M. Fenneman.
10. Bulletin 20. Geology of southern Ohio. —— pp., 1916. (In press). By Wilbur Stout. Includes Jackson and Lawrence counties and parts of Scioto, Gallia and Pike counties.

Other bulletins published since 1900 comprise the following subjects:

Bulletin 3. Manufacture of hydraulic cement.
8. Salt deposits and salt industry in Ohio.
10. The Middle Devonian in Ohio.
11. The manufacture of roofing tiles.
12. The Bremen oil field.
13. The Maxville limestone.
15. Devonian and Mississippian of northeastern Ohio.
16. Peat deposits of Ohio.
17. The Conemaugh formation in Ohio.

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*A complete list of publications of the Geological Survey of Ohio can be obtained from Prof. J. A. Bownocker, State Geologist, at Columbus, who distributes those in stock.

State Survey organizations previous to 1900 published a number of excellent reports, some of which are listed. The State Geologist has a limited number which can be obtained at prices given below.

Volume 1. Geology. 680 pp., 1873.
- Chapter I. Historical sketch; physical geography; geological relations, geological structures of the Silurian and Devonian systems. By J. S. Newberry.
- Chapter II. Local geology. The geology of Cuyahoga, Summit, Gallia, Meigs, Athens, Morgan, Muskingum, Hamilton, Clermont, Clark, Ashtabula, Trumbull, Lake, Geauga, Williams, Fulton, Lucas, Sandusky, Seneca, Wyandot and Marion counties. Price $1.25.

Volume II. Geology. 701 pp., 1874.
- Section I. Surface geology: The Carboniferous System. By J. S. Newberry.
- Section II. Local Geology. The geology of Erie, Lorain, Ottawa, Crawford, Morrow, Delaware, Van Wert, Union, Paulding, Hardin, Hancock, Wood, Putnam, Allen, Auglaize, Mercer, Henry, Defiance, Washington, Noble, Guernsey (southern half), Belmont (southern half), Monroe, Pickaway, Fairfield, Pike, Ross and Greene counties. Price $1.25.

Volume III. Geology. 958 pp., 1878.
- Section I. Review of Geological Structure of Ohio.
- Section II. Local Geology. The geology of Tuscarawas, Columbiana, Portage, Stark, Carroll, Harrison, Guernsey, Muskingum, Belmont, Huron, Richland, Knox, Licking, Medina, Warren, Butler, Preble, Madison, Clinton, Fayette, Shelby, Miami, Logan, Champaign, Darke, Ashland, Wayne, Holmes, Coshocton, Franklin, Jefferson, Mahoning and Brown counties. Price $1.25.

Volume V. Geology. 1124 pp., 1884.
- The stratigraphical order of the Lower Coal Measures of Ohio; the Coal Seams of the Lower Coal Measures of Ohio. By Edw. Orton.
- The Meigs Creek coal in Morgan, Muskingum, Guernsey and Noble counties. By C. N. Brown.
- Coal mining in Ohio. By Andrew Roy.
- The gas coals of Ohio. By Emerson McMillen.
- The iron ores of Ohio. By Edward Orton.
- Iron manufacture in Ohio. By N. W. Lord.
- The manufacture of coke. By Henry Newton.
- Building stones of Ohio; the clays of Ohio and the industries established upon them. By Edward Orton, Jr.
- The glacial boundary in Ohio. By G. Frederick Wright.
- Report of the chemical department. By N. W. Lord.
- Price $2.50.

Volume VI. Geology. 831 pp., 1888.
- Nearly 600 pages of this volume treat of petroleum and natural gas, by Edward Orton, F. W. Minshall, F. J. Newell, Emerson McMillen and S. W. Robinson.

The volume contains chapters on the Pittsburg coal in Belmont, Jefferson and Guernsey counties, by C. N. Brown; the Pomeroy and Federal Creek coal field, by Ellis Lovejoy; the manufacture of salt and bromine, by W. J. Root; natural and Portland cement, by N. W. Lord; gypsum and land plaster in Ohio, by Edward Orton; the production of lime in Ohio, by Edward Orton; the drift deposits of Ohio, by Edward Orton. Price $2.00.

U. S. Geological Survey, Washington.

GOVERNMENT DOCUMENTS AND THE PUBLIC LIBRARIAN.*

Julia L. V. McCord.†

A unique library exists in the Government Printing Office at Washington—a library composed exclusively of United States public documents and now comprising over 200,000 books. It is the most nearly complete collection extant of the documents published by authority of our Government. A complete collection of the early documents does not exist, nor is it known now with certainty what documents and reports were printed by the first fourteen congresses. To lack of foresight, perhaps, and the economies of inexperienced legislators, the vicissitudes of the young nation, and to destruction by fire of the earlier libraries gathered for the use of Congress—to all these causes the scarcity or complete disappearance of early documents may be attributed. As many as possible have been recovered and the collection is now sufficiently full to warrant the belief that nothing very important has been lost. Desultory efforts had been made from time to time to collect the public documents, but not until the office of Superintendent of Documents was created in 1895 did these efforts completely materialize. The nucleus of the public Documents Library was a miscellaneous mass of documents which had been accumulated in the Government Printing Office. This material was put in order, as were other lots obtained from time to time, provision was made for the addition of a copy of every future publication under Government authority, and the whole thoroughly and systematically catalogued. In this library are brought together the accounts of the labors of all the army of people who have been employed

* With the permission of the Director of the U. S. Geological Survey.
† Librarian, U. S. Geological Survey.

to carry on the government's activities. Here are the results of the studies of all the thousands of trained investigators, all the explorers, all the workers on land and sea who have gone forth authorized to perform their varied duties and execute the many missions incident to the life of a great nation. These pages form the journal of a growing nation's life—intimate, self-recorded. They reveal its high hopes, its egotism, its mistakes and disappointments, its gropings toward wiser aims and higher standards. From these records may the historian of a far future decipher the history of a better civilization than the world has ever before known.

However, our intimate interest is not in this particular collection gathered in Washington, but rather in what composes it. The abundance of practical, helpful, facts here put down—facts intimately related to our daily life and necessary activities—should be at the ready service of the people. Here is an opportunity for the public librarian. Government document literature has been neglected in our public libraries while undue prominence is given to the merely recreational. The urgent need of a wider publicity for the educational and scientific works printed by the Government is apparent. To meet it, publishing officials are making definite efforts which should have the active and intelligent co-operation of public librarians.

As a first step a better acquaintance with public documents on the part of librarians is necessary—many librarians of the smaller communities are utterly uninformed in regard to the field they cover. To all these the enlightening little periodical, "Monthly catalogue of public documents," issued by the Superintendent of Documents, is recommended. It lists and describes all current prints from the Government press, giving bright readable notes on those of special interest. The subscription price is $1.10 a year, but it is sent free to as many libraries as the edition will supply. The Librarian who regularly examines this catalogue, selects and obtains the publications of general interest and particularly those touching local needs is rendering a good service to the community. As a rule, Government publications may be had free, if the application is made while the supply lasts.

It is regrettable that our public documents appear in such unattractive form. The titles lack human interest, but abound in dull official verbiage. The names of the issuing department, bureau and officials, and the serial designation obtrude themselves between the reader and the book title, which latter seems seldom chosen with a view of rousing the reader's interest. The long line of print across the page wearies the eye. There is dreary monotony in the colorless bindings of those issued in cloth, and too poor a quality of paper in the covers of the others. More tasteful get-up should be aimed for and probably could be had at no greater cost than the present. Because they become torn and ragged after very little usage accounts for the fact that in so many libraries the government publications are stored in cellars and attics. There are indications that thought is being given to these points and we may see Government reports put out in a form to compete in attractiveness with the issues from commercial publishing houses.

Under the now-existing printing law, the Superintendent of Documents is authorized to send copies of all public documents, as issued, to the Depository libraries. About 475 libraries in the United States are now receiving them. No adequate provision for selective distribution has yet been made, that is for the supply only of documents on specific subjects. In order to obtain these automatically arrangements must be made with the issuing Department or Bureau.

The small community seems to offer to the public librarian a more encouraging field of service in respect to government document literature than does the large city. At any rate it should be her duty to obtain the government publications which interest or apply specially to the community and also others of general interest and to post them in the library and advertise them in the local newspaper. The rural community should know about the Farmers bulletins, the Soil Survey reports and the Good Roads bulletins. The business man will find helpful suggestions in the very live Commerce reports and the teacher in the publications of the Bureau of Education. Every intelligent dweller on the ground wants to know something of what is below the surface and to him the publications of the Geological Survey tell many an interesting story.

The cataloging of documents is done in Washington, the librarian's labor being greatly lessened thereby. The printed cards are obtainable from the Library of Congress at a small cost, and should be used by librarians wherever possible. Closer co-operation between public librarians and the publishing and library officials in Washington is to be desired.

BORIC ACID OCCURRING NATURALLY IN SOME FOODS.

Arthur H. Smith.

Among the common chemical preservatives which have been used in foods and which are prohibited entirely or tolerated under certain restrictions by the Federal Foods and Drugs Act, as now enforced, are benzoic acid, salicylic acid, sulfurous acid, boric acid and formaldehyde. Boric acid is used principally for preserving meats, meat products, fish and dairy products. Its presence can be detected readily by acidifying the ash of the sample with hydrochloric acid and then dipping a piece of turmeric paper into the solution. If boric acid is present the yellow turmeric paper becomes red on drying.

In the course of some food analyses the writer had occasion to test a sample of datenut butter which was made from dates ground very fine, and peanut butter. The butter has the consistency of a stiff jam and is very pleasing to the taste. I obtained a positive but not a very strong test for boric acid. It seemed unlikely that boric acid had been used as an artificial preservative in such small quantities as evidently existed in the material. I then tested some peanuts which had been roasted but found no boric acid in them. Dates, however, gave a test for boric acid when the acidified ash was tested with turmeric paper. It was obvious, then, that the boric acid in the datenut butter must be, in part, at least, naturally occurring in the dates. Several European writers have reported the occurrence of small amounts of boric acid in natural foodstuffs. In the Analyst for 1914 is an abstract of an article by G. Bertrand and H. Agulhon in Bull. Soc. Chim. 1913, 13, 824–827, citing the occurrence of boric acid in milk and eggs. In the Analyst for 1912 is an abstract of an article by L. Robin in Eighth Int. Cong. App. Chem. 1912, Vol. 1, 429–432, in which he states that boric acid is a natural constituten of wines. In the Analyst for 1913 is an abstract of an article by V. Villavecchia and I. Barboni in Ann. Lab. Chim. Cent. delle Gabelle 1912, 6, 27–68, in which the occurrence of boric acid in Italian salt is discussed. In Zeit. Offentl. Chem. 1905, XI, 231–234, is discussed the occurrence of boric acid in common salt.

The above mentioned facts led to experiments in which a quantitative analysis for boric acid was made in some of our common fruits. Because of the limited time and because of lack of fresh fruits, dried fruits were used. The writer tried at first to measure the boric acid by comparing the colors in tubes which contained about fifty cc. of solution. The standards were boric acid dissolved in weak hydrochloric acid to which was added some standard turmeric solution. In other tubes were hydrochloric acid solutions of the iron free ash of the sample to which a standard solution of turmeric had likewise been added. The Schriner-Schorey colorimeter was used. The quantities of boric acid in the fruits were so small, however, that the depth of color given with the standard turmeric solution was too weak to give accurate comparison.

The method finally used was one for estimating very small quantities of boric acid in organic substances described by G. Bertrand and H. Agulhon in Comptes rend. 1913, 157, 1433–1436 and reported in the Analyst for 1914. Ten or twenty grams of animal substance or one gram of vegetable substance are mixed with sodium carbonate and ignited to ash which need not be white. To the ash 5–10 cc. of phosphoric acid are added and the whole transferred to a flask with 20 cc. of methyl alcohol. The mixture is distilled and the distillate is collected in a platinum dish containing 2 or 3 drops of sodium hydroxide solution. A second portion of methyl alcohol is added and the second distillate collected with the first. The combined distillates are evaporated to dryness and the residue taken up with ½ cc. of tenth normal hydrochloric acid. A strip of turmeric paper 3 mm. by 45 mm. is put into the hydrochloric acid solution so that about 20 mm. extends above the edge of the containing vessel. The whole is set aside for 24 hours at room temperature or for 3 hours at 30 degrees. The length of the colored strip at the outer end of the turmeric paper is compared with a similar colored strip on paper immersed in solutions containing known amounts of boric acid. The method depends on the formation of a volatile compound of methyl alcohol and boric acid which is distilled over and the second portion of alcohol is used to make sure that all of the boric acid is taken over.

The standards for comparison are made by dissolving known amount of boric acid in weak hydrochloric acid. The standards must be treated exactly as the sample is treated—the same quality of turmeric paper must be used, it must remain in the solution the same length of time as the paper remains in the solution of the sample and the turmeric paper must be placed in each solution simultaneously. If these conditions are followed the writer found that the length of coloration of the turmeric paper is directly proportional to the quantity of boric acid present. For example where 0.2 mg. boric acid was used the coloration measured 4.5 mm.; with 0.4 mg. it was 9 mm.; with 0.6 mg. it was 13.5 mm.; with 0.8 mg. it was 16.5 mm. Experiments started at different times would show the same proportionality but different numbers. With practice in measuring the colored area on the strips the method becomes as accurate as any good colorimetric analysis method such as the determination of nitrates in water, for example.

Following is the data of the experiments:

TABLE I.

SAMPLE	WEIGHT	BORIC ACID	PERCENT
Dates	1.0010g	0.3 mg	0.0299
Dried Peaches	1.0054	0.066	0.0065
Dried Apricots	1.0174	0.022	0.00216
Prunes	1.0080	0.08	0.00792
Figs	1.0247	0.04	0.0039
Raisins	1.0178	0 05	0.0049

The writer had previously found boric acid in some sausages and these were now examined quantitatively.

TABLE II.

SAMPLE	WEIGHT	BORIC ACID	PERCENT
Wienerwursts (C. P. Co.)	10.0181 g	0.05mg	0.00049
Pork Sausages (C. P. Co.)	4.3720	trace	

The salt with which the meat was cured which was used in the preparation of these sausages was then examined. Salt from another packing house and also from a dairy was examined.

TABLE III.

SAMPLE	WEIGHT	BORIC ACID	PERCENT
Salt (C. P. Co.)	4.0907 g	0.02mg	0.00045
Salt (D. P. Co.)	4.0886	0.02	0.00048
Salt (Dairy)	2.5600	0.02	0.00077

Among the fruits dates show the largest percentage of boric acid with prunes next. The quantities in the other fruits and in sausages and salt is insignificant. These results show that in some of our common fruits, probably in meat and certainly in common salt there are minute though measurable quantities of boric acid occurring naturally. However, it does not seem probable that these amounts of boric acid could injure the persons eating the foods.

Ohio State University.

Date of Publication, December 28, 1916.

THE

Ohio Journal of Science

PUBLISHED BY THE

Ohio State University Scientific Society

Volume XVII JANUARY, 1917 No. 3

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REPORT OF THE TWENTY-SIXTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE.

The Twenty-sixth Annual Meeting of the Ohio Academy of Science was held at Ohio State University, Columbus, Ohio, on April 21 and 22, 1916, under the presidency of Professor G. D. Hubbard of Oberlin College. Fifty-five members were in attendance.

GENERAL PROGRAM.

Friday, April 21.

8:00 a. m.—Meetings of Committees.
9:00 a. m.—Business Meeting.
10:00 a. m.—Reading of Papers in General Session.
11:45 a. m.—Address by Prof. George D. Hubbard, President of the Academy: "What Has the Future for Geologists?"
12:15 p. m.—Lunch, Ohio Union.
1:30 p. m.—Reading of Papers in General Session.
3:00 p. m.—Reading of Papers, in Sectional Meetings.
5:45 p. m.—Dinner, Ohio Union, together with Ohio College Association and Affiliated Societies.
7:30 p. m.—Joint Session with Ohio College Association and Affiliated Societies.

Chairman, President Miner Lee Bates, of the Ohio College Association, Hiram College.

Address of Welcome, President W. O. Thompson, Ohio State University.

Address, Professor Charles H. Judd, University of Chicago: "The More Complete Articulation of Higher Institutions with the High Schools."

Informal Social Gathering of Members and Visitors.

SATURDAY, APRIL 22.

9:00 A. M.—Meeting of Ohio College Association—Symposium of Addresses by Representatives of Affiliated Societies.

"The Relation of the College to Research," Professor Lewis G. Westgate, Ohio Wesleyan University, representing the Ohio Academy of Science.

"Academic Relationships in the Training of Teachers," Dean H. C. Minnich, Miami University, representing the Ohio Society of College Teachers of Education.

"The Training of Science and Mathematics Teachers, Prospective and in Service," Professor George R. Twiss, Ohio State University, representing the Association of Ohio Teachers of Mathematics and Science.

"Mathematics and the College Curriculum," Professor A. D. Pitcher, Western Reserve University, representing the Ohio Section of the Mathematical Association of America.

10:45 A. M.—Reading of Papers in General Session.

11:45 A. M.—Adjourned Business Meeting.

MINUTES OF BUSINESS MEETINGS.

The first business session was called to order by President Hubbard at 9:00 A. M., on Friday, April 21. An adjourned session was held at 11:45 on the following morning.

The appointment of the following committees for the meeting was announced by the chair:

Committee on Membership—C. G. Shatzer, E. P. Durrant, Frank Carney.

Committee on Resolutions—L. B. Walton, Frank R. Elliott, A. B. Plowman.

Committee on Necrology—W. C. Mills, J. S. Hine, J. H. Schaffner.

The following Auditing Committee was elected by the Academy: C. G. Shatzer, W. R. Lazenby.

The following Nominating Committee was elected by the ballot of the Academy just before the close of the first business session: F. C. Blake, F. L. Landacre, Frank Carney.

Report of the Secretary.

The following report by the Secretary was received and ordered filed:

DELAWARE, OHIO, April 19, 1916.

The work of the Secretary since the last Annual Meeting has been largely routine.

A report of the Anniversary Meeting was printed in the OHIO JOURNAL OF SCIENCE and in SCIENCE; and notice of the present meeting has been sent to the leading dailies in Columbus, Cincinnati, Cleveland and Toledo.

As directed by the Academy, letters containing the relevant portions of the report presented at the last meeting by the Committee on Resolutions were sent to the societies naming delegates to the Anniversary Meeting, to all delegates in attendance, and to other individuals and organizations mentioned in the resolutions.

The Secretary has also followed the instructions of the Academy in revising and reprinting the circular of information concerning the scope of the work of the Academy. The revised circular was mailed with the preliminary announcement of this meeting.

At the last meeting the Secretary reported correspondence with Dean Leutner, Secretary of the Ohio College Association, concerning the desirability of an active co-operation of the Academy with the College Association. The change in the date of the annual meeting of the Academy has made such co-operation possible and natural. Further correspondence and conferences with the members of the Program Committee and with Dean Leutner have resulted in the present arrangement of the program. It may be noted that a rather unusually small number of titles on the Academy program has facilitated this co-operation. A fuller program might well lead to complications. In view of this fact, it may be wise for the Academy to take action at this meeting, instructing next year's Secretary and Program Committee as to the desirability of continuing, extending, or restricting this affiliation with the Ohio College Association and other societies.

Respectfully submitted,

EDWARD L. RICE, *Secretary.*

Report of the Treasurer for the Year 1916.

The report of the Treasurer was received as follows, and referred to the Auditing Committee:

For the year since our last annual meeting, the receipts, including balance from last year, have amounted to $547.70, and the expenditures to $249.57, leaving a cash balance of $298.13.

RECEIPTS.	
Balance from last year	$171.30
For sale of publications	98.40
Membership dues	278.00
Total	$547.70
EXPENSES.	
Miscellaneous expenses	$ 64.57
185 subscriptions to THE OHIO JOURNAL OF SCIENCE	185.00
Balance April 21, 1916	298.13
Total	$547.70

Respectfully submitted,

JAS. S. HINE, *Treasurer.*

Report of the Executive Committee.

The report of the Executive Committee was received as follows and ordered filed.

DELAWARE, OHIO, April 21, 1916.

Since the last Annual Meeting of the Academy two joint meetings of the Executive Committee and Publication Committee have been called—December 28, 1915, and April 21, 1916.

At the first meeting it was decided to hold the Annual Meeting of the Academy for 1916 in Columbus on April 21 and 22, in affiliation with the meeting of the Ohio College Association. The details of co-operation were left to the Program Committee for adjustment.

Owing to scanty attendance at this meeting, the consideration of the publication of the addresses presented at the Anniversary Meeting (referred by the Academy to the joint committees) was deferred. At the meeting of April 21 it was decided, after discussion, that the financial condition of the Academy will permit the publication of all the addresses in the Report of the Anniversary Meeting, and the Publication Committee was instructed to proceed with the publication.

Since the last Annual Meeting two applications for membership have been approved by the Executive Committee. These names will be presented to the Academy later for ratification.

Respectfully submitted,

EDWARD L. RICE, *Secretary.*

Report of the Emerson McMillin Research Fund.

The following report of the Trustees of the Research Fund was received and referred to the Auditing Committee.

For that part of the year 1915-16, dating from Nov. 25, 1915 to April 21, 1916.

RECEIPTS.

Unappropriated balance Nov. 25, 1915	$264.91	
Check from Emerson McMillin	250.00	
		$514.91

EXPENDITURES.

Dec. 4, 1915. L. B. Walton, for research	6.50
	$508.41

ASSIGNMENTS FOR 1916–17.

S. R. Williams and W. H. Shideler	$25.00	
L. S. Hopkins	50.00	
B. W. Wells	50.00	
F. L. Landacre	75.00	
		$200.00

Leaving an unassigned balance in the Treasury, April 21, 1916. . $308.41

WILLIAM R. LAZENBY, *Chairman.*

Report of the Publication Committee.

The report of the Publication Committee was received as follows and ordered filed.

The committee has published no reports since the November meeting.

The committee recommends that after the publication of the reports of the 25th meeting, the Proceedings of the Academy be enlarged to the standard magazine size, 7 x 10 inches.

JOHN H. SCHAFFNER, *Chairman.*

Report of the Library Committee.

For the Library Committee, Professor Mills made an oral report, introducing Mr. Reeder, of the Ohio State University Library. The following report by Mr. Reeder was received and ordered filed.

To the Ohio Academy of Science:

The University Library begs to report that it has cared for all the accessions to the Library of the Academy which have been received since the November meeting, 1915. The deposit has been moved to Deck 5, in the book stack, on which floor is shelved the Library's file of reports and proceedings of scientific societies.

During the period covered by this report, publications of the Academy have been sold to the amount of $22.00. This sum has been turned over to the Treasurer.

All correspondence, concerning the publications of the Academy and its exchanges, has been given prompt attention and is on file in the University Library.

Very respectfully,

C. W. REEDER.

April 21, 1916.

Report of the Committee on the Ohio Journal of Science.

The Committee on the Relation of the Academy to the Ohio Journal of Science presented a divided report. The majority favored the continuance of the present relation, modified somewhat in the direction of a closer affiliation; a minority recommended "that the present relationship of the Academy and the Ohio Journal of Science be terminated, and a committee be appointed to consider the question of some form of Academy publication, as ample and representative as our income will permit."

After extended discussion, the Academy took the following actions:

1. That the Committee on the Relation of the Academy to the Ohio Journal of Science be instructed to formulate more definitely the two plans, proposed respectively in the majority and minority reports, and to submit both to the membership of the Academy for an expression of opinion, this to be considered not as a formal ballot, but merely as a guide in the further consideration of the question by the next Annual Meeting.

2. That the Academy request the appointment upon the Editorial Board of the Journal of one representative from each organized section of the Academy. (Note—The Secretary has received notice of the cordial agreement of the management of the Journal to this request.)

3. That the detailed arrangements for the coming year be referred to the Executive Committee with power.

No formal report was presented by the Committee on Legislation. The Committee was continued.

Report of Committee on Catalog of Scientific Journals.

The following report was presented by Mr. Reeder, of the Ohio State University Library, for the Committee on Catalog of Scientific Journals. The report was received and ordered filed and the Committee continued to carry on the work.

April 21, 1916.

To the Ohio Academy of Science:

The Committee on the Union Catalog of Scientific Periodicals begs leave to submit the following report:

At a meeting held during the sessions of the American Association for the Advancement of Science, at the Ohio State University, December, 1915, it was decided to co-operate with the College Section of the Ohio Library Association in the preparation, not of a *purely scientific* catalog, but in a catalog of *all* periodical sets in Ohio Libraries. The College Section of the Library Association, at its annual meeting in October, 1915, appointed a committee consisting of Messrs. Miller (Ohio Wesleyan), Read (Cincinnati), and Reeder (Ohio State), to begin the preparation of a Union Catalog which would be of assistance to the Universities and Colleges in handling requests for the inter-library loan of books and volumes of sets. The Committee of the Academy felt that such a Union Catalog, if complete, would include the scientific and technical sets, and therefore duplicate the catalog planned by the Academy. It was decided that co-operation in this undertaking was advisable. Mr. C. W. Reeder, representing both the Library Association and the Academy, was instructed to draw up a statement outlining in detail the plans of both organizations for the preparation of the joint union catalog. After considerable correspondence, the following statement, which was to be sent to libraries, was agreed upon:

UNION CATALOG OF PERIODICAL SETS IN OHIO LIBRARIES.

The Ohio Academy of Science and the College Section of the Ohio Library Association, jointly, propose to compile a Union Catalog of the periodical and scientific sets (except documents) in the libraries of the State. This catalog is to be made on cards, (Library Bureau No. 33030 or any 3 x 5 stock) and filed with the Ohio State University Library, the official depository of the Ohio Academy of Science. Ultimately the Academy hopes to print this union catalog for the benefit both of librarians and of scientists. However, until printed, it will be possible for any one to write directly to the Ohio State University Library and secure information concerning the location of any scientific set in the State.

The Library of Congress rules will be followed in main entry. If a series has ceased publication, or has not been continued, the closed entry will be used as v. 1-10, 1865-1874. If the series is being continued, the open entry will be used, as v. 1, 1900-.

When the cards are received at the University Library, they will be stamped with the name of the sending library, and filed in the Union Catalog. If desired, any library may add its classification marks to the catalog cards.

It is recommended that the deposit include all the periodical sets (except documents) in the possession of the co-operating libraries.

The Ohio Academy of Science has been working on such a proposition for several years, and much of preliminary data has been received. At the October, 1915, meeting of the Ohio Library Association, a committee was named to compile a Union Catalog of periodical sets, so that librarians might know where sets are when needed by them in the various universities and colleges.

Therefore this joint effort of the two associations as outlined above, will bring into existence a bibliographical tool, the value of which will be indispensable to the college librarians and to the scientists of the Ohio Academy.

You are urged to co-operate in this undertaking by sending to the Ohio State University Library, the card record of your periodical sets, excluding documents.

The next step consisted in the preparation of a list of the libraries which would be invited to submit the record of their periodical sets. After correspondence, the following thirty-nine institutional libraries were selected:

Adelbert College Library.
Akron Municipal University Library.
Antioch College Library.
Baldwin-Wallace College Library.
Case Library (Cleveland).
Case School of Applied Science Library.
Cincinnati Public Library.
Cincinnati University Library.
Cleveland Public Library.
Columbus Public Library.
Dayton Public Library.
Denison University Library.
Hebrew Union Theological Seminary Library.
Heidelberg University Library.
Hiram College Library.

Kenyon College Library.
Lake Erie College Library.
Lloyd Library (Cincinnati).
Marietta College Library.
Mechanics Library, Cincinnati.
Miami University Library.
Oberlin College Library.
Ohio State Library.
Ohio State University Library.
Ohio University Library.
Ohio Wesleyan University Library.
Ohio Archaeological & Historical Society Library.
Otterbein College Library.
St. Ignatius College Library.
St. John's University Library.
St. Mary's College Library.
St. Xavier's College Library.
Toledo University College Library.
Toledo Public Library.
Western College for Women Library.
Western Reserve University College for Women Library.
Wilberforce University Library.
Wittenberg College Library.
Wooster College Library.

Letters with enclosure of the statement of plans were sent out to these libraries on March 24 and 25, 1916. To date, favorable replies have been received from eighteen (18) as follows:

Adelbert College Library.
Akron Municipal University Library.
Antioch College Library.
Case School of Applied Science Library.
Cincinnati Public Library.
Cleveland Public Library.
Hiram College Library.
Lloyd Library (Cincinnati).
Mechanics Library (Cincinnati).
Miami University Library.
Oberlin College Library.
Ohio State Library.
Ohio State University Library.
Ohio University Library.
Ohio Archaeological and Historical Society Library.
Ohio Wesleyan University Library.
Toledo Public Library.
Wittenberg College Library.

In two cases, the contributions have been sent in for the Union Catalog. Case School of Applied Science has printed a pamphlet giving the titles of sets and their completeness. Lloyd Library has issued as

Bibliographical Contribution, V. II, No. 1, "Catalogue of the Periodical Literature in the Lloyd Library," 104 pp. Two copies of these printed records have been secured, the entries have been clipped and pasted on cards, ready for filing.

It is not necessary to go into the detailed questions which are arising in connection with the preparation of these records in the various libraries. The points are numerous, but each is being given consideration so that this Union Catalog may approach, as far as possible, the acme of perfection.

Some letters reveal conditions which must be very disheartening to both the librarians and to the users, many of whom are members of the Academy.

"We do not have at present any separate list or catalogue of our periodical sets."

"A certain proportion of our periodical sets, just how large I cannot at present say, have never been classified or catalogued."

"Our periodicals have never been catalogued and we have only memorandum records at present."

The Committee recognizes that the request made upon the various libraries entails some work and perhaps some readjustment. If, however, this request will cause some libraries to straighten out the conditions surrounding the periodical sets, to make catalogs, to classify, to purchase or fill in missing volumes, and in general to improve the records, then at least one tangible result, with some attendant good, has been accomplished, not only beneficial to the libraries, but also to the members of the Academy and other users.

The Committee suggests that the members of the Academy, who come from institutions which have not yet signified their intention of joining this co-operative undertaking, should use their influence with the library authorities to prepare the data desired for the Union Catalog.

Very truly yours,

C. W. Reeder,
For the Committee.

Election of Officers.

From the double slate of nominations prepared by the Nominating Committee, the following officers for 1916-17 were elected by the ballot of the Academy:

President—Professor F. O. Grover, Oberlin College, Oberlin.

Vice-President for Zoology—Professor Stephen R. Williams, Miami University, Oxford.

Vice-President for Botany—Professor E. L. Fullmer, Baldwin-Wallace College, Berea.

Vice-President for Geology—Professor August Foerste, Steele High School, Dayton.

Vice-President for Physics—Professor M. E. Graber, Heidelberg University, Tiffin.

Secretary—Professor E. L. Rice, Ohio Wesleyan University, Delaware.

Treasurer—Professor J. S. Hine, Ohio State University, Columbus.

Elective Members of Executive Committee—Professor Bruce Fink, Miami University, Oxford; Professor L. B. Walton, Kenyon College, Gambier.

Member of Publication Committee—Professor J. A. Culler, Miami University, Oxford.

Trustee of Research Fund—Professor M. M. Metcalf, Oberlin College, Oberlin.

Member of Library Committee—Mr. C. W. Reeder, Ohio State University, Columbus.

Election of Members.

The Membership Committee reported fifteen names for election to membership, marked with * in the following list; two additional names already approved by the Executive Committee were also presented for ratification. The entire list was elected as follows:

* Baker, Rollo C., Anatomy, O. S. U., Columbus.
* Cole, Archie E., Zoology, Plymouth.
* Cole, Margaret, Biology, Plymouth.
* Forman, Johnathan, Pathology, Medical College, N. Park St., Columbus.
Harmount, Geo. P., Geology, Archeology, 2290 Indianola Ave., Columbus.
* Knouff, Ralph A., Anatomy, O. S. U., Columbus.
* McCloy, James H., Physics, Westerville.
* McPeek, Clayton, Physiology, 110 W. First Ave., Columbus.
* Martin, Benj., Entomology, Zoology, Berea.
* Okey, Catharine W., Anatomy, Zoology, O. S. U., Columbus.
* Reed, Carlos I., Physiology, 97 Price St., Columbus.
* Reeder, C. W., Library, O. S. U., Columbus.
* Scott, Ernest, Pathology, Medical College, N. Park St., Columbus.
* Stehle, Mabel E., Zoology, Entomology, 100 Mithoff St., Columbus.
Stout, Harry O., Botany, Geology, Agriculture, Zoology, 1031 Alger St., Fremont.
* Warren, James H., Anatomy, Medical College, N. Park St., Columbus.
* Weston, William H., Jr., Botany, Zoology, Biological Laboratory, Adelbert College, Cleveland.

In view of the work of Mr. Reeder in connection with the library of the Academy, it was voted that his membership dues be remitted, as was formerly provided by the Constitution in case of the Librarian.

Report of the Committee on Resolutions.

The following report was presented by the Committee on Resolutions, and adopted by the Academy.

Resolved, That the Academy heartily thank the authorities of the State University and the members of the Local Committee for their efforts in making the 26th Annual Meeting one successful in every way.

Resolved, That the members of the Academy formally thank Mr. Emerson McMillin for his continued support of research work in Ohio.

Resolved, That the Academy express its appreciation of the work done by Mr. Reeder of the University Library for his efforts in connection with cataloging the scientific literature of Ohio.

(Signed), L. B. Walton,
Frank R. Elliott,
A. B. Plowman.

The Report of the Committee on Necrology.

The following report was presented by the Committee on Necrology:

It becomes our painful duty, as Committee on Necrology, to report the death of two members of the Ohio Academy of Science. Professor F. M. Webster, of Washington, D. C., and Prof. John Royer, of Bradford, Ohio.

Prof. Webster's death came very unexpectedly. He came to Columbus during the holiday recess to attend the meeting of the American Association for the Advancement of Science. He arrived in the city on Monday and the Chairman of your Committee had the pleasure of meeting him at that time, and had quite a talk with him concerning old associations of the Academy. He expressed to me at that time, his regret that he was unable to attend the Quarter Centennial of the Academy but was glad to be back in Columbus and see the old places he knew in early days.

Prof. Webster was connected with the Bureau of Entomology, Washington, D. C. He died at Grant Hospital, Monday morning, January 3, 1916. He was taken ill on Wednesday evening preceding his death. After being stricken with his final illness, he felt sure of a speedy recovery, but as the days went by, he became worse and was taken to the hospital, where he passed away in a short time.

Prof. Webster was one of the most prominent of American entomologists and his death will be mourned by scientists in all parts of the world. His home was in Kensington, Md., and his office was at the Department of Agriculture in Washington.

Professor Webster was born at Lebanon, N. H., August 8, 1849. He received his degree of M. S. from the Ohio University in 1893.

From 1882 to 1884 he was State Entomologist for Illinois. Following the termination of his position, he was connected with the Government Agricultural Station until 1904, when he was placed in charge of cereal and forage-crop insect investigation for the U. S. Department of Agriculture. Professor Webster was one of the most prominent scientists in the Government service. He was sent to Melbourne, Australia, as special representative to the International Exposition held in that city in 1888–1891. He also was sent to Tasmania and New Zealand to study agricultural methods in these countries.

At the time of his death he was President of the Biological Society of Washington. Professor Webster was very active in the affairs of the

Academy in its early years and was elected as third President of the Academy in 1894; during all of the time of his connection with the Experiment Station at Wooster he was very active in Academy work, presenting many papers and taking an active interest in discussions.

He was ex-President of the Association of Economic Entomology, ex-President of the Society of Entomology at Washington, D. C., ex-President of the National Geographical Society, ex-President of the American Association of Naturalists, and an honorary member of many other scientific associations and societies of the country. His contributions to scientific publications, have been of special interest to scientists from all parts of the world; and in this way he made himself one of the most important men in the service of the government.

Professor John Royer died at Bradford, Ohio, October 13, 1915. He was born January 31, 1845.

Professor Royer was one of the early educators in Ohio, having spent more than forty years of his life as a teacher. He taught in the schools of Ansonia, Gettysburg, Versailles and Pleasant Hill, and was the first man to receive a certificate as a teacher in Darke County.

Professor Royer was the publisher of many books. Royer's Mental Arithmetic had a wide circulation, more than 120,000 of these books having been sold.

He also published Royer's Geography, which had quite a sale, as well as Royer's Course in English.

At one time Prof. Royer was editor of *The School Visitor*, which was published at Columbus and at Versailles, Ohio. He afterwards sold his interest in this publication to *The Ohio Teachers Magazine*, with which it was merged.

Professor Royer spent the last ten years of his life in retirement.

Wm. C. Mills,
John H. Schaffner,
J. S. Hine.

Report of the Auditing Committee.

The Auditing Committee presented the following report, which was accepted and ordered filed.

April 21, 1916.

The committee appointed by the Ohio Academy of Science to audit the books of the Treasurer, has examined the accounts and finds them as reported.

The committee appointed by the Ohio Academy of Science to audit the books of the Treasurer of the Emerson McMillin Research Fund, has examined the accounts and finds them as reported.

Respectfully,

C. G. Shatzer,
William R. Lazenby.

The meeting adjourned without determining the place of the next meeting.

Scientific Sessions.

The complete scientific program of the meeting follows:

Presidential Address.

What Has the Future for Geologists?..........G. D. Hubbard

Addresses in Joint Session with Ohio College Association and Affiliated Societies.

(See Page 69).

Papers.

1. Parthenogenesis in the Dandelion. 20 min. (Lantern).... Paul B. Sears
2. Exploration of Tremper Mound. 30 min. (Lantern)............W. C. Mills
3. The Educational Value of Wood Study. 10 min. (Lantern)..A. B. Plowman
4. Botanizing in Porto Rico. 30 min. (Lantern)................Bruce Fink
5. Parallelism between the Cystid Agelacrinites (fossil) and the Holothurian Psolus (recent), with Demonstrations. 15 min.......Stephen R. Williams
6. The Axial Rotation of Microorganisms and its Evolutionary Significance. 10 min...L. B. Walton
7. A New Method for Marking Slides. 3 min...................Paul B. Sears
8. Notes on Ohio Tingitidæ. 6 min..........................Carl J. Drake
9. Insect Population of Grasslands. 12 min. (Lantern)......Herbert Osborn
10. Genitalia of the Bedbug, with special reference to a Unique Method of Copulation. 7 min. (Lantern)........................P. B. Wiltberger
11. The Origin of the Gasserian and Profundus Ganglia in Rana. 5 min. Ralph A. Knouff, introduced by F. L. Landacre
12. The Fusion of the Gasserian and Profundus Ganglia in Plethodon. 5 min. Katherine Okey, introduced by F. L. Landacre
13. The Origin of the Placodal Ganglia in Squalus. 7 min. C. I. Reed, introduced by F. L. Landacre
14. Concerning Thyroid Glands in Amphibia. 10 min. (Lantern). R. A. Budington
15. Feeding Thymus and Thyroid Extracts. 5 min..............E. P. Durrant
16. Notes on Protozoa. (a) A Review of the Arcellidae. (b) Supplement to the Euglenoidina. 6 min................................L. B. Walton
17. Notes on Birds. 10 min....................................H. A. Albyn
18. A New Three-Salt Nutrient Solution for Sand and Water Cultures. 10 min...A. G. McCall
19. An Adjustment of the Sliding Microtome for Cutting Lignified Tissue. 2 min..Forest B. H. Brown
20. Notes on the Structure and Function of the Green Layer of the Bark of Woody Plants. 8 min. (Lantern)...................Forest B. H. Brown
21. The Distribution of Fungi in Porto Rico. 10 min.............Bruce Fink
22. The Genus Physcia in Ohio. 10 min, Martha McGinniss, introduced by Bruce Fink
23. Decrease of Permeability with Age (Preliminary Note). 5 min. H. M. Benedict
24. Methods of Spore Formation in the Zygnemales. 10 min....E. N. Transeau

25. Notes on the Germination of Tree Seeds. 10 min. WILLIAM R. LAZENBY
26. The Quince Leaf-Spot. 10 min. . . . . . W. G. STOVER
27. A Blade Blight of Corn. 10 min. . . . . . W. G. STOVER and W. N. ANKENEY
28. The Occurrence of the Volutella Rot in Ohio. 5 min. . GUSTAV A. MECKSTROTH
29. Observations on the Ontogeny of the Gall of Pachypsylla mama Riley. 30 min. (Lantern). . . . . . B. W. WELLS
30. On Wavemarks. 10 min. (Lantern). . . . . . WALTER H. BUCHER
31. The Northward Extension of the Physiographic Provinces of the United States. 20 min. . . . . . W. N. THAYER
32. Additions to the Anatomy of Lepadocystis moorei. 5 min. . . W. H. SHIDELER
33. Resistance of Electrolytes by a modification of Kohlrausch's Method. 12 min. . . . . . M. E. GRABER
34. Demonstration of Apparatus showing Analogy between Reactance Phenomena in Alternating Current Circuits and in Fluids. 15 min. F. C. CALDWELL
35. Absorption of High Frequency X-rays. 15 min. . . . . . S. J. M. ALLEN
36. A Relative Score Method for Unmeasured Characters. 10 min. . A. G. MCCALL
37. The Revegetation of the Katmai District of Alaska. 35 min. (Lantern), ROBERT F. GRIGGS
38. The Symbols used in Geometry. . . . . . JOHN H. WILLIAMS
39. Crystals. . . . . . W. N. SPECKMAN

Demonstrations.

1. Certain Points in the Celloidin Method. . . . . . A. B. PLOWMAN
2. A Recent Ohio Specimen of Henslow's Sparrow. . . . . . EDWARD L. RICE

EDWARD L. RICE, *Secretary.*

PRESIDENT'S ADDRESS.

WHAT HAS THE FUTURE FOR GEOLOGISTS?

George D. Hubbard.

At the last meeting of the Ohio Academy of Science we had an able review of the accomplishments in the field of Geology during the last quarter century. Today I want to ask you to look with me ahead perhaps even farther.

In my desire to take this forward look I am prompted by a question put to me more than a year ago, by a man with wide experience and observation. His question was the one in my subject: "What has the future for the Geologist?" And he added (by way of comment) that to him it seemed that the days of the Geologist were limited; that there was little more to do in this science except to conserve what knowledge we have and hand it down from generation to generation. He further granted that General Geology had a cultural value and hence should continue to be taught in our Colleges and Universities. His question may have been suggested by the fact that several State Geologic Surveys have already issued what purport to be "Final Reports."

I had not really taken stock in the manner best suited to provide me an answer to his question, but I felt quite sure he had underestimated our ability to find a job. I have therefore been hunting for the answer to his question for more than a year. In this connection I want to say further that if *this* man had not had time to look up the future for Geologists more thoroughly than his comments suggested, there may be others who have not taken time to see the new horizons.

It may not be any more amiss for a Geologist to consider his market as well as his equipment than it is for a merchant to study the needs of his community, as well as his stock in trade. Furthermore I must needs make my appearance here today; and the matter freshest in mind and most vital to my kind, may be more acceptably presented than matter less fresh and less vital, though more thoroughly known.

Well might the Geologist be proud if he had mastered his field and there yet remained nothing to do but to conserve his stock and perpetuate his race. We are ready to grant that geology is a cultural subject of no mean proportions, and that able teachers should be continually turned out to apply this culture to the rest of mankind. We believe men and women can live better for the vision a survey of our science can give, and we wish that many more than at present might gain that vision. But we are not ready to grant the rest. We believe that Latin and Greek are dead languages and yet that they have a cultural value and should be taught to large numbers of young people by competent teachers, and that a few of these young people should pursue the languages far enough to become in turn competent teachers.

We believe that geology is not in its coffin, nor on its dying bed. To establish this belief one can profitably note what yet remains to be done in several geologic lines, and the present rate of progress along these lines.

1. In the field of topographic mapping, the first serious work undertaken in any new region by our Federal survey, there is yet something to be done. The United States and Alaska are large enough that when mapped on the scale now most generally used, one mile equals one inch, 16,000 sheets will be necessary to contain them. We have been making these maps at the rate of some 200 per annum recently. At this rate eighty years will yet be needed to cover our land. And this is only preliminary to geologic work. This scale is much smaller than is used for the more refined work done in England, Switzerland and Germany. We have a few sheets for important mining regions or other special places on a larger scale. See California Alluvial Valley; sheets of Grand Canyon and Yosemite, Aspen and Mother Lode regions. Perhaps 35% of Europe is topographically mapped on some scale adequate for other geologic work. Portions of Egypt, all of Palestine, portions of India, China, Brazil and South Africa, patches in Australia, most of Japan and New Zealand, and small areas in Southern Canada are also mapped. Nearly all, however, of the earth outside of the United States and Europe is still unmapped on such scales, and progress thereon will be generally slow. When the United States and the countries of Europe have completed their work at home they will find many years of work yet to do in other continents. When most of the land is mapped on a scale of one mile to the inch many areas can very profitably be mapped on

a larger scale for more refined areal geology than can be done on the smaller scales.

2. In the field of areal geology—mapping by means of colors or designs the distribution of the rocks of each age or kind—the present time finds relatively little territory covered. In the United States about 200 folios have been published. Each covers from one to sixteen of the one inch to the mile sheets, or in all, about 850 quadrangles, or nearly 200,000 square miles. At the present rate of progress our country will last the Federal survey nearly 500 years. It may be said, however, that a good deal of work has been done by State surveys of about the same quality, some even better, and that this time may be cut down one-half. The countries of Europe are not as a whole far in advance of the United States, and most of the rest of the world has not been disturbed by any such refined work.

Mapping on the scale of one mile to the inch does not call for careful enough field work to even open many of the problems of geology. Some of our State surveys, some private companies, and occasional parties in the Federal survey have undertaken local studies of a much more detailed nature than the general run of work on the above scale. For example, see Butte, Montana, and Bisbee, Arizona, regions.

Geologists have made many generalizations and have built up many working hypotheses for all kinds of purposes. Of course, the work in the field upon which they are built has not yet gone far enough to thoroughly test the validity or falsity of either the generalizations or the hypotheses. Not until the evidence is all in can we say the laws are known. Better working hypotheses and more reliable statements of principles are appearing every year in the various fields of geology, while the older theories and statements having served their day as stepping stones are cast aside. Even in the mapping of areal geology and the interpretations thereof, the field is almost infinite, if the whole world be taken into account, and the scale be large enough to show what details can really be seen.

3. In the field of stratigraphy and stratigraphic interpretation the Geologist uses the areal work just discussed and attempts to unravel the succession of events—the chronology of geology. It is by this means in part that he has been able to assign units of time to his geologic history of the earth. Breaks

in the succession of rock layers indicate breaks in the process of sedimentation. Such a break is called an unconformity. The size of the area over which the unconformity extends and the amount of the break are used in determining the rank of the unconformity, i. e., whether it shall be used simply to mark the limits of two formations, or to mark the boundary between two systems or groups of rocks, or two periods or eras of time. Just as birthdays count off years so local and slight breaks or changes in the sedimentation mark off short time units; and just as centennial and millennial celebrations mark off hundreds and thousands of years, so widespread unconformities and great breaks in the geologic record mark off the larger periods and even larger eras of time.

In recent years unconformities of considerable significance have been found where they have been passed over unnoticed before. Perhaps others are yet to be found; and probably some now known only locally will be found to be very extensive. It is only by the careful study of hundreds or thousands of exposures over broad areas and the most judicious correlation from place to place that the facts of the extent and the amount of a given break can be known. Here then, is ample reason for the most detailed stratigraphic work over all known lands.

If enough were known of the unconformities and the character of each layer of rock wherever it occurs, it might be possible to plot on a map the distribution of lands and seas at any given time. Such mapping and the interpretation that goes with it is called paleogeography. It has been but a few years that men have had sufficient data to attempt such mapping. The first maps were supposed to give the extent of seas, bays, gulfs, and land areas for a whole period. They were in the same order of accuracy as a historical map of Europe which should attempt to show on a single map the distribution of the nations through the whole Christian era. In Europe in 1915-16 it is necessary to date the map to the month and the day to make it right. Paleogeography cannot be considered far advanced until it can produce one map for each of a hundred or more dates throughout the earth's sedimentary history, not only for one continent, but for six, with some intercontinental connections. In order to make such maps it will be necessary to have an enormous body of data for the area and for each particular horizon mapped. We cannot hope for perfect maps of sea and land, rivers and mountains, shorelines, islands, straits and bays for every horizon over large areas; but if we knew all the facts now recorded in the rocks of North America we might be able to make a map for each of many horizons, which would be of profound significance and interest to the paleontologist, the biologist, the economic geologist and the geographer.

Many paleogeographic maps have recently been made. One set of about fifty by Charles Schuchert, of Yale, is a marvel of what the paleogeographer can do. The series of final, correct maps of a continent can not possibly be made until all the continent has been mapped areally, and all correlations of strata and unconformities have been established.

All stratigraphic geologists are interested in making as complete a columnar, stratigraphic section as possible. Manifestly such sections in separate localities cannot be alike. unless the localities had the same conditions at the same interval throughout all of geologic time. The correlation of all sections one with another is a step in the making of the paleogeographic maps, and in the interpretation of the stratigraphy of a continent. Such correlation is done on the basis of rock character and fossils. Let me quote a few lines from Schuchert, in Pirsson and Schuchert's Text Book in Geology, page 450, which may contribute to the problems, both of unconformities and the making of the column. "These breaks are known to be many, but they are far greater in number, and their time durations, although admittedly very variable, are far longer than is usually believed to be the case. The geologic column will probably never be completed on the basis of the recoverable physical and organic evidence, but it will grow into greater perfection for a long time, through the discovery of formation after formation along the lines (levels) of these breaks."

4. The Paleontologic record in the rocks is largely yet to be deciphered. At present every paleontologist recognizes great breaks in the biologic succession. So numerous and great are these gaps that the theory of evolution of later from earlier forms cannot yet be considered a principle or law. Not until a column is completed, and that too of fossiliferous strata, can we know just what has been the succession of forms. The paleontologist must go on collecting as the study of areal

geology proceeds, and the paleogeographic maps grow, and multiply, and the columnar section becomes more complete, until such a time as he can have a complete series of forms from the beginning to the present. Then he may be able to answer the great question whether each flora and fauna has developed from a previous *ensemble* of life by gradual transitional changes, or has arisen by a sudden large change, or a creative fiat at some critical moment. Since this work of a biologic nature cannot precede, but must follow the stratigraphic and paleogeographic work it means many more years and probably centuries before the geologist need lay down his hammer and spade.

If there are *enchainments*, to use Gaudry's term, between species of one period and those of the next, our field studies ought to find them. Very few have yet been found, but in most cases there is rather a biologic hiatus. I have faith to believe that within the next thousand years or so a considerable number of real *enchainments* will be established. We may also find many actual centers of dispersion where the evolution of a fauna has gone rapidly forward in a more or less restricted area and from which the new forms have spread in startling suddenness and profusion. Indeed it is possible as we push our research farther and farther back and finally have mapped and studied minutely all stratified rocks from all parts of the earth that we shall find the beginnings of many of our large types of life. We may even find substantial paleontologic evidence for the evolution of man from the lower, more primitive and generalized mammals.

A few figures will present the biologic possibilities in a very different way. Pratt in 1911, estimated the described forms of animals to be a little over a half million. A recent estimate of the number of fossil animal species described gives 100,000. The 500,000 living forms were taken from one geologic period at one time. The 100,000 fossil forms were taken from the whole geologic section, which undoubtedly includes hundreds of geologic "times," any one of which was as long as the present, had as distinct a fauna as the present, and perhaps as many species with hard or preservable parts as we have now. Of course, our recent 500,000 described forms does not include nearly all of the living forms, possibly not 20%, and this ratio may be similar to the ratio of animals with hard parts to all animals. Probably too, life has become more diverse than it was in the early geologic times, but after making all necessary and reasonable allowances, it seems probable that we do not yet know one per cent of the forms that have lived and possessed hard parts, and certainly not more than one-tenth of one per cent of all forms that have lived. Butterflies are preservable in the geologic record. Twenty-two species have been described half of which came from one place and one horizon, while there have been described of living forms about 13,000 species. With this present incompleteness of our knowledge, is it any wonder that we do not succeed in establishing biologic concatenations as frequently as we wish? And how long will it take to discover the rest of the 10,000,000 preserved species? So far we can agree with a statement of Huxley that "the whole geologic record (at least so far as we know it) is only the skimmings of the pot of life."

5. In the field of dynamic geology—vulcanism, seismology, diastrophism and gradation—the last process is really the only one which we know. We cannot expect to understand vulcanism, a perpetual and almost universal process throughout geologic time, though not as much so as gradation, until at least all present volcanoes have been carefully studied for time sufficient to know their habits as well as we know those of Vesuvius. We have been nearly 2,000 years learning Vesuvius, and there are 500 living volcanoes, with 3,000 or more that are dormant or recently extinct.* Not only should we know their distribution and habits, but their connections and interrelations, the depths from which they draw their lavas, and many other items to be obtained only by careful and long continued observation of each volcano. Generalizations on limited observations of a half dozen volcanoes cannot be considered final. Centuries of study of hundreds of vents cannot be counted extravagant when one is after such fundamental and deep-hidden truth.

Earthquakes have but begun to tell their story. Many records of all the larger quakes should be made. Then comparisons and computations may disclose facts not only about earthquakes, but about the nature of the earth's interior.

6. On this latter problem—the earth's interior—so little is known that we feel that we *know* nothing, except that its

*Pirsson and Schuchert, Text Book in Geology, Page 204.

substance is heavy. With long continued and wide-spread study of vulcanism, seismology, and the igneous and metamorphic rocks themselves, we ought some day to answer some of the questions asked by the laity, even if we still fail to answer our own interrogations.

On the question of the nature of the interior of the earth, Chemist, Physicist, Mathematician and Geologist must each work for some time. I confess that we do not yet seem to know how to attack the problem. I think it is certain, however, that much study of vulcanism, diastrophism and seismology for a long time over the whole earth, and of the first two through the remote geologic past, will make great contributions to our interpretative theories of the earth's interior. Physicists and Chemists must help before the problem will yield, and it seems evident, even with these several scientific cohorts in siege, that the secrets will be only slowly and reluctantly surrendered.

7. With these problems comes that of the origin and nature of both igneous and metamorphic rocks. Three recent enlightening books on igneous rocks leave us not far, relatively, from where we were before their authors wrote, and this not because they wrote so little, but because they do not yet get together and because their data are still quite insufficient. Rock and mineral analyses are now on record by the tens of thousands, but there are not enough. Nearly all have come from rocks collected between latitudes 25° and 55° North and on but two continents. The rest of the earth has its contribution to make.

Daly* estimates that the sedimentary rocks, if spread uniformly over the earth, would make a layer one-half mile thick. The metamorphics would probably not be more than two or three times as much. It is assumed then that the rest of the earth to the center is of igneous rocks. "The final philosophy of earth history will therefore be founded on igneous rock geology."† But with essentially all the earth consisting of igneous rocks it is evident that our meager scratching on but 10–15 per cent of the surface of the earth cannot give us more than an introduction to the problem of Igneous Rocks. Daly adds, page 42: "The data for a quantitative study of the visible igneous matter in the earth fall far short of being complete enough for the ultimate needs of petrogeny." And

*Daly, R. A., Igneous Rocks and their Origin, Page 1.
†Daly loc. cit.

Harker† says: "A systematic treatment of igneous rocks on the lines of petrogenesis is not to be expected in the immediate future."

One attempt has been made to correlate remote igneous rock sections, viz., between Scandinavia and the Adirondacks. When we know enough of petrogenesis we may be able to correlate volcanic rocks pretty generally even as we do sedimentaries.

Concerning metamorphic rocks we cannot yet tell in many instances whether the specimen was made from sedimentary or from igneous rocks, and until methods for making such identification are found many stratigraphic and regional petrographic problems remain unsolved. And until we understand much more than at present of both igneous and metamorphic rocks we shall be in the dark on the nature of the earth's interior. Right here some day, however, as suggested above, we may look for important light on cosmic geology.

8. In the field of Economic Geology have been gleaned many facts. This is particularly true in connection with some of the richer ore deposits and especially in the United States, Europe and some English and German possessions. It is very difficult to say what more there is to learn in this field until more progress has been made in areal and petrographic geology. It certainly is true, however, that in three-fourths of the land surface of the earth but little is known regarding its deposits of mineral wealth. Discoveries of new and valuable deposits have been made with at least the usual frequency right down to date, and there is no reason to believe that we are near the end of such discoveries. They may reasonably be expected to continue for hundreds of years as our exploration of the stratigraphy continues over the rest of the earth, first in temperate zones, North and South, then in equatorial regions the world around, then in the high latitude lands, and finally as exploration of the igneous rocks is also prosecuted in all latitudes and longitudes.

Moreover, new uses may be found by geologist, chemist, or manufacturer for substances now neglected or little used, and the geologist must then explore for the deposits of the newly desired substances. There is, I believe, a great field for invention in the combinations of metals and semi-metals, and in the

†Harker, A., Natural History of Igneous Rocks, Page 376.

uses to which many substances can be put; inventions which will start the geologist and miner out anew.

May we not yet find unknown sources of heat, fuel, or electricity in the substances of the earth? May we not again find, as we have in the past, wholly new combinations or occurrences of elements?

Under this heading thus far I have really spoken of nothing but the purely economic possibilities. From the geologic side generalizations are now made on the basis of our studies of the deposits mentioned above; but such generalizations and any classification of ore deposits based upon them must necessarily be subject to continual revision as new discoveries are made. In some types of deposits I suppose our interpretations are fairly reliable. But some of our largest salt deposits, many gypsum and more anhydrite deposits are still in dispute. Hundreds of deposits of sulphides, tellurides, selenides, etc., are still under discussion. Whether of magmatic origin or segregated from the sedimentary rocks in joints of which they lie, or whether deposited by ascending juvenile magmatic waters, or by waters once at the surface, and now, after a journey down to high temperature depths, ascending with sufficient solvent power to segregate the ores, is still an unsettled and, just now, indeterminable question.

In many instances the ore deposit is intimately related to igneous rocks and cannot be understood until the story of igneous rock genesis is written. Lindgren* says, too, that "rock alteration is a subject of prime importance for the mining geologist." While this subject has long been studied, but little has been done in rock alterations beyond those changes that make rock waste. Alterations that make rocks over, andesites and limestones into highly siliceous rocks, black diabases into white rocks made of calcite, quartz and micas, are but little understood, and many analyses and comparisons must yet be made. And conversely, because of this relation of igneous rocks to ore deposits, the interpretations of the latter will certainly help to elucidate the genesis of the plutonic rocks. We have no right to ask to be excused from geologic research until the metaliferous deposits have all been studied. How long a job this is we cannot know, because we do not know how

*Lindgren, W., Mineral Deposits, Page 2.

many deposits are yet to be found. It is reasonably safe, however, to estimate that the known problems and occurrences will keep the geologist busy for some generations.

All these problems relating to the genesis of mineral, rock and ore deposits, those relating to the nature, and change of nature, of the earth's interior, those of vulcanism, seismology, and diastrophism, of stratigraphic interpretation, and of the paleontologic record run back to the question of the origin of the earth. The latter cannot be considered solved until these are worked out. But I prefer to postpone cosmic geology a moment for two other considerations.

9. In the field of Physiography or Physiographic Geology, as it is known by some investigators, the detailed mapping cannot well precede the topographic mapping discussed near the beginning of this paper. It was shown there that several generations will yet find employment before the topographic map of the world is done, unless our pace be greatly accelerated. Hence physiographic mapping will be equally delayed. But more can be said. Physiographic mapping not only cannot precede topographic work; it does not to date nearly keep up with the latter. Really but very limited and disconnected areas have been mapped and interpreted from the physiographic viewpoint. True, these are usually at more or less critical or typical places as New York City and Watkins Glen quadrangles, Tacoma quadrangle, Mooers, N. Y., Columbus, Ohio, Chicago, and Niagara, in America, and similarly restricted areas in Europe. Much excellent topical work has been done, as the Lake surveys of Scotland, Glacial features of the lobes of the Great Lakes and Prairie region of the United States, the studies of the Lake Plains in Northern Ohio, and others. But here again the problems that may be studied as topics are so numerous that one hardly knows which way to turn or where to begin. These studies already undertaken have led to many generalizations, but imperfections in some of these will undoubtedly stand out boldly as other similar or related areas are studied. Very little is known yet of the physiography, even descriptively, to say nothing of interpretation, in the portions of the earth in arid climates; and yet arid climates prevail over some 10,000,000 square miles, or one-fifth of the land area of the world. Nor do we know much as yet of the topography of the ocean floor.

Some years ago I chanced to be in a geologic conference, dealing with this phase of geology, in two sessions of which rathering striking statements were made, each by a man whose name and works are well known by scientists now before me. One man was tremendously impressed with the great size of the earth and the multiplicity of forms upon it. He said, "The earth is too big, I can't comprehend it all. I'm staggered by its display of variety; its maze of form and tangle of process." The other, approaching his problem more from the philosophic side and carrying fewer years, said, "Why, the present world is too small. I can't find nearly all the forms I can think of. I can imagine a plenty of forms I've never seen in any part of the world." Each lament points a finger in a direction which our physiographic research must take. The one must see all the world and find, record, and describe all the physiographic forms which occur, and even must uncover the past physiographies (for each geologic horizon has had its physiography as truly as it has had its distribution of sea and land), and from these ancient surfaces describe the features. The other must systematize the work of the first, classify the forms, put them into categories, resolve them into systems related to processes and stages in the process, devise formulae for describing great groups of them at once and thus make the comprehension of the whole world possible. Then must follow chapters of explanation for the types and groups.

10. In the field of Geography, whither some of our geologists have now gone to work, and whence came many of the pure geologists in days gone by, there is something yet to do. Geography is defined as that phase of science which deals with the relations existing between the physical and the cultural, between soil, topography, resource and climate on the one hand, and man and his activities on the other. The field has been cultivated, but poorly, by the historian and economist. It has been cultivated also a little by the geologist. I believe the latter has really the best equipment, but for the most effective work in this field the worker must have a good working knowledge, both of Physical Geology and Geography, and of History, Economics, Sociology, and Industries. But little work has been done in this whole field. A few score of workers are pursuing problems and the good things are beginning to come to light. While Geography has its roots in both the earth

sciences and the social sciences, it calls for some knowledge of Anthropology, Ethnology, Archeology, and even Modern Psychology. With all these contacts what then is the geographer to do? In brief, he is to work out the actual relations existing between man, and his environment, whether profitable or adverse; find geographic reasons, so far as they exist, for man's distribution, occupations, migrations, diseases, beliefs, and culture, not only in the present, but in the past. And, as his work progresses, he should be able to forecast for man, and advise; to show how man can succeed better or fail less by more careful adjustments to the environment; to show what we are doing here that we should not do here, but should do elsewhere; to show the possibilities of new lands and even of old ones, and a multitude of other things, for the good of his race. Geography holds many attractive openings for the geologist of the future and hence deserves probably the mention accorded it here, although it is not itself a branch of Geology.

11. It remains now to look into the field of cosmic geology. We are in a transition stage from rather secure trust in the Laplacian Hypothesis for the origin of the Earth and its associates, to a rather wholesome distrust of this theory and a chary approach to the Planetesimal Hypothesis. The old is decidedly unsatisfactory. The new is not wholly acceptable, but is a very suggestive working scheme. It is necessary for Geologists everywhere to adjust their *thinking* and *interpretations* to the *new theory* and to test them out together. Some weak places are found in the theory, but I am not here to discuss them. Let me mention, however, that it does not seem to account for the free oxygen in the air, and it leaves us to suppose that the chlorine in the salt of the sea came from the igneous rocks. I have made a little calculation on the latter point, a summary of which may prove interesting. Analyses show that chlorine occurs in igneous rocks to the value of about .06%. In the sea common salt constitutes about 77% of the salts and chlorine at least half of all dissolved mineral matter. The calculation shows that if a layer of igneous rocks twenty miles thick all over the earth, or seventy-five miles thick over the continents should be disintegrated, the process would liberate about as much chlorine as is now in the sea. But if this amount of igneous rock had disintegrated, where is the waste other than the chlorine? Sedimentary rocks, as formerly stated, would

not make a layer more than about a half mile thick. Thus some other source of chlorine than wasting igneous rocks must be found.

Whatever fundamental theory ultimately is established for the genesis of the earth, it will be reached by a long series of approximations. A body of facts must be built up, and over against it, a body of hypotheses. The research student must work between the two bodies. A new fact or group of facts may show the theory faulty in some particular, and make necessary its revision. The revision of the theory will point to a possible new field for investigation and the geologist will go in the quest of new truth. This truth, when found, may go beyond the theory again and thus require another revision. And so the growth of the theoretic side will proceed parallel with the growth of disclosed truth. A hypothesis for the origin of the earth must be in harmony with all known and discoverable facts of petrogenesis, paleontology, stratigraphy, and paleogeography; must be supported by all facts known of seismology, diastrophism, vulcanism, and ore deposition; and must take into account all truth discovered by astronomer, physicist, chemist and biologist. The geologist cannot complete his theoretic work until the field work is done in his own and the several related sciences.

This emphasizes the need of earnest co-operation between all scientists. "No man liveth unto himself." Men of all the enumerated branches of science are asking for the geologist's results. They, like geologists, cannot complete their tasks until facts are drawn from many related fields.

In conclusion, then, the geologist has in his own field many times more to do than he has yet accomplished along almost all lines; and he is not able to finish until other scientists have finished, because his truth is so interwoven with theirs. Science is one with many closely related ramifications. But back of all these items marshalled in previous paragraphs, items which probably amply answer the question of my subject, are the two incontrovertible facts that man is finite, while truth is infinite, and hence the whole truth will never be known. Men are at present making approximations toward it. We shall continue so to do. Our children and children's children, for many generations may also continue to do so, and with no fear of exhausting their task.

Oberlin College.

AMIOTIC PARTHENOGENESIS IN TARAXACUM VULGARE (LAM.) SCHRK. AND TARAXACUM LAEVIGATUM (WILLD.) DC.

A Preliminary Peport.*

Paul B. Sears.

The work of which the results are here offered, awaiting detailed presentation in a paper to follow, was begun at the University of Nebraska in 1914, under the direction of the late Dr. Charles E. Bessey. The two species of dandelion which have been studied are respectively the *Leontodon taraxacum* and the *L. erythrospermum* of the Second Edition of Britton and Brown's Illustrated Flora: the nomenclature used in the title of this paper has been adopted on the basis of evidence presented in the monograph of the genus *Taraxacum* by Handel-Mazetti.[1]

Both of these species were among the number found by Raunkiaer[2] to be "parthenogenetic" when he performed his classic castration experiments in 1903. His operation, which consists of removing anthers and stigmas before anthesis, and subsequent protection from pollination, has been frequently and successfully repeated in the case of both species, without affecting the viability of the seeds produced.

Moreover, the observations of various authors, notably Raunkiaer[2] and Kirschner[3], to the effect that its own pollen is not to be found germinating on the stigmas of *T. vulgare*, are true for both species investigated, so far as known. Whether or not the pollen of sexual species of dandelion would germinate on the stigmas of either of these forms is not to be ascertained by work here, for such sexual species are unknown in the mid-western United States.

In both species, to-wit, the grey-fruited and red-fruited dandelions, the development of the embryo-sac has been carefully studied. The embryo-sac-mother-cell, or megasporocyte, only divides once, forming two daughter cells with the somatic or 2x chromosome content. Juel,[4] of course, in 1904, found this to be true of *T. vulgare*, but I am aware of no similar investigation in the case of *T. lævigatum*. In both species one of the daughter cells degenerates, while the remaining one gives rise to an embryo sac of normal eight-nucleate type, but with

*Summarizing a paper read before the Ohio Academy of Science, April 21, 1916.

unreduced chromosome content. In *T. vulgare* the chalazal daughter cell gives rise to the embryo sac, while in certain cases at least, it is the micropylar daughter cell which seems to function in *T. lævigatum.* That this distinction is constant is scarcely to be expected.

There is, however, an equally interesting, and apparently constant difference in the form of the embryo-sac of the two species, the embryo-sac of *T. vulgare* being fully one-half as wide as long at maturity, while that of *T. lævigatum* is scarcely one-fourth to one-third as wide as long at the corresponding stage. This difference is reflected to some extent in the form of the ripened achenes.

In both forms the egg-cell gives rise to the embryo sporophyte without apparent external stimulus or sexual fusion. Division of the egg cell very frequently begins a considerable time before the opening of the flower and is accompanied by rapid (often amitotic, according to Schorbatow[5]) division of the endosperm nuclei. The fact that the embryo arises from an unfertilized egg-cell of unreduced chromosome count makes it seem advisable to employ the expression "amiotic parthenogenesis"—to describe the phenomenon, rather than the term "apogamy." This expression "amiotic parthenogenesis" is of course the equivalent of Winkler's[6] ambiguous "somatic parthenogenesis." The word "apogamy," for the sake of clearness—not the least object to be sought—should be restricted, it would seem, to cases of embryo-origin from purely vegetative tissue; just as the expression "true parthenogenesis" must be limited to embryo-origin from an unfertilized egg of haploid chromosome number.

The heads of *T. lævigatum,* the red-fruited species, contain a high percentage—often between 15% and 20%—of empty or sterile achenes, to be explained in some cases by an early breaking down of archesporial and nucellar tissue, in other cases by a failure of the ovulary to develop anything but purely vegetative tissue. Empty or sterile fruits are of rarer occurrence, so far as noted, in *T. vulgare.*

Both forms, in all cases examined both in Nebraska and Ohio, produce pollen in abundance, but even cursory inspection shows the grains to vary extremely in size. Cytological studies of both species reveal varying degrees of pollen degeneration.

Many anthers, particularly in the case of *T. vulgare,* contain in whole or in part pollen grains of normal appearance and even size, formed in tetrads, as by means of ordinary reduction division. In other cases tetrads are found consisting of two large and two small cells. Again, in both species but particularly in the examples of *T. lævigatum* which were studied, the pollen grains are formed in groups of irregular numbers, at times as many as six or seven being found in a cluster. In such cases, wide disparity of size is the rule, the larger grains frequently being devoid of stainable nuclear material.

Finally, in the red-fruited species, *T. lævigatum*, bodies exactly like mature pollen grains in outward form are found in pairs. This type of pollen development corresponds exactly to the diads found by Osawa[7] to be so frequent in the amiotically parthenogenetic Japanese species, *T. albidum* (?). The presence of such diads would superficially suggest the complete loss of reduction division, already true of the embryo-sac-mother-cell.

Detailed studies of pollen genesis indicate that, as a matter of fact, the tetrads of normal appearance are formed by ordinary reduction division, just as they are in the sexual species of dandelion that have been investigated. In many cases observed, however, the divisions were seen to be quite irregular, in that the spindle mechanism was unable to effect a simultaneous transfer of all the chromosomes entering into the first division. This means that a varying number of chromosomes lag behind and are either (a) included in one of the two daughter nucleii, augmenting its size at the expense of the other, or (b) formed into separate supernumerary nucleii. In the former case of course a second division would result in the formation of two cells of large size, and two of reduced size, a situation which, as indicated above, is often found. In the latter of the two cases mentioned subsequent divisions might or might not occur, in either case giving rise to an irregular number of pollen grains of widely varying size and nuclear content.

Again, a number of clearly defined cases were observed in which nucleii were dividing amitotically, as indicated by dumb-bell forms and other criteria laid down by careful workers in the past. These amitotic divisions were found at times to replace the first division of the mother cell, as well as subsequent divisions. This finding also coincides with the condition obtaining in *T. albidum*, as worked out by Osawa.[7]

Finally, clear explanation of the large number of anucleate pollen grains, generally found in association with smaller grains, was found in the frequent occurrence of well-defined nuclear extrusion; this phenomenon occurs extensively in *T. lævigatum*, and has been found in material so carefully prepared and in such well-defined stages that its genuineness cannot be brought into question. This phenomenon apparently was not observed by Osawa[7] as contributing to the pollen abnormalities of *T. albidum.* As found in *T. lævigatum*, this extrusion takes the form of a centrifugal wandering of granules of stainable material and their speedy organization into accessory nucleii so soon as they pass through the parental nuclear membrane.

Finally, the occurrence of diads, as before mentioned, is due to entire loss of the reduction division—the mother cell dividing once and both daughters forming into "pollen-grains."

In neither of the species studied is the chromosome count any lower than in any sexual species for which it has been taken, as is generally true for the amiotically parthenogenetic species of *Taraxacum* that have been investigated. Moreover, both species possess such a wide range of forms that the only safe criterion for separating them seems to be achene color and form. While this polymorphy may be correlated with what seems to be an unwieldy chromatin content—so far as the reproductive cells are concerned—nevertheless, when taken in conjunction with the observed pollen abnormalities and the chromosome count it points strongly toward hybridism, possibly quite complex hybridism, as an explanation. That this idea has the specific sanction of Blaringhem[8] and others is well known. However, I do not wish to be understood as asserting that such evidence can ever *prove* the existence of complex, or even simple, hybridism, as some workers undoubtedly believe.

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Date of Publication, January 20, 1917.

THE

Ohio Journal of Science

PUBLISHED BY THE

Ohio State University Scientific Society

Volume XVII FEBRUARY, 1917 No. 4

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A SURVEY OF THE NORTH AMERICAN SPECIES OF MERRAGATA.

By Carl J. Drake.

The genus *Merragata* (family Hebridæ), based on *M. hebroides* from the Hawaiian Islands, was established by F. B. White in "Annals and Magazine of Natural History" (London), Vol. XX, page 113, 1877. The genus is closely allied to the genus *Hebrus* Curtis (*Nœogeus* Laporte), but differs from it in having the fourth and fifth segments of the antennæ conjoined without a trace of a suture between them. In the "Biologia Centrali-Americana," Rhynchota, Vol. II, page 121, 1898, Dr. G. C. Champion slightly amplifies the generic description of the antennæ as given by White so as to include two new species from Mexico and Central America. In the same volume Dr. Champion also describes the male of *M. hebroides* White from a single specimen that was taken at Chapultepec, Mexico, and states, "It is probable that the species has been introduced into the Hawaiian Islands."

The new Nearctic forms described herein agree with the tropical and semi-tropical species in having the tarsi composed of two segments and the antennæ of four, the minute segment at the base of the third segment of the antenna not being counted as a true segment, but as a part of the third. The heads of the Mexican and Central American species have either a fine or a distinct median, longitudinal groove while the Nearctic forms have the head with two longitudinal grooves, converging anteriorly, and a median ridge between these grooves. The members of the genus are all very small insects, being two millimeters or less in length. Dimorphism seems to be characteristic of the genus—macropterous and brachypterous forms occurring in the same species, the latter form having only short wing-pads that vary somewhat in size in the same species and in different species.

The habits of those species of *Merragata* White that I have observed indicate that they are dwellers in still and stagnant waters. Their favorite haunts are secluded coves of lakes, ponds, and swampy pools, where the water is shallow, and where there is an abundant growth of aquatic plants. I have rarely seen them on the damp ground near the water's edge. The Merragatas are aquatic pedestrians, capable of standing, walking, and running upon the surface of the water, their entire body being covered with a velvety pile which effectively sheds the water and prevents them from becoming wet. They can move forward or backward, but the usual mode of progression is a steady forward movement, all three pairs of legs being used in locomotion. I have often found them on *Lemna*, *Nymphæa*, and various other aquatic plants. It is not uncommon to find them on the underside of floating leaves, or even among the roots of floating water plants. When submerged in the water, the insects are surrounded by a film of air which enables them to stay beneath the surface film for a considerable period of time. In an aquarium I have often watched them standing or walking for a period of a half hour or a little longer on pieces of cork or plants that were beneath the water. Occasionally, they will walk down the sides of the glass aquarium beneath the surface of the water, and when the water is shallow, they will walk across the bottom and come up on the opposite side. Nothing seems to be known of their food habits and life history.

KEY TO THE GENERA OF AMERICAN HEBRIDAE (NAEOGEIDAE).

Antennæ consisting of four segments, the minute segment at the base of the third being counted as a part of the third segment....
Genus *Merragata* White.

Antennæ consisting of five segments, the minute segment at the base of the third being counted as a part of the third segment......
Genus *Hebrus* Laporte.

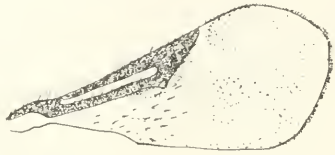
The known species of *Merragata* White (*Lipogomphus* Berg) may be differentiated by the following synopsis, the characters of the Mexican, Central American and South American species being based on the keys of Champion ("Biologia Centrali-Americana," Vol. II, page 121) and Bueno ("Canadian Entomologist," Vol. XLIV, page 32):

1. Apex of scutellum bifid, antennal segments two to four subequal, the basal segment shortest and stoutest........*M. lacunifera* Berg.
   Apex of scutellum blunt, not bifid............................2.
2. Head with either a faint or a distinct median, longitudinal groove..3.
   Head with two longitudinal grooves converging anteriorly and with a median ridge between these grooves......................5.
3. Antennæ short, less than twice the length of the head; segments from one to three subequal, the fourth rather stout and fusiform. *M. hebroides* White.
   Antennæ longer; third segment slender and very much longer than the second; fourth segment slender and subfusiform..........4.
4. Pronotum moderately constricted at the sides...*M. brevis* Champion.
   Pronotum deeply constricted at the sides..*M. leucostricta* Champion.
5. Pronotum moderately constricted at the sides, the disc with a broad, deep, longitudinal furrow; color blackish, the hemelytra white with distinct dusky patches.............*M. foveata* spec. nov.
   Pronotum more abruptly constricted, the disc with a shallower groove; color reddish-brown or dark reddish-brown, the dusky patches of the hemelytra evanescent.....*M. brunnea* spec. nov.

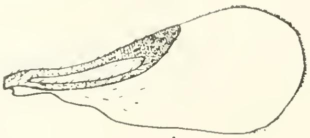
Merragata foveata spec. nov. (Fig. 1a).

Very like *M. hebroides* Champion in size, color, and antennal characters, but readily separated from it and the other Mexican and Central American species by having the head bisulcate longitudinally and with a distinct median ridge between these furrows. From its only Nearctic congener, *M. brunnea* n. sp., it is easily recognizable by the less abruptly constricted sides of the pronotum, the larger size, the angular nervure on the inner margin of the corium, and blackish color.

Moderately large and robust. Head long, hairy, strongly deflected, with two distinct, longitudinal furrows (the furrows converging anteriorly) and a distinct median ridge between these furrows, the sides very strongly depressed above the eyes, and a longitudinal furrow just beneath the eyes and antennæ. Eyes prominent, the facets few and large. Antenniferous tubercles large, prominent. Antennæ very short, a little longer than the head; first, second, and third segments sub-equal, the fourth stoutest, longest, and fusiform. Bucculæ large, with a longitudinal furrow on each side at the base. Pronotum rugulose, very coarsely punctate or pitted, beset with a few hairs, moderately constricted at the sides, with a broad, median, longitudinal furrow in which are two rather regular rows of foveæ, with a rather broad, transverse, punctate depression on each side just back of the collar. Collar prominent, ornated with foveæ. Humeri well defined by a sulcus in which is a row of six or seven foveæ; posterior margin of pronotum also with a transverse row of foveæ. Sides of thorax with quite regular rows of foveæ. Scutellum distinctly carinate. Rostral sulcus broad; rostrum extending a little beyond the thorax. Acetabuli very far apart, especially the intermediate and posterior pairs. Legs rather stout, hairy; claws very long, almost half the length of the terminal tarsal segment. Entire body velutinous. Abdomen densely hairy beneath; connexivum narrow. Venter longitudinally depressed in the male, concave in the female. Hemelytra with large, hairy nervures. Length 1.6 mm.; width .75 mm.



1a



1b

Fig. 1a. Wing of Merragata foveata n. sp.
Fig. 1b. Wing of M. brunnea n. sp.

Color: General color blackish. Antennæ dark-yellow, the terminal segment infuscated. Prothroax blackish, the disc more or less reddish-brown. Legs testaceous, the tips of tarsi infuscated (the claws excepted). Body beneath blackish, the thorax and abdomen covered with a grayish pubescence. Hemelytra white, with dusky patches; nervures brownish-black. Wings white, opaque.

Numerous macropterous examples, taken in a stagnant pond at Ira (Summit Co.), Ohio, August 31, 1916, by Prof. Hine and the writer. I have received a specimen from Prof. C. P. Gillette labeled, Fort Collins, Colorado, August 8, 1898. Type in the author's collection; paratypes in the collections of Prof. Osborn, Prof. Gillette, Prof. Van Duzee, Ohio State University, and the National Museum.

Merragata brunnea spec. nov. (Fig. 1b).

Shorter than *M. foveata* n. sp., the pronotum more abruptly constricted on the sides, the inner margin of the corium rounded, the head and the pronotum reddish-brown or dark reddish-brown, and the dusky patches on the hemelytra evanescent.

Macropterous form. Head hairy, strongly deflected, the sides strongly depressed above the eyes, with two longitudinal furrows converging anteriorly (a median narrow ridge between the longitudinal furrows), a longitudinal furrow on each side of the head just beneath the eyes and antennæ. Antenniferous tubercles large and prominent. Antennæ short, a little longer than the head; first, second, and third segments subequal; fourth segment longest, stoutest, fusiform. Rostrum reaching a little beyond the posterior coxæ. Pronotum rugulose, coarsely punctate, sparsely hairy, the sides more abruptly constricted than in *foveata*, with a transverse, punctate depression on each side just back of the collar. Collar prominent, ornated with foveæ. Scutellum with a narrow median carina. Sides of thorax with somewhat regular, transverse rows of foveæ. Abdomen hairy beneath; venter in ♂ slightly depressed longitudinally and convex in the female. Hemelytra with large, prominent nervures; the inner nervure of corium broadly rounded. Wings about as long as the hemelytra. Length (♂ and ♀) 1.45 to 1.5 mm.; width about .65 mm.

Color. General color reddish-brown or dark reddish brown. Antennæ testaceous, the apical segment infuscated. Legs testaceous, the apical segment infuscated (claws excepted). Abdomen beneath blackish, border with reddish-brown. Hemelytra white, the dusky patches evanescent.

Brachypterous form. Head and antennal characters agree with the macropterous form. Prothorax less constricted on the sides, the humeri less prominent, the disc with a shallower median, longitudinal groove. Scutellum broader. Connexivum very broad. Wing pads vary in size, but usually very small.

Color: General color reddish-brown. Wing pads white. Legs and antennæ agree with long winged form.

Numerous examples, taken at various times during the summer at Hebron (Licking Co.), Sugar Grove and Rockbridge (Hocking Co.), Delaware (Delaware Co.), Columbus (Franklin Co.), and Ira (Summit Co., one specimen only). Type in the author's collection. Paratypes in the collections of Prof. Herbert Osborn, Prof. Van Duzee, and Ohio State University.

THE CROWFOOT FAMILY IN OHIO.

Nellie F. Henderson.

Ranunculàceæ, Crowfoot Family.

Perennial or annual herbs, or woody climbers, with acrid sap. Leaves usually alternate, sometimes opposite; simple or compound, with clasping or dilated base; stipules none. Flowers hypogynous, actinomorphic or sometimes zygomorphic, bisporangiate or occasionally monosporangiate; perianth of similar segments or differentiated into calyx and corolla; capels usually separate; stamens numerous. Fruit an achene, follicle or berry.

SYNOPSIS.

I. Petals or sepals with a nectariferous pit, spur or tube.
  1. Petals broad with a nectariferous pit; sepals not spurred.
     (1) Ranunculus; (2) Ficaria; (3) Batrichium.
  2. Petals cup-shaped or narrow; sepals not spurred.
     (a) Pods sessile; leaves not trifoliate.
        (4) Trollius; (5) Helleborus; (6) Nigella.
     (b) Pods long stalked; leaves trifoliate.
        (7) Coptis.
  3. Either petals or sepals spurred, or hooded; actinomorphic or zygomorphic.
     (8) Aquilegia; (9) Aconitum; (10) Delphinium.

II. Sepals and petals without a nectar pit or spur; sepals usually petal-like.
  1. Styles usually elongated, often very prominent in fruit; fruit an achene.
     (a) Sepals imbricated in the bud.
        (11) Anemone; (12) Hepatica.
     (b) Sepals valvate in the bud; leaves opposite.
        (13) Clematis; (14) Viorna.
  2. Style short in fruit; fruit a many-seeded follicle, or a berry.
     (a) Flowers usually solitary, not racemose.
        (15) Caltha; (16) Hydrastis.
     (b) Flowers racemose.
        (17) Actaea; (18) Cimicifuga.
  3. Style short in fruit; fruit an achene or a few-seeded follicle; leaves ternately compound or decompound.
     (19) Syndesmon; (20) Isopyrum; (21) Thalictrum.

KEY TO THE GENERA.

1. Petals or sepals or both with a nectariferous cup, or spur; flowers frequently yellow. 2.
1. Petals and sepals, when present, without a nectariferous cup, pit, or spur; flowers not yellow, except Caltha. 11.
2. Flowers actinomorphic. 4.
2. Flowers zygomorphic. 3.
3. Posterior sepal hooded, not spurred. *Aconitum.*
3. Posterior sepal spurred. *Delphinium.*

4. Petals flat, with a small pit or cup; carpels usually numerous. 5.
4. Petals narrow, cup-shaped, or tubular at base; carpels usually fewer than 8. 7.
5. Petals yellow; leaves usually not finely dissected. 6.
5. Petals white; leaves usually very finely dissected. *Batrachium.*
6. Sepals 5; flowers not scapose. *Ranunculus.*
6. Sepals 3; flowers scapose. *Ficaria.*
7. Carpels united; flowers with an involucre of dissected leaves. *Nigella.*
7. Carpels separate. 8.
8. Petals long spurred; leaves ternately decompound. *Aquilegia.*
8. Petals small, cupshaped, not projected backward into a spur. 9.
9. Flower stem leafy; leaves lobed or divided irregularly. 10.
9. Flowers on slender leafless scapes; leaves compound with three leaflets. *Coptis.*
10. Petals narrow, linear, with a nectariferous pit at the base; carpels 9 or more. *Trollius.*
10. Petals small, green, tubular cups; carpels usually fewer than 8. *Helleborus.*
11. Leaves alternate or whorled. 12.
11. Leaves large, opposite, compound, twining; our species slightly woody climbers. 20.
12. Flowers yellow; leaves simple, entire, reniform or cordate. *Caltha.*
12. Flowers not yellow; leaves compound, lobed, or dissected. 13.
13. Flowers solitary, umbelliferous or paniculated. 14.
13. Flowers in large branched or simple racemes. 19.
14. Scapose flowers with three sepal-like bracts immediately below the flower. *Hepatica.*
14. Not with sepal-like bracts immediately below the flower. 15.
15. Flowering stem with two alternate, palmately lobed leaves; flowers solitary; perianth deciduous. *Hydrastis.*
15. Flowering stem with an involucre or with more than two alternate leaves. 16.
16. Flowers solitary or few in an umbel. 17.
16. Flowers in large, terminal panicles; often diecious. *Thalictrum.*
17. Flowers umbellate or solitary subtended by a definite involucre. 18.
17. Flowers not involucrate; ovules several. *Isopyrum.*
18. Carpels very numerous; each flower usually solitary on a large peduncle, subtended by an involucre. *Anemone.*
18. Carpels 4-15; flowers usually umbellate. *Syndesmon.*
19. With one carpel, petals spatulate or narrow. *Actaea.*
19. With 1-8 carpels, petals 2-lobed or none. *Cimicifuga.*
20. Flowers panicled; sepals and stamens recurved or spreading. *Clematis.*
20. Flowers usually solitary; sepals and stamens erect. *Viorna.*

Ranúnculus (Tourn.) L. Crowfoot, Buttercup.

Perennial or annual herbs with simple, or usually compound or divided alternate leaves. Flowers solitary, or few in a cluster; yellow or rarely white; usually with five petals and sepals; stamens and carpels numerous, distinct, spirally arranged. Achenes tipped with a minute or elongated style.

1. Leaves entire, terrestial or swamp plants, stems rooting at the nodes. *R. obtusiusculus.*
1. Leaves finely dissected, aquatic plants, achenes callous margined. *R. delphinifolius.*
1. Some or all of the leaves divided or lobed, terrestial plants or in wet places. 2.
2. Some or all basal leaves merely crenate or entire. 3.
2. Leaves all lobed or divided. 5.
3. Basal leaves cordate or orbicular, crenate, occasionally some may be 3-lobed, flowers inconspicuous, achenes smooth. 4.
3. Basal leaves 3-lobed, divisions linear, the lowest may be entire, flowers conspicuous. *R. arvensis.*
4. Basal leaves cordate, stems glabrous. *R. abortivus.*
4. Basal leaves more or less orbicular, not cordate; stems villous below. *R. micranthus.*
5. Flowers inconspicuous, less than 3-8 inch broad. 6.
5. Flowers conspicuous, 1-2–1 inch broad. 8.
6. Stems glabrous, achenes merely apiculate. *R. sceleratus.*
6. Stems densely hirsute, achenes with short or recurved beak. 7.
7. Divisions of leaves wedge-shaped or lanceolate, deeply incised, fruit oblong or cylindrical. *R. pennsylvanicus.*
7. Divisions ovate, lobed, fruit globose. *R. recurvatus.*
8. Carpels with a short style or beak. 9.
8. Carpels with a long prominent style or beak. 11.
9. Stems erect; divisions of the leaves deeply and abundantly cleft. 10.
9. Stems recumbent or creeping by stolons; divisions of the leaves only moderately cleft, the lobes rather broad. *R. repens.*
10. Stem with a thick bulbous base; leaves appearing pinnate, ultimate divisions narrow; calyx reflexed. *R. bulbosus.*
10. Stem without bulbous base; leaves palmately divided, the ultimate segments linear; calyx spreading, not reflexed; inflorescence much branched. *R. acris.*
11. Stem leaves sessile, lowest basal leaves may be entire. *R. arvensis.*
11. Leaves all petioled and divided. 12.
12. Leaf segments broad, bases cuneate. 13.
12. Leaf segments narrow, appearing pinnate; roots thickened or fascicled. *R. fascicularis.*
13. Stems glabrous or pubescent; achenes with a long stout style. *R. septentrionalis.*
13. Stems usually densely villous or hispid; achenes abruptly tipped by a subulate style. *R. hispidus.*

1. **Ranunculus abortìvus** L. Kidney-leaf Crowfoot. Pale green, succulent, branching herbs, ½-1½ ft. high, glabrous or slightly pubescent. Basal leaves cordate or reniform, crenate, occasionally 3-lobed, long petioled; stem leaves 3 to 5 parted, segments linear or cuneate, sessile. Flowers inconspicuous, pale yellow, petals shorter than the reflexed sepals. Achenes, tipped by a short beak, forming a globose head. In shady places. General and abundant.

2. **Ranunculus micránthus** Nutt. Rock Crowfoot. Stems branched, spreading, villous, 6-18 in. high. Basal leaves 3-lobed, crenate, dark green; stem leaves sessile, divided into linear, entire, or sharp-toothed segments. Flowers inconspicuous light yellow. Head of fruit ovate, receptacle linear glabrous. Open deciduous woods, often on rocks. Clermont County.

3. **Ranunculus sceleràtus** L. Celery-leaf Crowfoot. A tall, stout stemmed branching herb, ½ - 2 ft. tall. Basal leaves 3-5 lobed, long broad petioles; stem leaves, except upper ones, petioled, parted into linear segments, entire or several toothed. Flowers inconspicuous, pale yellow, petals scarcely exceeding sepals. Head of fruit oblong, achenes apiculate. Swamps and wet ditches. Rather general.

4. **Ranunculus recurvàtus** Poir. Hooked Crowfoot. Erect, branching, hirsute herb, ½-2 ft. tall. Leaves 3-parted, divisions ovate, toothed and lobed, hirsute. Flowers inconspicuous, pale yellow, petals shorter than, or about equal to the reflexed calyx. Head of fruit globose, achenes with a recurved beak. General and abundant.

5. **Ranunculus àcris** L. Tall Buttercup. Tall, erect herbs, branching above, pubescent. Basal leaves 5-7 parted, the divisions sessile, cleft into linear segments, stem leaves small, 3-parted, sessile. Flowers in a spreading cyme, bright yellow, waxy; petals obovate, much longer than the sepals. Head of fruit globose, achenes compressed, beak short. In fields and meadows. From Europe. Rather general, except in southern part of state.

6. **Ranunculus bulbòsus** L. Bulbous Buttercup. Erect, branching, pubescent stems, from a thickened bulbous base. Basal leaves 3-parted, lateral divisions sessile, terminal one stalked giving the leaf a pinnate appearance; divisions cleft, ultimate segments narrow. Flowers conspicuous, bright, glossy

yellow, sepals reflexed. Head of fruit globose; achenes compressed beaks very short. Fields and roadsides. From Europe. Columbiana County.

7. **Ranunculus pennsylvánicus** L. f. Bristly Crowfoot. A branching leafy herb with erect densely hirsute stems, 1-2 ft. tall. Leaves all divided, segments stalked, cuneate or lanceolate, sharply notched, hispid. Flowers inconspicuous. Head of fruit short, cylindrical, achenes smooth. Wet open places. Cuyahoga, Perry, Lucas, Fairfield, Licking, Ottawa, Lake, Wayne.

8. **Ranunculus rèpens** L. Creeping Buttercup. A low herb, creeping by runners and forming large patches. Stems pubescent. Leaves all petioled, 3-divided, divisions wedge-shaped, cleft and lobed, usually stalked, often blotched. Flowers conspicuous bright yellow. Head of fruit globose, achenes margined and tipped by a short stout beak. Wet ground in fields, or in roadsides. From Europe. Columbiana, Scioto.

9. **Ranunculus septentrionàlis** Poir. Swamp Buttercup. Erect or ascending herbs, 1–3 ft. tall; later stems decumbent and may root at the nodes; almost or quite glabrous, rather stout. Leaves 3-divided, divisions stalked, 3-cleft, and cut, cuneate. Flowers conspicuous, 1 in. broad, bright yellow; petals obovate, much longer than the sepals. Head of fruit globose or oval, achenes flat, tipped by sword-shaped style. Low moist or swampy ground. General.

10. **Ranunculus híspidus.** Mx. Hispid Buttercup. Similar to R. septentrionalis, but densely villous when young, less hispid when old. Does not send out runners. Dry woods and thickets. General.

11. **Ranunculus fasciculàris** Muhl. Tufted Buttercup. Ascending or spreading, low plant growing in a tuft from a cluster of fleshy roots. Stems pubescent. Lateral leaf-sections sessile, terminal one stalked, giving the leaf a pinnate appearance; ultimate divisions linear or slightly oblong. Flowers conspicuous, bright yellow. Head of fruit globose, achenes flat, margined and tipped with a long style. Woods and hill-sides. Ottawa, Lucas, Cuyahoga.

12. **Ranunculus arvénsis** L. Corn Crowfoot. Erect, branching herbs, 6 in. to 1 ft. tall. Stems glabrous or slightly pubescent. Basal leaves broad petioled, 3-cleft, divided into linear segments, lowest ones may be entire; stem leaves similar,

sessile. Flowers pale yellow, petals longer than the sepals. Achenes spiny-tuberculate on both sides and margins. Waste places. From Europe. No specimens.

13. **Ranunculus obtusiúsculus** Raf. Lance-leaf Buttercup. Stems ascending, 1–3 ft. long, often rooting at the nodes. Leaves lanceolate, entire or denticulate, petioles clasping. Flowers panicled, bright yellow, ½-¾ in. broad. Fruit compressed achenes, forming a globose head. Wet ditches and swamps. Licking, Cuyahoga, Lorain, Lake, Franklin, Erie, Jackson.

14. **Ranunculus delphinifòlius** Torr. Yellow Water Crowfoot. Aquatic or partly immersed herbs with long branching stems rooting at the nodes. Immersed leaves finely dissected; emersed leaves 3–5 divided. Flowers yellow, ¾–1½ in. broad. Head of fruit globose, achenes callous margined and tipped by a straight beak. Ashtabula, Darke, Auglaize, Lucas, Wood, Wyandot, Huron, Williams, Marion.

Ficària (Rupp.) Huds. Golden-cup.

Succulent, perennial herbs with fleshy tuberous roots. Stem leaves alternate, simple, entire or crenate. Flowers yellow and solitary; sepals 3–5, deciduous; petals 7–12; stamens and carpels numerous. Achenes in a head; cotyledon only one.

1. **Ficaria ficària** (L.) Karst. Golden-cup. A low herb, 3–5 in. high, found in moist places. Leaves cordate, 1–2½ in. broad, obtuse crenate, with broad petiole. Flowering stem scapose with broad petiole. Flowering stem scapose with one or two leaves. Flowers 1–1½ in. in diameter. From Europe. Lake County.

Batràchium S. F. Gr. Water-crowfoot.

Aquatic, perennial herbs; usually with dissected leaves; the immersed ones very finely dissected. Flowers solitary on peduncles borne opposite the leaves; white or the claw of the petals yellow; sepals and petals usually 5; stamens many; carpels several. Achenes transversely wrinkled.

1. Leaves petioled, flaccid when taken from the water. *B. trichophyllum.*
1. Leaves sessile or nearly so, rigid when taken from the water. *B. circenetum.*

1. **Batrachium trichophýllum** (Chaix) Schlutz. White Water-crowfoot. Leaves all under water and dissected, larger than 1 in. broad. Rather general.

2. **Batrachium circinàtum** (Sibth) Rchb. Circinate Water-crowfoot. Leaves all under water; 1 in. broad or smaller, standing at right angles to the stem. Auglaize, Licking.

Tróllius L.

Erect perennial herbs with glabrous palmately parted leaves and a solitary terminal flower. Sepals yellow, whitish or purplish, petaloid, 5–7 in number; petals 15–25, very small, linear, with a nectar pit at base; stamens and carpels numerous. Follicles forming a head. Marshy places.

1. **Trollius lâxus** Salisb. American Globe-flower. Stems slender, ½–2 ft. high. Leaves usually 5-parted, 1–½ in. broad, upper leaf sessile. Flowers greenish-yellow; sepals obovate, spreading. Stark and Columbiana.

Helléborus (Tourn.) L. Hellebore.

Erect perennial herbs. Leaves palmately-parted, basal ones large, petioled; stem ones sessile. Flowers solitary, white, greenish or yellowish; sepals 5, obovate, clawed; petals 8–10, tubular, shorter than the stamens; stamens numerous; carpels fewer than 8. Capsules.

1. **Helleborus víridis** L. Green Hellebore. Stems stout, 8–24 in. high. Leaves alternate, usually 3–5 parted, those at base of branch may be bract-like. Sepals green, petaloid. Waste places. Stark, Miami, Gallia, Franklin.

Nigélla (Tourn.) L.

Slender stalked, erect herbs with very finely dissected leaves. Flowers solitary, terminal and subtended by an involucre which overtops it; sepals 5, petaloid; petals minute, cupshaped; stamens numerous; carpels 5, united. Fruit a capsule. A cultivated plant which sometimes escapes.

1. **Nigella damascèna** L. Love-in-a-mist. Leaves alternate, pinnately dissected, 1–3 in. long. Flowers about 2 in. in diameter, showy, bluish. Seeds black aromatic. From Eurasia. Hamilton, Erie.

Cóptis Salisb.

Low erect herbs, 4–6 in. high, from a slender, yellow, rootstock. Leaves basal, glabrous, evergreen, shining, 3 leaflets; sepals 5–7, petaloid, deciduous; petals 5–7, minute, clubshaped, cucullate; stamens numerous; carpels 3–7, stipitate, forming follicles in fruit. In damp mossy woods.

1. **Coptis trifolia** (L.) Salisb. Gold-thread. Leaf-blades reniform, 1–2 in. broad, 3 leaflets, ovate, prominently veined, rich green, paler beneath. Follicles on stipes, spreading. Summit, Stark, Portage, Geauge, Defiance.

Aquilègia (Tourn.) L. Columbine.

Erect, perennial herbs, with ternately decompound leaves and conspicuous nodding flowers. Sepals 5, petaloid; petals 5, spurred, spurs projecting backward between the sepals; stamens numerous; carpels 5, separate, forming spreading follicles in fruit. Rocky woods and thickets.

1. Spurs straight, knobbed at tip. *A. canadense.*
1. Spurs curved inward. *A. vulgaris.*

1. **Aquilègia canadénse** L. Wild Columbine. Stem branched, 1–1½ ft. high, glabrous or very slightly pubescent. Basal leaves slender-petioled, leaflets palmately lobed or parted; upper stem leaves nearly sessile. Flowers solitary, terminating the branches, longer than broad, red with yellow lips, spurs straight, stamens and carpels exserted. Fruit erect, follicles tipped with filamentous style. General.

2. **Aquilegia vulgàris** L. European Columbine. Stem stout, erect, pubescent or nearly glabrous, slightly branched. Flower as broad as long; blue, purple, pink or white; stamens and carpels hardly exserted. From Europe; escaped from gardens. Fulton County.

Aconìtum (Tourn.) L. Monkshood.

Erect or trailing, slender, perennial herbs. Leaves alternate, palmately-cleft; lower ones slender petioled, the upper nearly sessile, 3–5 cleft, substending flower peduncles. Flowers ½–2 in. broad, conspicuous; the upper two concealed in the hooded sepal, very small, the others when present are minute; stamens numerous; carpels 3–5 distinct, sessile forming follicles in fruit.

1. **Aconitum noveboracénse** Gray. New York Monkshood. Erect plants, 1½–2 ft. high. Leaves glabrous, thin, 2–4 in. long, deeply cleft, Panicles few-flowered; flowers blue, whitish below, hood with a prominent descending beak. Summit and Portage.

Delphinium L. Larkspur.

Erect annual or perennial herbs. Leaves alternate, cut and divided. Flowers in showy terminal racemes; sepals 5, petaloid, upper one spurred; petals 2–4, the upper ones prolonged backward into the spur, the lateral ones small or wanting; stamens numerous; carpels 1 or 3. Follicles. Open woods, meadows or roadsides.

1. Carpels 1. *D. ajacis.*
1. Carpels 3. 2.
2. Leaves 3–5 cleft; division wedge-shaped, 3 cleft at apex; roots elongated and woody; 2–6 ft. tall. *D. exaltatum.*
2. Leaves 5–7 cleft; division linear; roots short and tuberous; 1–3 ft. tall. *D. tricorne.*

1. **Delphinium tricòrne** Mx. Dwarf Larkspur. Stem rather stout, finely pubescent. Flowers deep blue in usually few-flowered recemes; petals bearded. Pods divergent. General.

2. **Delphinium exaltàtum** Ait. Tall Larkspur. Stems slender. Leaves large. Racemes dense, elongated; flowers blue or purplish; petals bearded. Pods erect. Franklin, Stark.

3. **Delphinium ajàcis** L. Garden Larkspur. Erect, much branched annuals. Leaves finely dissected into narrow linear divisions; lower ones petioled, upper ones nearly or quite sessile. Flowers blue or rarely white, numerous on spicate racemes, spur long and slender. Belmont, Ashtabula, Adams, Knox, Montgomery, Lake, Madison, Hamilton, Franklin, Wayne, Muskingum, Monroe, Preble.

Anemòne L. Anemone.

Erect perennial herbs, with palmately compound or parted leaves. Basal leaves long-petioled, stem leaves forming an involucre below the peduncled flower or flowers. Sepals petaloid; petals none; stamens and carpels numerous. Achenes.

1. Leaves of involcure sessile; stems usually 2–several flowered. *A. canadensis*
1. Leaves of involucre petioled. 2.
2. Small, 4–12 in. high, stems slender, almost glabrous. *A. quinquefolia.*
2. Tall, 2–3 ft. high, stems pubescent. 3.
3. Leaf divisions narrow, wedge-shaped. *A. cylindrica.*
3. Leaf divisions broad, ovate. *A. virginiana.*

1. **Anemone cylíndrica** Gr. Long-fruited Anemone. Tall plants, 1–3 ft. high, softly pubescent, purplish, branching at the involucre. Leaves 2–4 in. broad, 3–5 parted, the divisions narrow, notched and toothed; basal leaves tufted. Flowers greenish-white, 1–1½ in. broad. A head of woolly achenes each tipped by a short style. Open places. Wyandot, Erie, Ottawa, Wood.

2. **Anemone virginiàna** L. Virginia Anemone. Herbs, 1–3 ft. tall, pubescent, branching at the involucre. Basal leaves long petioled, 4–8 in. broad, broader than long, lobed and notched; stem leaves petioled. Flowers solitary, greenish-white, 1–1½ in. broad. A head of downy achenes tipped by divergent styles. River banks and open woods. General.

3. **Anemone canadénsis** L. Canada Anemone. Erect herbs with rather stout somewhat pubescent stems, branching at the involucre, 1–1½ ft. tall. Basal leaves long petioled, 3–5 parted, cleft and toothed; stem leaves sessile, 4–8 in. broad. Flowers white, 1–1½ in. broad, sepals obovate, obtuse. A globose head of flat achenes each tipped by the persistent style. General.

4. **Anemone quinquefòlia** L. Wind-flower. Erect herb; 4–12 in. tall, with slender frail-looking, nearly glabrous simple stems, from a slender rootstock. Leaves 5-parted, slender petioled, 2–3 in. broad; basal leaves appear later than the flowering stem. A globose head of oblong achenes. Open woods and thickets. General, except southern and southwestern parts of state.

Hepática (Rupp.) Mill. Liver-leaf.

Perennial herbs, with 3-lobed evergreen basal leaves and solitary white, pink or purplish flowers on hairy scapes. An involucre of 3 small sessile leaves substends the flower. Sepals petal-like, petals wanting, stamens numerous. Fruit, short-beaked, pubescent achenes.

1. Lobes of leaves obtuse or rounded. *H. hepatica.*
2. Lobes of leaves acute or pointed. *H. acutiloba.*

1. **Hepatica hepática** (L.) Karst. Roundlobed Liver-leaf. Scapes 3–8 in. Leaves reniform, 2–3 in. broad, with slender hairy petioles. Flowers ½–¾ in. broad; sepals oval or oblong, longer than the stamens. Several achenes forming a head. General.

2. **Hepatica acùtiloba** DC. Sharplobed Liver-leaf. Differs from the preceding species only in having the stem leaves and the lobes of the basal leaves acute or pointed. General.

Clématis L. Clematis.

Woody vines, climbing by means of petioles twisted about the support. Leaves opposite, compound; 3 ovate, stalked leaflets; or simple, 3-lobed. Flowers in loose many-flowered, cymose, panicles, nearly diecious; sepals 4–5 spreading, petaloid; petals none; stamens numerous, spreading; carpels numerous, long-styled. Achenes with long plume-like, persistent style.

1. **Clematis virginiàna** L. Virginia Virgin's-bower. A long vine, found on fences and bushes. Leaves glabrous. Flowers white. General.

Viórna Reichb. Leather-flower.

Woody vines or erect herbs, with opposite simple or compound leaves with the petiole prolonged into a tendril. Flowers solitary, bell-shaped; stamens and carpels numerous; styles plumose. Achenes with long persistent style.

1. **Viorna viórna** (L.) Small. Leather-flower. A vine growing to the height of 10 ft. or more. Leaves mostly compound, with petiole prolonged and tendril-like; leaflets ovate, entire, often trifoliate. Calyx purple, with very thick sepals; petals none. Anthers long and slender. Southern half of State; also in Auglaize County.

Cáltha (Rupp.) L. Marsh-marigold.

Succulent perennials with alternate reniform, crenate or entire leaves and conspicuous solitary yellow, white or pink flowers. Sepals 5–9, petaloid, stamens and carpels numerous. Follicles.

1. **Caltha palústris** L. Marsh-marigold. Stems hollow, erect, 6–15 in. tall. Leaves crenate, 3 in. broad or less. Flowers bright yellow, waxy, $1/2$–1 in. broad. In swamps. General.

Hydràstis Ellis. Golden-seal.

Erect perennial herbs with a thick, knotted, yellow rootstock. Stem pubescent with 2 alternate palmately lobed leaves near the summit. Flowers small, solitary, greenish-white; sepals deciduous; petals none; stamens and carpels numerous. Fruit a crimson aggregate berry.

1. **Hydrastis canadénsis** L. Golden-seal. About 6 in. tall. Lower leaf long-petioled, 5–9 lobed; upper leaf subtending the flower. Filaments flattened. Fruit ovoid. Rich woods. General.

Actàea L. Baneberry.

Erect perennial herbs, with ternately compound leaves and terminal racemes of white flowers. Sepals 4 or 5, petaloid, deciduous; petals very small, flat, clawed, narrow; stamens numerous with slender filaments; carpels united, forming a single ovulary; stigma sessile, 2-lobed. Fruit a berry.

1. Pedicels slender, fruit red. *A. rubra.*
1. Pedicels stout, fruit white. *A. alba.*

1. **Actâea rùbra** (L.) Wild. Red Baneberry. Tall herbs, 1–3 ft. high. Lower leaves long petioled, decompound, divisions ovate, incised. Pedicels slender. Open woods. Sandusky, Erie.

2. **Actaea álba** (L.) Mill. White Baneberry. Leaflets more deeply incised than preceding species; lowest ultimate leaflet may be compounded. Pedicels as thick as peduncles. Open woods. General.

Cimicìfuga L. Bugbane.

Tall, erect perennial herbs, with large ternately decompound leaves and white flowers in terminal compound racemes. Sepals 4 or 5, petaloid, deciduous; petals 1–8, minute, clawed, 2-lobed; stamens numerous; carpels 1–8, forming pods. Open woods.

1. **Cimicifuga recemòsa** (L.) Nutt. Black Cohosh. Slender, 3–8 ft. tall. Divisions of leaves ovate or oblong, cleft. Racemes densely flowered, conspicuous, 1–2½ ft. long. Stigmas sessile. Pods oval, beaked. Eastern half of state to Erie, Fairfield and Clermont Counties.

Syndésmon Hoffing. Rue-anemone.

Low, glabrous, perennial herb. Basal leaves slender petioled, ternately compound; stem leaves in a whorl subtending an umbel of white or pinkish flowers; sepals numerous. Achenes.

1. **Syndesmon thalictroìdes** (L.) Hoffm. Rue-anemone. Stems very slender, 4–9 in. high, from a cluster of tuberous roots. Open woods. General and abundant.

Isopyrum L.

Erect glabrous herbs, with slender stems and ternately decompound leaves. Roots fibrous. Flowers white, solitary, terminal; sepals 5–6 petaloid, deciduous; stamens numerous; carpels 2–20. Follicles forming a head.

1. **Isopyrum biternàtum** (Raf.) T. & G. False Rue-anemone. Stems branching. Basal leaves with long slender petioles, thin, ultimate leaflets 3-lobed, broadly ovate. Sepals 5, white, 1/2 in. long; petals none; carpels about four. Follicles spreading, tipped with a beak. Moist woods and thickets. South-west fourth of state; also in Cuyahoga County.

Thalíctrum (Tourn.) L. Meadow-rue.

Tall erect perennial herbs with ternately decompound leaves. Stem leaves alternate. Flowers small, greenish-white, in loose panicles; sepals deciduous; petals none; stamens numerous; carpels several; may be diecious. Achenes usually beaked.

1. Filaments slender, fibrous. 2.
1. Filaments stout, nearly as broad as the anthers; leaflets sub-orbicular; plant stout and tall. *T. polygamum.*
2. Leaflets sub-orbicular; plant slender, 1–3 ft. tall. *T. dioicum.*
2. Leaflets oblong; plant stout, tall. *T. dasycarpum.*

1. **Thalictrum diòicum** L. Early Meadow-rue. Stems slender, glabrous. Leaves slender, petioled, ultimate leaflets orbicular, thin, pale beneath, 5–9 lobed. Flowers diecious green, in spreading panicle of lateral umbels or corymbs; anthers long. Achenes ribbed. Open woods and fence corners. General.

2. **Thalictrum dasycàrpum** Fisch. & Lall. Purplish Meadow-rue. Stems stout, purplish, 4–7 ft. tall, leafy branching. Leaves sessile, leaflets oblong or obvate, 3 apical lobes, glabrous, dark green above, lighter and pubescent below. Panicles loose, compound. Achenes with 6 or 8 wings. Open woods and meadows. General.

3. **Thalictrum polýgamum** Muhl. Tall Meadow-rue. Stems stout, branching and leafy, 3–11 ft. tall. Stem leaves sessile; leaflets obovate or lanceolate, some with 3 apical lobes. Panicles compound, leafy. Anthers short. Rather general.

A PRELIMINARY LIST OF CICADELLIDÆ (HOMOPTERA) OF SOUTH CAROLINA, WITH DESCRIPTIONS OF NEW SPECIES.

FRANK H. LATHROP.

During the summer of 1914 the writer began the collection of Cicadellidæ or "Jassids" of South Carolina for the purpose of making a systematic study, which was submitted in 1915 to the Ohio State University as a thesis required for the master's degree. At present the work is still being prosecuted with a view of making the paper more complete and of bringing in additional material along other than purely systematic lines. It seems desirable now, however, to publish a list of species and descriptions of new forms found in the State.

All species not otherwise indicated were collected by the writer. Besides this material, the collections at hand include species secured by Professor Herbert Osborn at Columbia and Clemson College, Mr. H. C. Eagerton at Marion, Mr. G. M. Anderson at Walterboro, Mr. L. L. Ferebee at Ridgeland, and Professor G. H. Pearce at Sievern.

The nomenclature proposed by Van Duzee in his recent check list* has been used in this paper.

Subfamily BYTHOSCOPINÆ Burmeister.

Bythoscopus robustus Uhler. Orangeburg, Eutawville, St. George.

Idiocerus nervatus Van Duzee. Clemson College.

Agallia constricta Van Duzee. Clemson College, Columbia (Professor Osborn), Orangeburg, Denmark, Eutawville, Eutaw Springs, Ferguson, Marion (H. C. Eagerton), Walterboro (G. M. Anderson,) Ridgeland (L. L. Ferebee), Charleston.

Agallia novella Say. Clemson College, Orangeburg.

Agallia 4-punctata Provancher. Orangeburg.

Agallia sanguinolenta Provancher. Columbia (Professor Osborn), Orangeburg, Denmark, Eutawville, Eutaw Springs, Ferguson, Marion (H. C. Eagerton), St. George, Walterboro (G. M. Anderson), Charleston, Isle of Palms.

*Van Duzee, Edward P., Check List of the Hemiptera of America, North of Mexico, N. Y. Ent. Soc., 1916.

Agallia immaculata n. sp. (Fig. 1). Form and structure closely similar to *A. sanguinolenta* Prov. but smaller, and lacking the color markings.

The entire surface minutely granulated. Vertex nearly parallel margined, the posterior margin evenly arcuate and slightly elevated. Pronotum slightly more than twice as wide as long, faintly transversely striated on the disc; the posterior margin with a shallow emargination. Scutellum slightly shorter than its basal width, the apex produced.

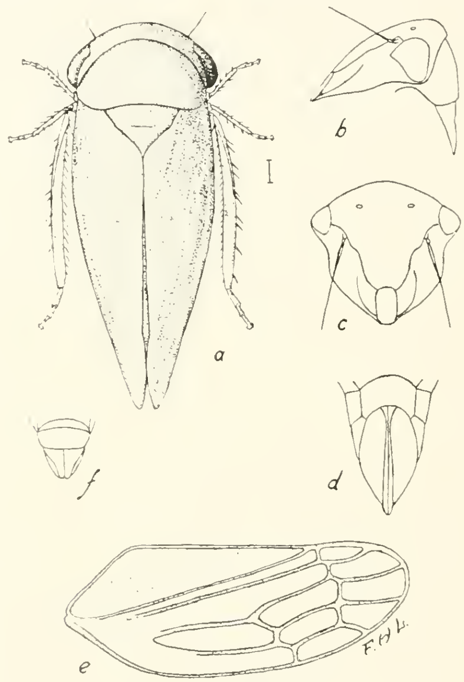


Fig. 1. Agallia immaculata n. sp.
a, Dorsal view of female; b, Lateral view of head; c, Face; d, Female genitalia; e, Elytron; f, Male genitalia.

Elytra broad and short, the apex bluntly rounding, nervures distinct, raised. Face somewhat longer than the width on the base, the sutures depressed, the suture between the front and the clypeus obsolete. Front broad on the base, abruptly narrowing before the middle; below this the margins are straight and nearly parallel, abruptly rounding to the clypeus.

Coloration: nearly uniformly tawny, somewhat intensified on the pronotum, the humeral margins of the elytra, and the front. The ocelli red; eyes dark fuscous, irregularly margined with red. The males are darker, varying to fuscous, and in very dark specimens there may be a pair of indistinct spots near the posterior margin of the pronotum, a pair on the disc of the vertex, which, with the frontal sutures, the antennal sockets, and indistinct arcs on the front are fuscous or blackish. The elytra sometimes fuscous with the venation a trifle lighter. Below, light fuscous, somewhat darker in the males.

Genitalia: ♂ valve short and wide, distinctly narrowed posteriorly; posterior margin truncate; plates short, broad on the base, sharply narrowing to behind the middle, then nearly parallel margined to the obtusely rounded tips. ♀ ultimate ventral segment somewhat crescentiform, the posterior margin roundingly emarginate.

Length: ♂ 2.75 mm., ♀ 2.75–3 mm.

Described from twelve males and five females from Orangeburg, Denmark, St. George, Charleston and Isle of Palms.

Macropsis viridis Fitch. Clemson College.

Subfamily CICADELLINÆ Van Duzee.

Aulacizes irrorata Fabricius. Clemson College, Orangeburg, Denmark, Ferguson, Marion, (H. C. Eagerton), Walterboro (G. M. Anderson), Isle of Palms.

Oncometopia undata Fabricius. Clemson College, Orangeburg, Ferguson, Marion (H. C. Eagerton), St. George.

Oncometopia lateralis Fabricius. Clemson College, Orangeburg, Denmark, Ferguson, Marion, (H. C. Eagerton), Ridgeland (L. L. Ferebee).

Homalodisca triquetra Fabricius. Orangeburg, Ferguson, Charleston.

Cicadella occatoria Say. Orangeburg, Walterboro (G. M. Anderson), Marion (H. C. Eagerton).

Kolla bifida Say. Clemson College, Orangeburg, Eutawville, Walterboro (G. M. Anderson).

Kolla geometrica Signoret. Clemson College, Orangeburg.

Graphocephala coccinea Forst. Clemson College, Orangeburg, St. George, Walterboro (G. M. Anderson), Marion (H. C. Eagerton), Ridgeland (L. L. Ferebee).

Graphocephala versuta Say. Clemson College, Orangeburg, Ferguson, Denmark, St. George, Marion (H. C. Eagerton), Walterboro (G. M. Anderson), Charleston, Isle of Palms.

Dræculacephala mollipes Say. Orangeburg, Eutaw Springs, St. George, Walterboro (G. M. Anderson). Variety **7-guttata** Walker. Orangeburg, Walterboro (G. M. Anderson). Variety **minor** Walker. Clemson College, Orangeburg, Eutawville, Eutaw Springs, Denmark, St. George, Marion (H. C. Eagerton), Walterboro (G. M. Anderson), Ridgeland (L. L. Ferebee), Charleston.

Dræculacephala reticulata Signoret. Clemson College, Columbia (Professor Osborn), Sievern (G. H. Pearce), Orangeburg, Eutawville, Eutaw Springs, Ferguson, Denmark, St. George, Marion (H. C. Eagerton), Walterboro (G. M. Anderson), Ridgeland (L. L. Ferebee), Charleston.

Subfamily GYPONINÆ Berg.

Gypona striata Burmeister. Clemson College, Orangeburg, St. George.

Gypona octolineata Say. Silver (H. C. Eagerton).

Gypona pectoralis Spangberg. Orangeburg.

Xerophlœa viridis Fabricius. Orangeburg, Ferguson, St. George, Marion (H. C. Eagerton), Charleston.

Subfamily JASSINÆ Am. and Serv.

Xestocephalus pulicarius Van Duzee. Clemson College, Orangeburg, Ridgeland (L. L. Ferebee).

Xestocephalus tesselatus Van Duzee. Orangeburg, Walterboro (G. M. Anderson).

Spangbergiella vulnerata Uhler. Orangeburg, St. George.

Parabolocratus flavidus Signoret. Clemson College, Orangeburg, Denmark, St. George, Isle of Palms.

Platymetopius cuprescens Osborn. Orangeburg.

Platymetopius acutus Say. Clemson College, Orangeburg, Ridgeland (L. L. Ferebee).

Platymetopius slossoni Van Duzee. Orangeburg.

Platymetopius cinereus Osborn and Ball. Orangeburg.

Platymetopius angustatus Osborn. Orangeburg, Denmark.

Platymetopius parvus n. sp. (Fig. 2). Quite similar in form to *P. angustatus* Van D., but more heavily inscribed with fuscous above, and marked with fuscous below.

Vertex moderately acute in the female, shorter in the male and nearly right angled. Pronotum broad and short, posterior margin broadly, shallowly emarginate. Elytra broadly rounded on the apex.

Coloration: the vertex a dull testaceous, with the markings in the form of irregular, pale, longitudinal vittæ. Face pale yellow, moderately infuscated on the outer portions of the genæ and the base of the front. A pale angulate line on the base of the front, continued behind the eyes. Pronotum tinged with yellow on the anterior border, the disc mottled with fuscous and marked with five, rather obscure, pale vittæ. Scutellum dull testaceous, tinged with orange near the outer angles. Elytra closely inscribed with fuesous, which is intensified on the apical region. The pale areola spots distinct. A number of deep fuscous recurved veins on the costal area. Below, fuscous, marked with pale yellow and white. Legs pale, spotted with black.

Genitalia: ♂ valve large, shield-shaped, fuscous on the base, the tip pale. Plates rather long, triangular, the outer margins set with short spines. ♀ ultimate ventral segment tapering from the base, slightly produced and feebly notched on the middle, the outer angles rounding.

Length: ♂ 3.5 mm., ♀ 4 mm.

Described from seven males and two females from Orangeburg, Denmark, Marion (H. C. Eagerton), Walterboro (G. M. Anderson), Ridgeland (L. L. Ferebee), and Isle of Palms.

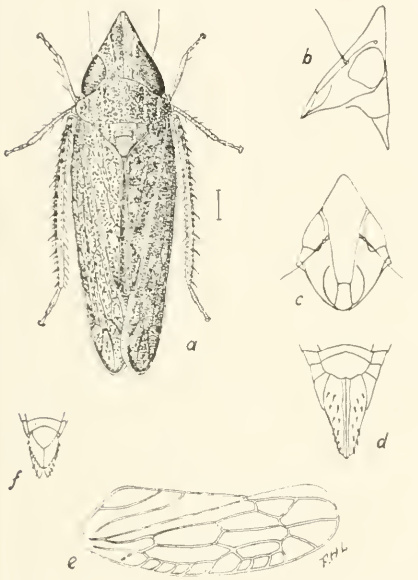


Fig. 2. PLATYMETOPIUS PARVUS n. sp. a, Dorsal view of female; b, Lateral view of head; c, Face; d, Female genitalia; e, Elytron; f, Male genitalia.

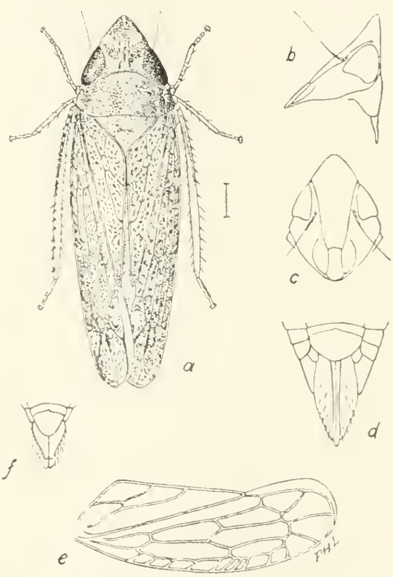


Fig. 3. PLATYMETOPIUS CAROLINUS n. sp. a, Dorsal view of female; b, Lateral view of head; c, Face; d, Female genitalia; e, Elytron; f, Male genitalia.

Platymetopius frontalis Van Duzee. Orangeburg, Denmark, Marion (H. C. Eagerton), Walterboro (G. M. Anderson), St. George, Charleston.

Platymetopius carolinus n. sp. (Fig. 3). Resembling *P. acutus* Say in form, but somewhat smaller and with a much shorter vertex.

Vertex short and little more acute than a right angle, sides somewhat convex. Posterior margin of the head strongly emarginate. Posterior margin of the pronotum truncate, humeral angles distinct. Elytra broadly rounding on the apex; the appendix rather narrow.

Coloration: vertex dull testaceous with an interrupted, transverse vitta midway between the eyes and the apex. A narrow longitudinal dash on the apex, and sometimes a pair of median longitudinal vittæ extending from the base to the transverse vitta, pale. Anterior margin of the head pale. Face testaceous, approaching fulvous, with minute pale mottlings; a pale angulate line on the base of the front and continuing behind the eyes. Pronotum testaceous, the longitudinal vittæ and mottlings obscure. Scutellum testaceous, four points on the anterior margin and the angles of the apical field, pale. Elytra washed with testaceous, and moderately inscribed with fuscous points, the pale areola spots rather small but fairly distinct. Venation fuscous, intensified on the apex and the recurved nervures along the costal margin. Below, testaceous marked with fuscous and white in the female, darker in the male. Legs pale, marked with fuscous points.

Genitalia: ♂ valve rather small, apex bluntly rounded; plates long and narrow, margins set with a few bristles; pygofers about equalling the plates in length. ♀ ultimate ventral segment tapering from the base, the posterior margin broadly, roundingly produced.

Length: ♂ 4 mm., ♀ 4.5–4.75 mm.

Described from two males and two females collected at Walterboro by Mr. Anderson and one female collected at Orangeburg by the writer.

Platymetopius pyrops Crumb. Orangeburg, Denmark.

Deltocephalus reflexus Osborn and Ball. Orangeburg, Marion (H. C. Eagerton), Ridgeland (L. L. Ferebee), Isle of Palms.

Deltocephalus weedi Van Duzee. Clemson College, Orangeburg, Denmark, Ferguson, Eutawville, St. George, Walterboro (G. M. Anderson), Isle of Palms.

Deltocephalus compactus Osborn and Ball. Clemson College.

Deltocephalus obtectus Osborn and Ball. Orangeburg, Ridgeland (L. L. Ferebee).

Deltocephalus apicatus Osborn. Orangeburg.

Deltocephalus flavocostatus Stal. Clemson College, Orangeburg, Ferguson, St. George, Walterboro (G. M. Anderson), Charleston.

Thamnotettix morsei Osborn. Orangeburg.

Thamnotettix shermani Ball. Orangeburg.

Thamnotettix nigrifrons Forbes. Clemson College, Orangeburg, Eutawville, Ferguson, St. George, Walterboro (G. M. Anderson), Charleston, Isle of Palms.

Thamnotettix colonus Uhler. Clemson College, Orangeburg, Denmark, Ferguson, St. George, Isle of Palms.

Scaphoideus auronitens Provancher. Orangeburg.

Scaphoideus scalaris Van Duzee. Orangeburg, Ferguson.

Scaphoideus productus Osborn. Orangeburg.

Scaphoideus immistus Say. Orangeburg.

Euscelis exitiosus Uhler. Clemson College, Sievern, Orangeburg, Denmark, Eutawville, Ferguson, St. George, Marion (H. C. Eagerton), Walterboro (G. M. Anderson), Ridgeland (L. L. Ferebee), Charleston.

Euscelis anthracinus Van Duzee. Clemson College.

Euscelis bicolor Van Duzee. Clemson College, Orangeburg, Ferguson, St. George, Marion (H. C. Eagerton), Walterboro, (G. M. Anderson), Charleston.

Euscelis obtutus Van Duzee. Clemson College, Orangeburg, St. George, Walterboro (G. M. Anderson), Ridgeland (L. L. Ferebee).

Driotura robusta Osborn and Ball. Clemson College.

Driotura gammaroidea Van Duzee. Clemson College (H. C. Eagerton).

Chlorotettix necopina Van Duzee. Clemson College.

Chlorotettix galbanata Van Duzee. Orangeburg, Eutaw Springs, St. George.

Chlorotettix tunicata Ball. Clemson College (H. C. Eagerton), Marion (H. C. Eagerton).

Chlorotettix viridis Van Duzee. Clemson College, Orangeburg, Denmark, Eutawville, St. George, Marion (H. C. Eagerton), Walterboro (G. M. Anderson), Charleston, Isle of Palms.

Chlorotettix balli Osborn. Orangeburg, Marion (H. C. Eagerton).

Chlorotettix tergata Fitch. Orangeburg.

Chlorotettix rugicollis Ball. Isle of Palms.

Chlorotettix spatulata Osborn and Ball. Marion (H. C. Eagerton.

Eutettix strobi Fitch. Orangeburg, Walterboro (G. M. Anderson).

Eutettix seminuda Say. Orangeburg, Denmark.

Eutettix cincta Osborn and Ball. Orangeburg.

Phlepsius cinereus Van Duzee. Orangeburg, Charleston.

Phlepsius fuscipennis Van Duzee. Charleston.

Phlepsius costomaculatus Van Duzee. Orangeburg, St. George, Ridgeland (L. L. Ferebee).

Phlepsius irroratus Say. Clemson College, Orangeburg, Eutawville, Ferguson, St. George, Marion (H. C. Eagerton).

Phlepisus torridus n. sp. (Fig. 4). In form resembling *P. irroratus.*

Vertex one-half longer on the middle than against the eyes, obtuse, nearly right angled, moderately impressed on the disc, anterior edge bluntly angulate. Margins of the front below the antennæ, nearly straight; clypeus broadened apically; outer angles of the genæ prominent, broadly rounded. Pronotum strongly rounded in front, hind margin broadly sinuate. Elytra rather narrow.

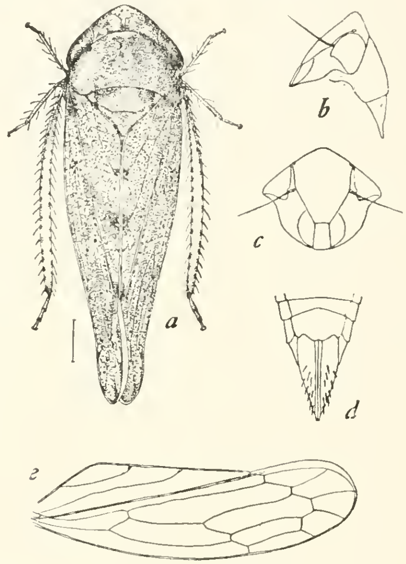


Fig. 4. Phelpsius torridus n. sp.
a, Dorsal view of female; b, Lateral view of head; c, Face; d, Female genitalia, e, Elytron.

Coloration: vertex pale yellow, mottled with fuscous; front and genæ fuscous, a few indistinct arcs and numerous fine irrorations, pale yellow; loræ and clypeus lighter. Pronotum pale yellow on the anterior margin, sordid whitish behind, the entire surface mottled with fuscous. Scutellum fuscous, coarsely marked with pale. Elytra whitish, rather evenly inscribed with fuscous; venation fulvous, varying to fuscous on the apical region. Below dark fuscous, marked with deep testaceous. Legs deep testaceous with black and fuscous markings.

Genitalia: ultimate ventral segment with a large, almost semicircular, shiny black lobe on the middle of the posterior margin, the apex of which bears a small, but distinct, triangular notch, lateral angles prominent.

Length, 6 mm.

Described from one female collected at Oranegburg.

Phlepsius carolinus n. sp. (Fig. 5). Quite similar to *P. franconiana* Ball in form.

Vertex little longer on the middle than against the eyes, obtusely angled, moderately impressed across the disc, anterior edge distinct. Face broad and short; front rather broad, strongly narrowed to the clypeus; margins below the antennæ nearly straight; clypeus broadened apically; the outer angles of the genæ rounded. Pronotum broadly rounded in front, posterior margin rather strongly sinuate.

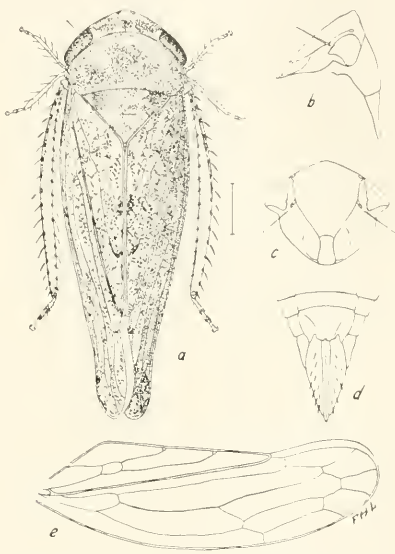


Fig. 5. Phelpsius carolinus n. sp.
a, Dorsal view of female; b, Lateral view of head; c, Face; d Female genitalia; e, Elytron.

Coloration: vertex pale yellow, mottled with fuscous; front fuscous with numerous irrorations and a few arcs, pale. The rest of the face pale yellow, mottled with fuscous. Pronotum pale yellow before, sordid whitish on the posterior margin, the whole coarsely mottled with fuscous. Elytra whitish, the pigmentation forming three very faintly indicated oblique bands. Below, pale yellowish; legs pale testaceous, marked with black.

Genitalia: ultimate ventral segment narrowed posteriorly; a median and two oblique, lateral carinæ on the disc; a broadly rounded lobe on the middle of the posterior margin, notched on the apex; lateral angles exceeding the median lobe.

Length, 7 mm.

Described from one female from Orangeburg.

Phlepsius similis n. sp. (Fig. 6). Resembling *P. collitus* Ball in form.

Vertex distinctly, though obtusely angled. Face broad, weakly impressed across the base; front strongly narrowed to the clypeus; clypeus distinctly broadened apically; outer angles of the genæ broadly rounded. Anterior margin of the pronotum strongly rounded, the posterior margin broadly emarginate.

Coloration: vertex pale yellow, irrorate with coalescing fuscous points. Face pale yellow, closely irrorate with fuscous; a few obsolete arcs on the front, the apex of the front, the disc of the loræ, and the middle

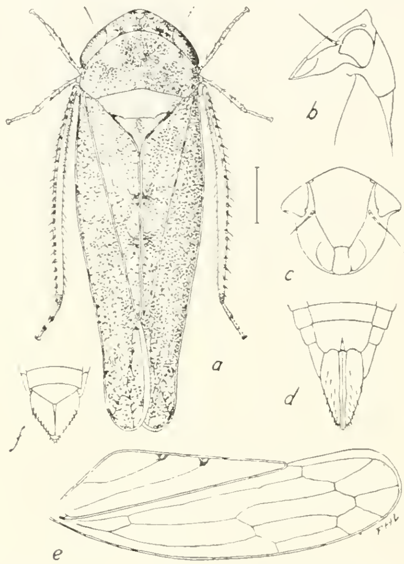


Fig. 6. Phelpsius similis n. sp.
a, Dorsal view of female; b, Lateral view of head; c, Face; d, Female genitalia; e, Elytron; f, Male genitalia.

of the clypeus, immaculate. Pronotum pale yellow on the anterior portion, darker on the disc and posterior portion, the whole strongly irrorate with fuscous. Scutellum pale yellow, obsoletely mottled with fuscous, four dark spots on the hind margin. Elytra whitish; the venation and numerous irrorations fuscous. The claval veins ending in white points surrounded by fuscous. Below, pale, marked with fuscous and black.

Genitalia: ♂ valve obtusely triangular; plates broadly triangular, tips rather blunt, a row of short spines on the lateral submargins. ♀ ultimate ventral segment about twice as long as the penultimate, the posterior margin rather strongly sinuate on each side of a minute median notch, lateral angles prominent.

Length: ♂ 7 mm., ♀ 7.75 mm.

Described from one male and one female from Clemson College, and two females from Orangeburg.

Phlepsius collitus Ball. Orangeburg, Eutaw Springs, St. George.

Phlepsius franconianus Ball. Ridgeland (L. L. Ferebee).

Phlepsius excultus Uhler. Orangeburg, Denmark, St. George, Marion (H. C. Eagerton), Walterboro (G. M. Anderson), Ridgeland (L. L. Ferebee), Isle of Palms.

Phlepsius superbus Van Duzee. Clemson College (H. C. Eagerton).

Phlepsius decorus Osborn and Ball. Orangeburg.

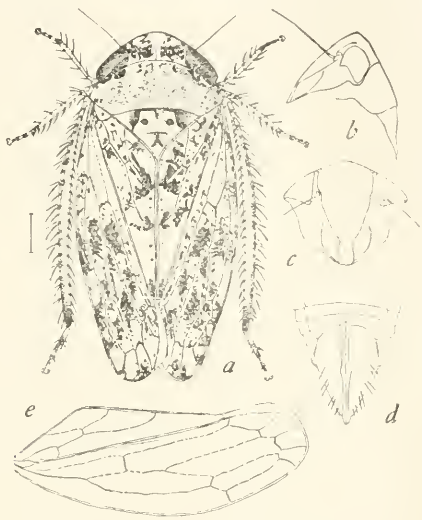


Fig. 7. PHELPSIUS DISTINCTUS n. sp.
a, Dorsal view of female; b, Lateral view of head; c, Face; d, Female genitalia; e, Elytron.

Phlepsius distinctus n. sp. (Fig. 7). Similar to *P. ovatus* in form, but the strongly contrasting black and white coloration easily distinguishes this from other species of the genus.

Vertex twice as wide as long, roundingly angled, sloping, feebly impressed on the disc, anterior edge obtuse; genæ broadly sinuate below the eyes, outer angles about on line with the apex of the front. Pronotum two and one-half times as wide as long; posterior margin broadly sinuate, nearly parallel to the anterior margin; the surface rugulose and minutely punctate except on the anterior portion. Scutellum obscurely rugulose on the apex. Elytra rather broad, venation distinct.

Coloration: ivory white, strongly contrasting with the fuscous markings. A broken transverse band on the disc of the vertex, and irregular markings on each side of the apex, fuscous; the median suture margined by pale yellow which extends as a faint line to the apex. The facial sutures, the antennal sockets, and irrorations on the front, clypeus, and loræ, fuscous. Pronotum ivory white, marked with fulvous and fuscous on the anterior portion, sordid white and obscurely marked behind. Scutellum with two large areas within the basal angles, the anterior margin, two spots on the disc, and an inverted "Y" on the apex, fuscous. Elytra ivory white, opaque, with irregular subhyaline areas, the venation and large irregular splotches at the tips of the claval veins and on the anteapical, discal, and costal cells, dark fuscous or black. Ventral portion of the abdomen, fuscous, irrorate with fulvous, the lateral margins of each segment, and the lateral angles of the ultimate segment, ivory white.

Genitalia: ultimate ventral segment, short and broad, the posterior margin roundingly emarginate, about half the depth of the segment, a median notch in the bottom of the emargination; lateral angles prominent, rounded.

Length: 5 mm.

Described from one female sent from Ridgeland by Mr. Ferebee.

Phlepsius majestus Osborn and Ball. Orangeburg.

Acinopterus acuminatus Van Duzee. Clemson College, Orangeburg, Walterboro (G. M. Anderson), Ridgeland (L. L. Ferebee).

Neocœlidia tumidifrons Gillette and Baker. Charleston.

Paracœlidia tuberculata Baker. Marion (H. C. Eagerton).

Jassus olitorius Say. Orangeburg.

Jassus melanotus Spangberg. Walterboro (G. M. Anderson).

Cicadula 6-notata Fallen. Clemson College, Marion (H. C. Eagerton), Ridgeland (L. L. Ferebee).

Cicadula variata Fallen. Clemson College, Orangeburg.

Eugnathodus abdominalis Van Duzee. Clemson College, Orangeburg, Ridgeland (L. L. Ferebee).

Alebra albostriella Fallen. Clemson College.

Dicraneura abnormis Walsh. Clemson College (G. G. Ainslie), Orangeburg, Charleston.

Dicraneura fieberi Low. Clemson College (G. G. Ainslie).

Empoasca unica Provancher. Orangeburg.

Empoasca obtusa Walsh. Clemson College, Orangeburg, Eutaw Springs.

Empoasca mali LeBaron. Clemson College.

Empoasca flavescens Fabricius. Clemson College, Orangeburg, Denmark, Eutawville, Marion (H. C. Eagerton), Charleston, Isle of Palms.

Empoa rosæ Linnæus. Orangeburg.

Erythroneura trifasciata Say. Clemson College, Orangeburg.

Erythroneura tricincta Fitch. Clemson College, Orangeburg, St. George.

Erythroneura comes Say. Clemson College, Orangeburg, Denmark, St. George, Charleston. Variety **rubra** Gillette. St. George. Variety **ziczac** Walsh. Clemson College. Variety **octonotata** Walsh. Orangeburg, Denmark. Variety **infuscata** Gillette. Clemson College, Ridgeland (L. L. Ferebee).

Erythroneura illinoiensis Gillette. Orangeburg, Denmark.

Erythroneura obliqua Say. Clemson College, Orangeburg.

ADDITIONS TO THE CATALOG OF OHIO VASCULAR PLANTS FOR 1916.

John H. Schaffner.

The following are among the plants that have been added to the state herbarium during the year 1916. They represent important extensions in range or distribution as given in the Catalog of Ohio Vascular Plants and also a number of new species. The collector's name is given with each number.

18. **Pellaea atropurpurea** (L.) Link. Purple Cliff-brake. Ironton, Lawrence County. Lillian E. Humphrey.

68. **Pinus strobus** L. White Pine. West slope near Rock Run schoolhouse, Fallsburg, Licking County. Forest W. Dean.

69. **Pinus rigida** Mill. Pitch Pine. Upper part of Rocky Fork valley near Hickman, Licking County. About 8 miles south of Knox County line. Forest W. Dean.

79. **Sagittaria cuneata** Sheld. Arum-leaf Arrow-head. Cedar Point, Erie County. E. L. Fullmer.

93. **Potamogeton praelongus** Wulf. White-stem Pondweed. Biemillers' Cover, Cedar Point, Erie County. John H. Schaffner.

101.1. **Potamogeton filiformis** Pers. Filiform Pondweed. Cleveland, Cuyahoga County. Edo Claassen.

139.1. **Cyperus ovularis** (Mx.) Torr. Globose Cyperus. In fields. Madisonville, Cincinnati, Hamilton County. E. Lucy Braun.

195. **Carex diandra** Schr. Lesser Panicled Sedge. Cranberry Island, Buckeye Lake, Licking County. Freda Detmers.

316. Change name from **Panicularia fluitans** (L.) Ktz. to **Panicularia septentrionalis.** (Hitch). Bickn.

321. **Panicularia pallida** (Torr.) Ktz. Pale Manna-grass. Phalanx, Trumbull County. Almon N. Rood.

416. **Phalaris canariensis** L. Canary-grass. In damp ground. East Cleveland, Cuyahoga County. Edo Claassen.

455.1. **Paspalum setaceum** Mx. Slender Paspalum. East Cleveland, Cuyahoga County. Edo Claassen.

532.1. **Commelina communis** L. Asiatic Day-flower. From Asia. Escaped from gardens in Cleveland and East Cleveland, Cuyahoga County. Edo Claassen.

578. **Blephariglottis leucophaea** (Nutt.) Farw. Prairie Fringed-orchis. Sandusky, Erie County. E. L. Fullmer and P. W. Fattig.

617. **Ranunculus fascicularis** Muhl. Tufted Buttercup. In open woods, Miamiville, Clermont County. E. Lucy Braun.

703.1. **Thlaspi perfoliatum** L. Perfoliate Penny-cress. Miamiville, Clermont County. In gravel soil. E. Lucy Braun.

742.1. **Dentaria multifida** Muhl. Multifid Toothwort. Madisonville, Cincinnati, Hamilton County. In Beechwoods. E. Lucy Braun.

750. **Diplotaxis muralis** (L.) DC. Sand Rocket. Change name to D. tenuifolia (L.) DC.

755. **Cleome spinosa** L. Spider-flower. Steubenville, Jefferson County. Harriet Smurthwaite.

776. **Linum medium** (Planch.) Britt. Stiff Flax. In dry soil near California, Cincinnati, Hamilton County. E. Lucy Braun.

780. **Zanthoxylum americanum** Mill. Prickly-ash. Warrensville, and on road east of Cleveland, Cuyahoga County. Edo Claassen.

792. **Croton monanthogynus** Mx. Single-fruited Croton. In gravel soil on terraces. Broadwell, Hamilton County. E. Lucy Braun.

816. **Callitriche heterophylla** Pursh. Larger Water-starwort. Richmond Twp., Huron County. W. L. Shuman.

829. **Hibiscus moscheutos** L. Swamp Rose-mallow. In swamps near Glenwood, Warren County. E. Lucy Braun.

866.1. **Viola walteri** House. Walter's Violet. Near Hayden's Falls, south of Dublin, Franklin County. Emery C. Leonard.

880. **Viola triloba** Schw. Three-lobed Violet. Dry woods on steep hillsides. Anderson's Ferry, Cincinnati, Hamilton County. E. Lucy Braun.

885.1. **Passiflora incarnata** L. Passion-flower. Along river bank, Ironton, Lawrence County. Lillian E. Humphrey.

887. **Sagina procumbens** L. Procumbent Pearlwort. East Cleveland, Cuyahoga County. Edo Claassen.

912. **Silene latifolia** (Mill.) Britt and Rend. Bladder Campion. Railway freight yards, Chicago Junction, Huron County. John H. Schaffner.

923. **Vaccaria vaccaria** (L.) Britt. Cow-herb. Freight yards, Chicago Junction, Huron County. W. L. Shuman.

952. **Chenopodium leptophyllum** (Moq.) Nutt. Narrowleaf Goosefoot. Put-in-Bay, Ottawa County. E. L. Fullmer. Sandusky, Erie County. John H. Schaffner.

962. **Cycloloma atriplicifolium** (Spreng.) Coult. Tumbleweed. Freight yards, Chicago Junction, Huron County. W. L. Shuman.

965.1. **Corispermum hyssopifolium** L. Bugseed. Freight yards, Chicago Junction, Huron County. W. L. Shuman.

980. **Tracaulon arifolium** (L.) Raf. Halbert-leaf Tear-thum. In swamps, Madisonville, Cincinnati, Hamilton County. E. Lucy Braun.

1027. **Rubus strigosus** Mx. Wild Red Raspberry. Bog at Celeryville, Huron County. John H. Schaffner.

1098. **Chamaecrista nictitans** (L.) Moench. Omit Stark County from distribution.

1330.1. **Grossularia missouriensis** (Nutt.) Cov. and Britt. Missouri Gooseberry. On rocks, Newton, Hamilton County. E. Lucy Braun.

1344. **Raimannia laciniata** (Hill.) Rose. Cutleaf Evening-primrose. In gravel pits, near Camp Dennison, Hamilton County. E. Lucy Braun.

1345. **Kneiffia pratensis** Small. Meadow Sundrops. In wet meadows. Deer Park, Hamilton County. E. Lucy Braun. Specimens in the Herbarium also from Lorain, Cuyahoga, Summit, Richland and Clark Counties.

1347. **Kneiffia fruticosa** (L.) Raim. Common Sundrops. In upland meadows, College Hill, Cincinnati, Hamilton County. E. Lucy Braun.

1397. **Rhododendron maximum** L. Great Rhododendron. Ironton, Lawrence County. Lillian E. Humphrey.

1419. **Phlox glaberrima** L. Smooth Phlox. In open woods, north of Oxford, Butler County. E. Lucy Braun.

1473. **Bartonia virginica** (L.) B. S. P. Yellow Bartonia. Richmond Township, Huron County. W. L. Shuman.

1474. **Menyanthes trifoliata** L. Buckbean. Richmond Township, Huron County. W. L. Shuman.

1546. **Veronica hederaefolia** L. Ivyleaf Speedwell. Anderson's Ferry, Cincinnati, Hamilton County. E. Lucy Braun.

1567. **Linaria canadensis** (L.) Dum. Blue Toadflax. Richmond Township, Huron County. W. L. Shuman.

1613. **Verbena canadensis** (L.) Britt. Large-flowered Verbena. Cincinnati, Hamilton County. E. Lucy Braun.

1634. **Hedeoma hispida** Pursh. Rough Pennyroyal. Castalia prairie, near Castalia, Erie County. E. L. Fullmer.

1681. **Monarda punctata** L. Horsemint. Near Madisonville, Cincinnati, Hamilton County. E. Lucy Braun.

1722.1. **Thaspium pinnatifidum** (Buckl.) Gr. Cutleaf Meadow-parsnip. In open woods, College Hill, Cincinnati, Hamilton County. E. Lucy Braun.

1727. **Foeniculum foeniculum** (L.) Karst. Fennel. In waste places. Sandusky, Erie County. John H. Schaffner.

1756. **Houstonia angustifolia** Mx. Narrow-leaf Houstonia. Rattlesnake Island, Ottawa County. John H. Schaffner.

1759. **Spermacoce glabra** Mx. Smooth Buttonwood. Rocky shores. Ohio River bank, at Seven Mile, Hamilton County. E. Lucy Braun.

1760. **Diodia teres** Walt. Rough Buttonweed. East Cleveland, Cuyahoga County. Edo Claassen. Freight yards, Chicago Junction, Huron County. W. L. Shuman. Near Mt. Washington, Hamilton County. E. Lucy Braun.

1760.1. **Galium verum** L. Yellow Bedstraw. Near Old Man's Cave, South Bloomingville, Hocking County. From Europe. Emery C. Leonard.

1781.1. **Viburnum rufidulum** Raf. Southern Black Haw. College Hill, Cincinnati, Hamilton County. In woods. E. Lucy Braun.

1786.1. **Triosteum aurentiacum** Bickn. Scarlet-fruited Horse-gentian. Woods on steep hillsides. Riverside, Cincinnati, Hamilton County. E. Lucy Braun.

1825. **Xanthium spinosum** L. Spiny Cocklebur. Freight yards, Chicago Junction, Huron County. W. L. Shuman.

1827. **Ambrosia psilostachya** DC. Western Ragweed. Railway freight yards, Chicago Junction, Huron County. John H. Schaffner.

1856. **Helianthus petiolaris** Nutt. Prairie Sunflower. Railway freight yards, Chicago Junction, Huron County. John H. Schaffner.

1863. **Coreopsis tinctoria** Nutt. Golden Tickseed. Railway freight yards, Chicago Junction, Huron County. John H. Schaffner.

1882. **Silphium terebinthinaceum** Jacq. Prairie Dock. Clay bluffs, Miamiville, Clermont County. E. Lucy Braun.

1883.1. **Parthenium integrifolium** L. American Parthenium. Euclid Heights, Cleveland, Cuyahoga County. Edo Claassen.

1886. **Helenium nudiflorum** Nutt. Purple-headed Sneezeweed. Hyde Park, Cincinnati, Hamilton County. E. Lucy Braun.

1901. **Grindelia squarrosa** (Pursh) Dun. Broad-leaf Gumplant. Railway freight yards, Chicago Junction, Huron County. John H. Schaffner.

1942. **Aster phlogifolius** Muhl. Thin-leaf Aster. On shaded clay bluffs. Miamiville, Clermont County. E. Lucy Braun.

1988. **Elephantopus carolinianus** Willd. Carolina Elephant's-foot. In open woods. Hamilton County. E. Lucy Braun.

2028.1. **Centaurea maculosa** Lam. Spotted Star-thistle. Roadsides near Elizabethtown, Hamilton County. E. Lucy Braun.

2030.1. **Centaurea solstitialis** L. Barnaby's Star-thistle. Roadsides, West Fork Creek, Hamilton County. E. Lucy Braun.

2035. **Hypochaeris radicata** L. Long-rooted Cat's-ear. Cedar Point, Erie County. E. L. Fullmer.

Date of Publication, February 17, 1917.

THE

Ohio Journal of Science

PUBLISHED BY THE

Ohio State University Scientific Society

Volume XVII | March, 1917 | No. 5

TABLE OF CONTENTS

GEOGRAPHY IN THE COLUMBUS, OHIO, QUADRANGLE.*

George D. Hubbard.

INTRODUCTION.

The Columbus quadrangle (Fig. 1) includes an area which has had a long complex physiographic history, and yet today it presents very simple topography.

Paleozoic strata†, essentially limestones in the west, shales through the central part and sandstones in the east, underlie the whole area and are almost horizontally disposed. Subjected to stream erosion from the date of its uplift to the beginning of the glacial period, the region was apparently almost completely base leveled; and then the streams were rejuvenated, at least before Illinoian time, and young valleys were carved below the peneplain. During the glacial period at least two distinct ice invasions occurred and each modified the topography both by erosion and deposition. In interglacial stages, streams developed youthful valleys which were subsequently drift-filled. As the last or Wisconsin ice melted off, the present stream cycle was begun. In post-glacial time, the streams have carved several long narrow valleys with multitudes of short minor tributaries.‡

*Published with permission of the Ohio State Geologist. A part of the cost of illustrating this article was covered by a grant from the Emerson McMillin Research Fund, Ohio Academy of Science.

†Ohio Geological Survey, Vol. 3, p. 599f. U. S. Geol. Surv. Folio 197.

‡A full description and discussion of the stratigraphic and physiographic history of this region may be found in Bulletin 14, 4th series, Geological Survey of Ohio, by the author in co-laboration with Drs. J. A. Bownocker and C. R. Stauffer.

The present stream cycle may be said to be in an advanced stage of youth, developed on a remarkably level till plain, which is varied in places by crescentic moraines and feeble outwash, kame and esker deposits.

Most of the quadrangle belongs to the prairies of the more nearly level type; but the Allegheny Plateau occupies the

Fig. 1. The Columbus Quadrangle in relation to Ohio counties. Columbus here shows as a Greek cross.

eastern margin, though its characteristic features are nearly concealed through the leveling effects of the drift mantle. An active, growing city, and a prosperous farming community with their transportation, manufacturing, and residence elements have developed and fitted down upon these physical features, until there exists today a good degree of adjustment and harmony of physical and cultural factors.

It is the purpose in this paper to point out these adjustments, the relations obtaining, and the influence operating between the physical and cultural features.

EARLIEST RESPONSES TO GEOGRAPHIC CONDITIONS.

Mound-builders, Indians* and the earliest white people to occupy this territory were attracted to it by the opportunities to hunt and probably, to some extent, to engage in a primitive kind of agriculture; but the real call to colonization, to settlement and actual occupation was a call which reached the people of the central group of the original colonies and led them to the level fields, fertile soils and occasional open prairie tracts for the purpose of fixed agriculture. It was easy to put the land under cultivation, for like most of the prairie it was not fully timbered, and only a part needed to be cleared before all could be turned over by the plow, and planted. So level, too, was the land that none was really waste, unless too wet; and communication either by canoe in stream or by wagon was easy in all directions. The timber along streams and over parts of the upland plains furnished all lumber needed for the quickly-built log houses, fences and stock shelters, and provided ample fuel for all early needs, but was not so heavy, dense or widespread as to depress the people or obstruct their progress in agriculture and intercourse.

The region early gained prominence because of the proximity to the Scioto and Olentangy rivers and to their junction near the center of the area. Further, its position, central in the Territory of Ohio, led to the selection of its chief town as the State Capital as soon as such a place was needed. This political asset in turn has ministered to the development of many interests in the region.

DEVELOPMENT IN HARMONY WITH ENVIRONMENT.

When once the farming and concomitant trading population was established in the region the favorable conditions for agriculture—moist temperate climate, deep fertile soils and river access to markets—encouraged the inhabitants to develop what they already had; and soon Franklin County which contains most of the Columbus quadrangle became known as one of the most prosperous agricultural counties in Ohio.

*Suggestions here and at several subsequent points have come from Prof. Frank Carney's papers on Ohio Geography in Bull. Den. Sci. Lab. 1910-11.

The abundance of limestone lying in plain view and very accessible along the Scioto River cliffs invited quarrying for building purposes; and the presence of wood made possible the burning of the stone for lime. Thus the foundations of two early industries were laid; the quarrying has persisted and grown to the present, but the burning of lime has long ceased because better lime could be made near by from rock of no value for building.

At an early date, also, waterpower was developed on the Scioto and Olentangy rivers and on the Darby, Alum and Walnut Creeks and even on some minor streams. Valleys narrowing and widening as they passed from rock to drift and again to rock, because they intersected buried interglacial valleys, formed tempting sites for grist or saw mills. Many more of these sites might have been used.

Springs, and good wells where springs were wanting, have furnished excellent waters which have made for comfort and health from the days of earliest settlement. These wholesome waters are possible because of the abundance of glacial drift both stratified and unstratified. A few in the eastern part come from the sandstones.

Communication and transportation early demanded attention because the till, especially when wet, made rather treacherous roadbed. The abundant glacial gravels in outwash, kame and esker deposits were used most extensively for wagon roads over the till plain until a few years ago when crushed rock sprang suddenly into almost universal use. The rock used for miles around the capital is limestone, quarried and crushed at various openings along the Scioto River within the area studied. Both gravel and crushed rock have been extensively used for railroad ballast also. By making use of these resources, here so abundant and near at hand, a much better roadbed is made than could be constructed of the other available materials, logs, planks, drift and cinders. In this instance again the more close the adjustment to the physical conditions—the more thorough the use of resources—the better it is for the people. And, again, the longer the people study the situation and work out their problem, the more they make use of their resources and become adjusted to the whole environment.

When the canal system was being constructed in Ohio, Columbus citizens desired water connections with Lake Erie and with the Ohio River but the divide between them and the lake is high, hence neither of the through lines selected traversed the capital. One line did, however, come from Newark to Lockbourne and proceed southward to Portsmouth, and the Columbus people took advantage of one side of the Scioto flood plain for an easy canal route south to Lockbourne, as shown on the topographic* map. From that town, the main canal led down the flood plain about five miles, and then at a point where the river crowded close to the canal-(east) side of the flood plain the canal turned aside into an abandoned glacial overflow channel and continued southward out of danger from the menace of the river.

CULTURAL LOCATIONS GEOGRAPHICALLY DETERMINED.

Houses.—Outside of the towns the houses are usually placed with reference to some physiographic feature. A number are located on alluvial fans, partly because the fan furnished a little elevation above the flood plain, allowed better drainage or a more inspiring view than the lower plain, partly because it was desired to build at the junction of two valleys or two valley-determined roads.

Throughout the eastern sixth of the area many house sites were selected because of the proximity of a spring. Springs are common here, the water rising from the sandstones. Essentially all spring water is softer than well water from the drift, and it is always cool.

Along the Scioto, Olentangy and Big Darby a number of houses have been built upon rock terraces.† (Fig. 2.) These afford pleasing outlooks, and a residence far enough above the flood plain to be out of danger of floods yet not as far away from the flood plain fields as would be a residence back on the upland. A spring at the rear of the terrace has given some terraces an advantage over others, and some parts of large terraces over other parts.

Bluffs overlooking the flood plain have proven very attractive to both Mound-builder and Caucasian. At Arlington, west of Columbus, the best residences fringe the bluff from the Marble

*At this point and many others the readers will find it advantageous to have at hand the four local topographic maps published by the U. S. Geol. Survey and the physiographic maps in the folio No. 197 and the Ohio Survey Bulletin 14, mentioned in the opening paragraph.

†Ohio Nat., Vol. IX (1908-09), pp. 397-403.

Cliff station on the Pennsylvania Railroad south and east for two miles. Even the car from the city to Arlington is called the Grandview car. North of Columbus for two or three miles along the pike on the east Olentangy bluff there is being built a beautiful residence section. (Fig. 4.) In the city much more attention has been paid to the æsthetic in house location during the past ten years than ever before.

Fig. 2. The rock terrace at Marble Cliff in the Scioto Valley. This level stretch, many acres in extent, stands some 50 feet above the river level and at least an equal distance below the upland. Looking nearly north.

Over very much of the area even outside the specific moraine belts are strewn moraine hummocks, little swells in the till plain. Literally hundreds of farm and village houses are built on these hummocks. The slightly greater altitude gives better outlook and better drainage than has the plain in general. In a few instances, an esker ridge has furnished a place attractive enough for the farmer builder.

Railroads.—North of Columbus in the central part of the area four railroads connect the city with Toledo, Sandusky, Cleveland and intermediate centers. The Hocking Valley, on the interstream strip between the two major streams, climbs from its flood plain station in the western part of the city, up the bluff obliquely for seven miles until it emerges on the upland, and then almost immediately plunges into a deep cut with ascending grade through the Powell moraine to a still higher inter-morainal till plain beyond the town of Powell. Two engines are employed to pull nearly every freight train this far out from the city. Where the road is well up on the interstream area it swings away from the main stream beyond the head ends of the little fringing tributaries bordering the Olentangy River. This is done to find a more nearly level course and to avoid building so many bridges.

The Big Four, Pennsylvania and former Cleveland, Akron and Columbus, now a Pennsylvania line—the other three roads to the north—leave the Union Station on the east bluff of the Scioto River; hence do not need to make a climb but at once strike out on the interstream till plain. (Fig. 3.) The first and second are essentially parallel as far as the northern boundary of the area with no curves, bridges, cuts or fills, because they are so far from the major streams that the till plain is still undissected. (See topographic map.) One small bridge over a stream while still really within the city, and a slight grade south of, and a shallow cut through, the Powell moraine constitute the only exceptions to this generalization. If it were not for this adjustment—if, for example, the route of either railroad had been laid out one to one and one-half miles nearer the Olentangy stream—thirty-five to forty bridges would have been necessary with almost continuous cutting and grading. No road follows either of the four valleys north from Columbus because the interstream areas afford a much more practicable route.

All the roads east, south and west lie on the level till plain paying no particular attention to valley or stream, because none is far below the till plain. No railroad out of Columbus follows a valley even for a short distance, except the Pennsylvania, the Toledo and Ohio Central, and the Big Four west for two or three miles, and the Hocking Valley and the Toledo and Ohio Central south for an equal distance. In all these cases, exit from the valleys is made as quickly as possible in order to use the level upland till plain. Not only do the roads out of the city avoid the valleys but over the whole area no railroads can be found in valleys at all.

Figure 3. Railroad yards as seen looking east from Fourth Street elevated bridge. All roads but one have direct access to these yards, which spread over the level till plain and touch the wholesale district.

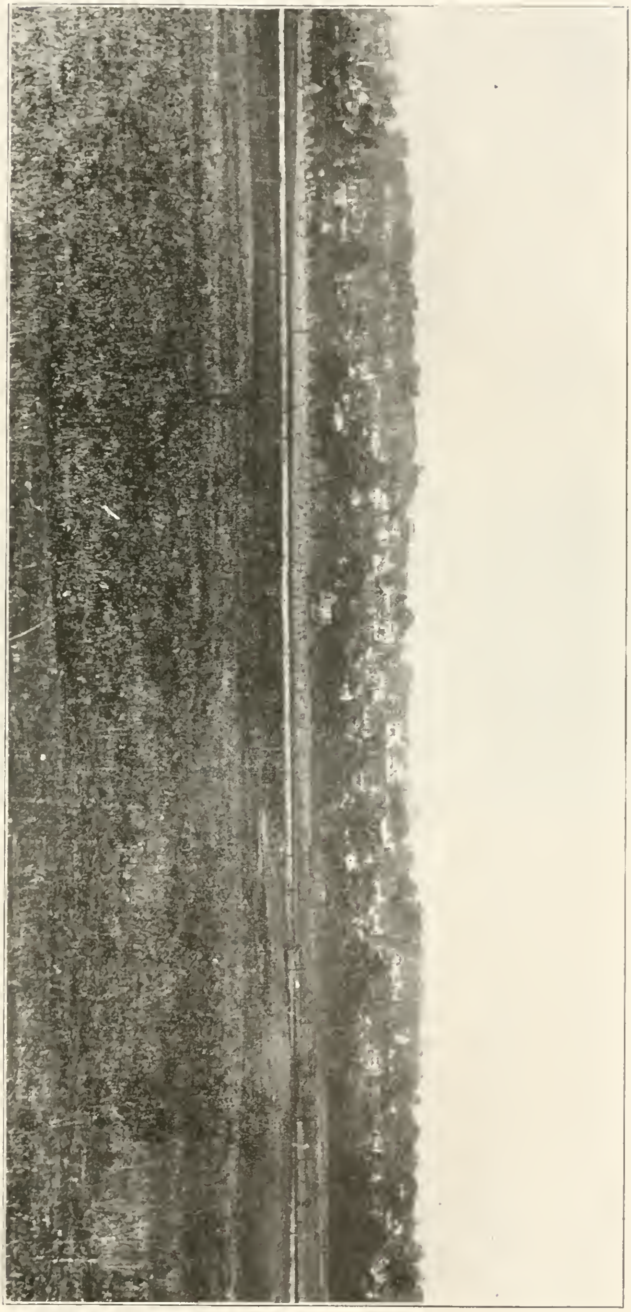


Figure 4. Looking east from a point on the uplands west of the river across the Olentangy. Hundreds of residences have been built over this rising slope, taking advantage of the beautiful westward outlook and the clear air from across the valley.

Railroad Bridges.—The valleys are often so narrow in this area that the railroads cross on bridges supported on tall trestles. The Baltimore and Ohio over Big Darby Creek at Harrisburg has a bridge 90 feet high and about one-fourth mile long. (Fig. 5.) The Pennsylvania crosses the Scioto River at Marble Cliff west of Columbus on a high bridge and leads up a long rock terrace slope at the east end of the bridge to gain sufficient height for the crossing. (Fig. 2.) The Cleveland, Akron and Columbus crosses Big Walnut near Sunbury on a bridge high enough to be flush with the till plain, and the Baltimore and Ohio crosses Black Lick at Black Lick station in precisely the same manner.

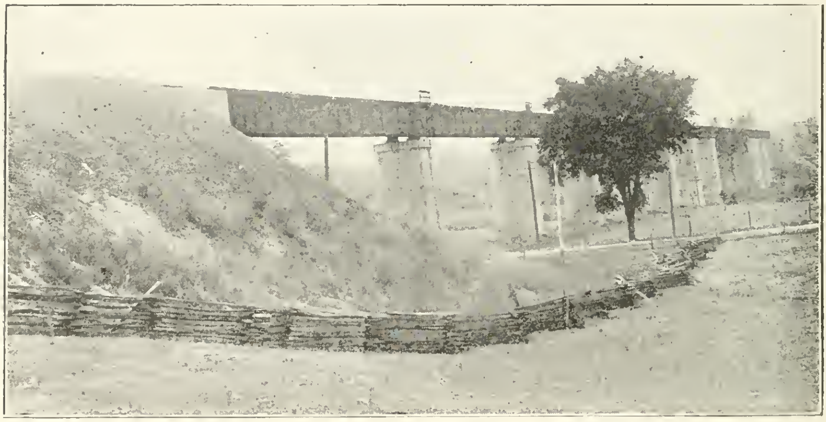


Fig. 5. Bridge of Baltimore and Ohio railroad over Darby Creek at Orient. The track dips but little to make this crossing. Such a high level bridge is possible because the valley is in the youthful stage, and advisable because the valley is so deep.

Alluvial fan slopes are sometimes used by the electric railroads in getting out of and into a valley. The Arlington-Grandview car so ascends from the Scioto flood plain across a fan and up a little ravine to reach the upland till plain. All these harmonious adjustments of railroads are responses of the cultural to the physical.

Wagon Roads.—It is probable that as many examples of wagon road adjustment could be found as of railroad responses. Many roads were laid out in "bee-line" from Columbus to the neighboring towns, in order to facilitate communication between them. Parallels and meridians are occupied by a few roads;

but many miles of road are directed by streams or valleys. The Scioto River is followed by one road all the way from Columbus to the northern limits of the area and frequently by two for short distances. Similar response is found along the Olentangy River. Alum and Big Walnut valleys have proved sufficiently influential to have at least one road follow each most of the distance across the northern half of the area, but the road is upon the till plain a portion of the way. The valleys are crooked and streams more so, and the latter crowd closely under one bluff then under the other necessitating many bridges if the valley floor be followed.

Wagon Bridges.—Over most of the smaller streams wagon bridges have been built where the fords were formerly, or so near, that obviously the ford crossing and its road connections determined the bridge site; but this is not the case with many of the larger bridges. Often narrow places, or sites with rock banks on one side or both, or specially good drift or gravel banks have been sought out for bridges, just the conditions that were avoided when the fords were located. This has necessitated the laying out of new roads and the construction of crooked, indirect roads across the valleys in many places. The bridge over Big Darby, midway between Georgesville and Harrisburg, and the upper bridge at the latter place are good illustrations of this principle. The bridge is located at a desirable place with reference to the stream, but where considerable circuitous driving is necessary to use the bridge. So common is this kind of response that a bridge, so placed as to make the road straight across the stream, and continuous with roads on opposite sides, is a rather rare feature in the area.

In many places the suitable crossing, whether ford or bridge, and particularly if a bridge, is approached by several roads. A convergence of three, four and even five roads from one side of the bridge and a corresponding divergence on the other side is a frequent occurrence.

Quarries.—Many opportunities are afforded by the physiography for access to the rock. Valleys are youthful and deep enough to have been cut well into the rock. The steep-sided valleys of the Scioto and several of its tributaries, and of the Darby creeks are, in more than a score of places, the sites of limestone quarries. Several old quarries are found south of the Scioto, where it runs eastward, west of Columbus. Four or five more newer and much larger ones are located just north of the Marble Cliff bend; and then a series of lesser quarries, some old and some new, occupy favorable sites from these larger ones northward even to the northern boundary of the area. Not only have the streams carved deep cuts into the rock and thus accomplished all the preliminary work of opening, but they have cut so deeply that large quarries can be worked above river level with no fear of water to trouble the workmen.

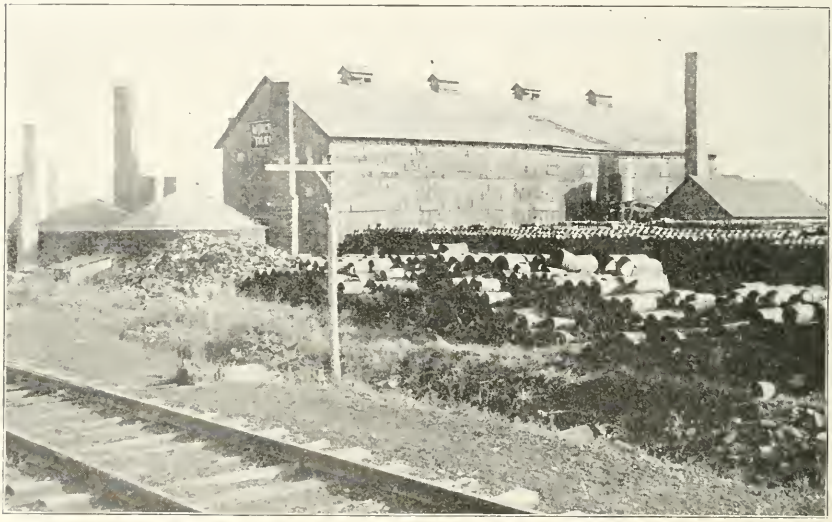


Fig. 6. Drain tile plant situated near Black Lick, because the soft Bedford shales are here available.

Another item which makes quarrying easy is the fact that the glacier, scouring over this region removed nearly all partly decayed rock, leaving the fresh solid limestone, shales and sandstones at the surface; and again as the larger streams have made their valleys they have removed nearly all drift that the glaciers left, on these future quarry slopes.

In the northwest portion of the area preglacial interstream ridges of limestone are so thinly mantled, and so thoroughly cleared by the glaciers of their partly weathered rock, that quarries have been opened in them without the aid of the rivers.

Just as the streams and glaciers have prepared easy quarrying of the limestones in the western half, so in the eastern half of the area the same agencies have made sandstone quarrying easy. The sandstone is not nearly as good of its kind as is the limestone.

Brick and Tile Plants.—The softer beds of the Devonian shales are exposed in several places and have determined the location of a sewer pipe plant in North Columbus and a brick and tile plant on East Fifth Avenue. Both factories find a large local market and do an extensive business. With the development of the brick industry on an abundant natural resource, and with the exhaustion of the timber has come a change in the kind of buildings from frame to brick houses. There should be much less of the former type of construction and much more of the durable limestone and brick construction in Columbus, and undoubtedly this adjustment will continue. A brick plant and a tile factory are located at Taylor's, some nine or ten miles east of Columbus, where the purple and red soft Bedford shales come to the surface. Another tile factory at Canal Winchester uses the same Bedford formation (Fig. 6). No factories of these kinds occur in the western part of the quadrangle, because the suitable shales are wanting. Several minor tile- and brick-making establishments are using the glacial drift. Some take it directly from the till plain, others are drawing from glacial kettles which have been more or less filled with clay during post-glacial time. Some plants using the drift are located at Pickerington, in the south part of Columbus, near Greencastle and near Hilliards.

Tile for draining the nearly level till plain finds considerable market over most of the area. Thus the needs, purely geographic, is readily supplied by using natural resources already in place when the need arose.

Sand and Gravel.—Sand for building purposes and gravel for wagon and railroad beds are abundant. Outwash deposits occur in and around Columbus and southward in abundance. Others are found along the streams north of the city. Eskers in North Columbus, Pickerington and southwest of Canal Winchester, and kames south of Columbus at Bakers and Spanglers Hills furnish much gravel, easily available. The Hocking Valley railroad company has built a spur to Bakers and expects to remove the whole hill. The demand for both sand and gravel is great in recent years in the building trade, and a company has thereby been called into being to dredge the Scioto River in Columbus, through which great quantities of both sand and gravel are supplied to the local market.

Diversified Agriculture.—In the early part of the agricultural history of this region, general farming was the rule, but it has now been recognized that most of the land is better suited to some one class of farming than to others*. Certain uplands are given over almost entirely to timothy hay, or to pasture. Many small stream floodplains are now used for pasture alone, because they are too wet in most years for cultivation. Large

Fig. 7. Alluvial tracts southwest of Columbus adapted for and devoted to truck farming.

flood plains have been leveed and with the terraces or second bottoms are repeatedly planted to corn. A rotation of oats, corn, wheat and clover or alfalfa is used on many upland farms, for without a rotation any one of the grain crops soon fails. Some cold, heavy, upland fields are put into buckwheat, a crop especially adapted to such soils. Orchards and fruit have been put upon many well drained slopes. This is particularly true near Columbus, where fruit markets are largest.

A lake bed of about forty acres, four and one-half miles south of South Columbus, is devoted year after year to onions. The soil is especially adapted, being black with organic matter, rich, loose and warm. Many other similar tracts, though rarely so large, could be thus used for onions or celery. Around

*Map 20, Columbus sheet. Bur. of Soils, Rept. Field Operations, 1902. Map 30, Westerville sheet, ibid., 1905.

Fig. 8. The State University Campus spring from outwash gravels and sands beneath a thin capping of till. The stones are boulders and blocks of limestone transported to the spring to enhance its beauty.

Columbus and particularly southward are hundreds of acres devoted to intensive gardening. This is partly a response to the call of the market, but the specific location of many of the gardens is determined by the fertile, alluvial, deposits of second bottoms south and west of the city (Fig. 7). Here and northwest of Columbus are the two most favored gardening sections. North and east of town this specialized phase of agriculture does not occur, although all conditions but soil are probably as suitable, as in the two sections used.

Fig. 9. General view of the steel plant at South Columbus, at intersection of three railroads.

Windmills.—Over most of the western half of the area the drift is deep and wells range from 50 to 150 feet in depth. In response to this combination, hundreds of farmers have erected windmills to pump the water. Winds usually move over this level country with force enough to do the pumping. Occasionally the deep well seems to necessitate the installation of a gasoline engine, because the wind is scarcely able to do the pumping.

In a strip four to eight miles wide along the eastern part of the area, springs from the sandstone are so common that wells are rare; and wells, when needed, are so shallow that windmills are still less common. The spring-house, however, and the roadside watering trough are constant reminders to the traveler of the different conditions. Springs also occur in the gravel streaks of the glacial drift (Fig. 8).

Industries Lacking Geographic Reasons for Location Here.

A few examples of industries in which adjustment cannot be made, may profitably be mentioned. In such a city and community large quantities of cement are used and one might think a cement plant would be built here, but the natural resources limit the project. The limestone is not suitable for cement, and no suitable clays exist within many miles. Hence all cement must be shipped in, thus establishing geographic connections with a broader environment. The iron industry is rooted here in South Columbus (Fig. 9), but there is no element to encourage it beyond the local market and good flux limestone. Further, the plant sells but very little product in Columbus. Coal and iron must both be hauled many miles. While so much coal mining is financed from Columbus in the Hocking Valley and other districts to the southwest, that coal mining is considered the largest single business in Columbus, not a particle of coal is actually mined anywhere within the quadrangle. The iron ore for the iron and steel industry comes by way of Toledo from Lake Superior iron mines.

A glass factory is running in the eastern part of Columbus, with quartz sand from Toledo and gas from 30 miles southeast. Market, labor and transportation facilities are about the only favorable conditions for this industry. No industry making heavy demands on lumber has located here, because of the natural scarcity of timber. Limitations of this sort are put upon many lines of manufacturing.

The Growth of Columbus.

Starting on the grounds formerly selected and used by the Wyandotte Indians for a straggling town, the village of Columbus began to take shape along the east bluff of the Scioto River one half mile to one mile below the mouth of the Olentangy. At this place the ground is high and gravelly, affording good drainage and in general much better conditions for building than most places near by.

Nearly parallel with the general direction of the Scioto and Olentangy, along the slight elevation at the crest of the bluff, very appropriately came High Street (Fig. 10). And in distinction from many shorter streets leading eastward, one was called Long Street. Broad Street was laid out wider than

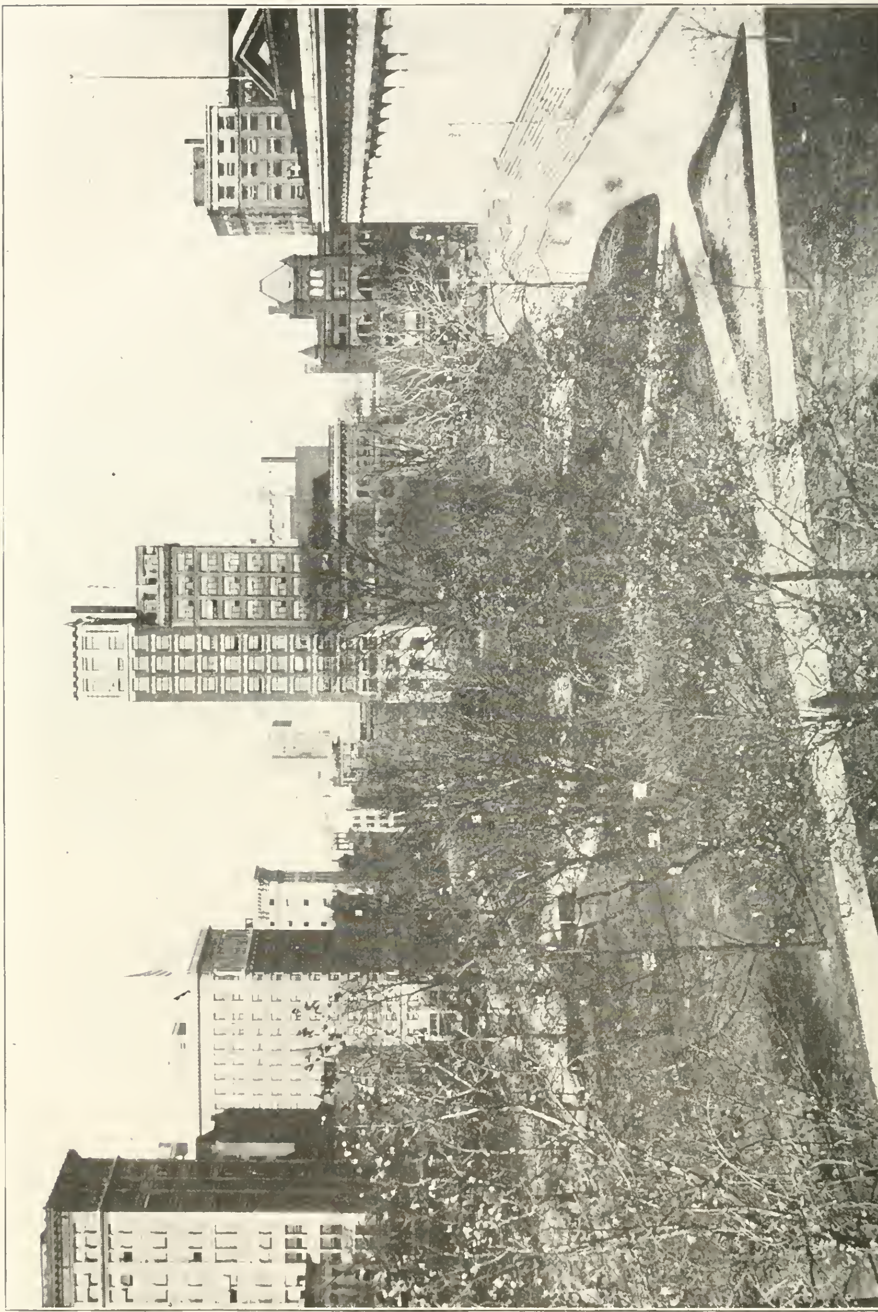


Fig. 10. Business center on High Street. State House on right, and grounds in foreground. Hotels, Office buildings and mercantile houses.

any other, hence its name. The intersection of High and Broad streets, both leading far into the country, became the chief center and the State House corner. This pre-eminence was further augmented when Broad Street west became the national pike and High Street north the Columbus-Sandusky pike. Main Street lies along the national pike east and early became a leading street. Because of the relation of High Street to the river, and of the relation of the two leading streets to the incoming pikes, the town has pushed out in four directions, making a great Greek cross, (Fig. 1); and not until quite recently has there been much filling in of the corners. Ten or twelve years ago Columbus reached seven miles north and south and almost seven miles east and west, with an area of scarcely twenty square miles and nearly two of these bare flood plain.

The older manufacturing plants, such as the carriage factories and shoe factories were located in the heart of town, in order to be in touch with river, canal and later the first railroads. Of course they still remain there and enjoy these locational privileges. Several later plants, as the Kilbourne-Jacobs and Kinnear machinery factories, and the Pennsylvania railroad shops and some of the State Institutions have been built up on the periphery of the old town, the former along the railroads, the latter on the attractive streets, east, north and west. And now, a later chain of manufacturing plants has been swung around the recent city three or four miles from the center and along the railroads;—the steel plant (Fig. 9), starch factory and fire apparatus factory on the south, where the Hocking, Toledo & Ohio Central and Norfolk & Western railroads part company; the lithograph company, at the intersection of the Big Four and Fifth Avenue east; foundaries, machine shops and cold storage and butterine plants along the west side of the north arm of the city on the short spur from the railroad yards just north of the mouth of the Olentangy. The asylums for the insane (Fig. 11) and the feeble-minded stand on beautiful sites on the Scioto bluffs far out in the western arm. Many other plants owe their general location away from the center to their late arrival and the crowded condition of the business district; and their specific location to the intersection of two railroads or to some other transportational facility.

The presence of the manufacturing district in the northeast corner of Columbus has prevented the spreading of the residence section into that corner until recently; and now, in the last five years, there has been a phenomenal growth between the factories and shops of this corner and the State Fair Grounds. This recent growth has occurred also still farther northeast beyond the Fair Grounds and the State University. Alum Creek also served as a temporary barrier for many years on the east, but these same recent years have seen a great expansion

Fig. 11. State Asylum for the Insane. The flood plains below are used for gardens, the wooded slopes for walks and the level upland for the buildings, drives and lawns.

beyond that stream over the till plain for a mile and a half east, and for three miles north and south. Likewise there has been added to the city about four square miles of residence blocks in the southeast corner of the Greek cross. This tract was wet and undesirable for city lots, was poorly drained, untouched by street car service which for years had been confined very closely to the four cardinal arms of the city and was far from much of the business and manufacturing. But with the establishing of factories and mills even beyond this district, and the crowding from within the city business section, the necessity of improving this 4-mile tract has been forced upon the city; and now much needed improvements have come, beginning with thorough draining, the paving of the main thoroughfares (the old country roads) and the building of car lines along several of these established highways.

In a similar manner, and by almost the same steps, the northwest corner, Marble Cliff-Arlington district, is now filling in. As stated above, the Scioto bluff in this section has for many years had a fringe of comfortable looking residences and club houses located with reference to the "grandview" to the south and west; but the less attractive till plain is now well drained and taken up for residences, stores, school houses, and offices.

Probably, however, the most attractive residence section now being built, is along the Columbus-Sandusky pike north. This road, now completely rebuilt and in excellent condition to keep pace with its surroundings, skirts along the Olentangy east bluff and is followed by the Columbus, Delaware and Marion electric railroad. Now for fully two miles cross streets have been laid out leading up the beautiful wast-facing bluff; and hundreds of houses have been built. (Fig. 4.) Clintonville, almost five miles north of the Union station is now structurally a part of Columbus.

The city is, in a large way, a manufacturing, commercial and mercantile city and thus a product of the influence of the geographical conditions. As pointed out, transportation has from the start been easy, and now the many radial lines of steam railroad, electric railroad and pike are very influential in the growth of the city. The fine farming lands, calling for a numerous, active, well to do agricultural population, have been responsible for the great development of manufacturing of buggies, wagons, shoes, and other leather goods, farm machinery, iron and steel goods, and for the growth of the meat-packing, tile-making, and many other industries. Further, the coal, oil, and gas, and limestone nearby have called for manufacture of well-drilling, mining, quarrying and electric apparatus. And with the growth of these industries, have come subsidiary, dependent or related industries in considerable numbers as in any other city.

Influence of State Institutions.—While so much is in large degree a response to physical conditions here before the town came at all, and is a measure of the adjustment already accomplished, no small importance must be attached to the location of the State Capital, the State University, and a half dozen other State Institutions in and about the city. But since these came partly because of the opportunities already offered and are now a part of the geographic environment, they may be considered among the geographic factors aiding in the growth and importance of the city. They each bring many workmen, skilled and otherwise, whose homes are a part of the residence districts, and whose expenditures add a large item to the business of the city. Not only through their employes but directly

Fig. 12. Drives, shade and conservatory in Franklin Park. Sags and swells of moraine may be seen among the trees on both left and right.

through their own maintenance do these institutions each contribute to the importance of the city. Further, most of them owe no small part of their size and usefulness to the fact that they are in the midst of a large, growing, prosperous community.

Parks and Drives.—Columbus has taken advantage of but little of its narural beauty and attractiveness in its park and drive system. Two parks in the thickly settled parts of town and the U. S. Barracks in the midst now of a manufacturing district constitute all that could be called park until the outskirts of the city are reached, and all these lie on the exceedingly level uninspiring till plain. Franklin Park on the eastern border along Alum Creek is part flood plain and part till plain, with a rolling somewhat sandy intermediate zone of charming country suitable for drives, shrubbery and flowers. Some use of of this tract is already being made. (Fig. 12.) The stream itself is not made use of, and its borders within the park are essentially waste. Broad Street (Fig. 13) and Bryden Road (Fig. 14), shady well kept residence streets, connect the park with the business district. At the west end of the city, two State Institutions, the Asylums for the Insane and for the Feeble-minded have spacious green and shade areas lying over the definite bluffs of the Scioto and on both the till plain above and the flood plain below. (Fig. 11.) Neither reaches the river. They

Fig. 13. East Broad Street. Fine residence properties and splendid drives on the even till plain.

are not in any sense public parks, yet in some respects they serve that function and might be greatly beautified by taking advantage of more of their geographic setting.

In a similar manner the State University grounds (Fig. 15), well north in the city, lie over the bluffs and upon adjacent upper and lower plains along the Olentangy River and a small tributary ravine. A very little effort has here been made to use natural beauty by restraining the waters of a group of springs for a lake, and limiting their flow to one large spring bowl. Not half as much has been accomplished as might be to make attractive a really pretty natural site. A private company has

Fig. 14. Bryden Road, the better residence part of East Town Street.

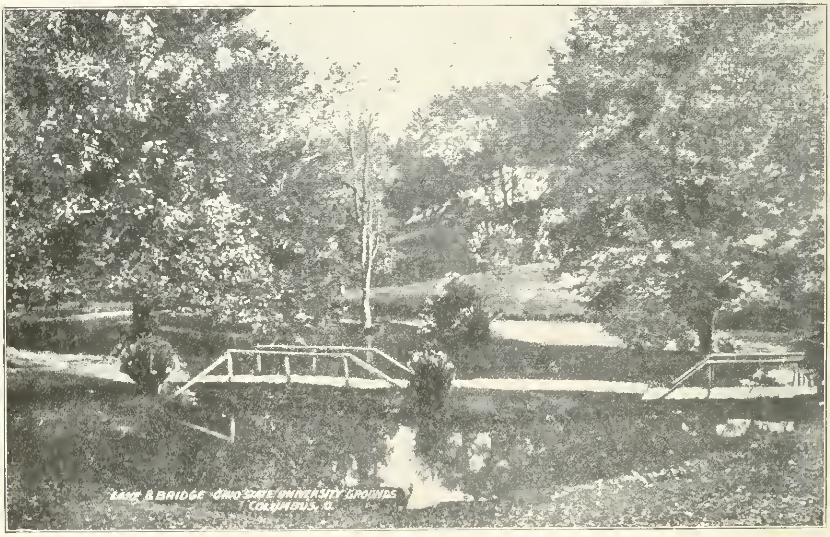


Fig. 15. A beauty spot over the bluffs of a little ravine tributary to Olentangy River, now a part of the State University Campus.

selected a beautiful place at the northern limits of town, on the Olentangy River and a tributary ravine, and has there built up an amusement and picnic park. Much has been done to make the site over the slopes attractive by buildings, walks, stairs and seats. A suggestion is here given of what the city might do.

East from this park, up the ravine about a mile, the glen, here possessing a small flood plain, is now used for a park. Paths and seats, with rustic bridges over the stream and a well or two constitute the chief improvements but they are sufficient to draw the public to the pretty site for picnics and pleasure walks. No true boulevards are to be found at Columbus.

Fig. 16. Concrete Storage Dam, which retains 1,000,000,000 gallons of water in the Scioto gorge. Built where the youthful gorge narrows suitably.

City Water Supply.—For many years the shallow well system of water supply was used in Columbus as in the country districts around, but finally the waters of the Scioto River were drawn upon, and a city waterworks plant was put into operation thus laying under control another item in the environment. This was, however, surface water, hard, variable both in supply, and in freedom from mud, and always open to contamination from a thousand upstream sources. The Scioto valley, while essentially a rock gorge across the entire northern half of the quadrangle, and narrow enough to be effectively obstructed by a large dam, is wide enough to make a very satisfactory reservoir. About twelve years ago the city council decided to take another step in the adjustment to the physiographic conditions by building a massive concrete dam across the river. (Fig. 16.)

The site selected was six miles above the city, at a place where the valley walls were fairly close together, and above which the valley widened a little. The dam was built on solid limestone all the way across and set into limestone bluffs on each side. Rock removed to build approaches and abutments was crushed and used in the concrete construction. When completed, the dam was high enough to pond the water back for fully four miles or almost to the Dublin bridge. The mouths of little tributary gorge valleys and several little quarries were drowned. The old Dublin road had to be raised or reconstructed 50 to 100 feet higher up the bluffs. This improvement with a large filtration, softening, and pumping plant most admirably situated near the junction of the two large rivers has put Columbus in touch with one of the best water supplies to be found.

Natural slopes toward the Scioto River from all parts of the city, and the great gravel and sand beds south of the city for settling tanks and filters have been taken advantage of in the construction of a sewage system and disposal plant.

Floods.—The young valleys of the Scioto and Olentangy rivers with their considerable drainage basins above are subject to floods of devastating dimensions. Nearly every spring a moderate flood arrives at Columbus, and in years with exceptional combinations of circumstances the quantity of water becomes alarming. The valleys above the city are rather steep floored and at the city there is a decided decrease in the fall of the stream with a widening of the valley. The unfortunate condition is still further accentuated by several railroad grades and wagon roads across the flood plain in the western part of the city. These grades were built in part to keep the traffic up and out of the water and in part to make easy grades for trains getting in and out of the valley. They do not have enough bridge section but are solid earth and stone walls nearly all the distance across the valley and hence obstruct greatly the ready egress of the water poured out upon the flats from the steeper upper stream courses.

The flood of 1913* proved the most destructive in the history of the city, and made it very plain that measures should speedily be taken to provide for this variable geographic factor—the river flood stage. Among necessary improvements

*Griggs, Julian, Engineering News, April, 1913.

are the rebuilding of the various grades so that they shall offer as little obstruction as possible, the straightening of the river channel in two large curves in the south part of town, the removal of encroaching buildings and bridge abutments at several points, together with more careful levee building. Much of this work would lend itself to the general scheme of city beautification.

FUTURE OF THE DISTRICT.

The general directions along which adjustments to geographic conditions in the area shall move, are already clearly indicated by present progress. There is no reason to believe that material change in the industrial or commercial tendencies will be called for by the environment. Relative values however, may change considerably. Because of the soil, climate, and market conditions prevailing in the region the farm lands will be devoted to agriculture, except where needed for the growth of the towns. The diversification already begun will continue. Market gardening, and fruit growing will each seek out the most favorable places and conditions for their respective expansion, and they will greatly increase at the expense of general agriculture. This is because of the general call of increasing population for more intensive agriculture and a greater supply of products from a smaller area, and because of the particular call of the larger population through the local markets. Stock-raising for meat will increase for the same reason.

Minor Centers.—Small towns will yet spring up at many points within the area, partly as residence suburbs of Columbus and partly to care for the commercial and mercantile interests of communities becoming more densely populated. These latter will be mainly at intersection points of railroads or of railroads and electrics or even in some places at improved road intersections.

Probably nothing new in the development of mineral resources will come to this district; but several industries now in their early and unimportant stages will greatly enlarge. Brick manufacturing has good opportunities, and it will yet grow much because of the abundance of shales, adjacent coal and gas, and the increasing demand for brick buildings. Stone quarrying, for crushed rock, cement and road material will become a larger industry; and quarrying for building stone may be more than restored to its former significance as the desire in the city for more permanent buildings increases.

Manufacturing, along many lines, especially those catering to the local markets, will increase. New plants will arise at various points along the railroads and may form the nuclei for some of the new towns predicted above, but most of the factories will cling to the borders of the city.

The City.—Columbus may be expected to expand industrially, commercially and artistically for many years to come. Industrially, many building sites along river and railroad will be occupied; and commercially, as the population and manufacturing increase, the facilities for communication and transportation must needs be augmented. No doubt new electric lines will yet be built, and certainly several steam lines will doubletrack to increase the external relations and connections of the city. Possibly a new railroad or two may yet be demanded to care for the products coming into and going out from this city.

While the industrial development of Columbus may be expected to be concentrated along the railroads, and to run in some places, miles into the country, the residence districts will as certainly be built up between railroads. This points definitely to three districts beside the tract north of town and east of the Olentangy, already discussed, which may look for great improvement and a rapidly growing population. One of these, and if geographic conditions are to count for much, the first to receive attention, is the beautiful well drained, easily reached, upland between the two large rivers. Already much progress has been made in the southern part of this tract but the farms north of Fifth Avenue in both Clinton and Perry Townships must pass from farming lands to town lots, streets, drives and school yards, and city car lines must reach out along the present roads.

The next most desirable district is between the Big Four tracks north from Columbus and the Pennsylvania track northeast, in the vicinity of Linden. One electric line connecting with Westerville already runs close to this tract; others will come. The farms in this section are now so valuable for residences that they are not profitable for farming and the response must soon come.

The third district lies south-west from the city beyond the cemeteries and between the Baltimore and Ohio railroad, and the Big Four. Its gently rolling topography and its moderate slope eastward to the Scioto, insuring good drainage, added to the short distance from the manufacturing plants in the western part of the city and the pressure of population from the same parts, constitute the chief reasons for development of this section for residences.

Scarcely a city in Ohio excels Columbus in the matter of opportunities to beautify and adorn itself with parks, drives,

Fig. 17. Hayden Falls, three miles above the Storage Dam, which should be made available by good road connections with the city. (Photo by C. R. Stauffer.)

shade and shrubbery. Two or three natural water-ways lead out of the city along which roads and walks could be constructed for recreation walks and drives. The most attractive of these is unquestionably the Scioto valley. A good automobile road now runs up the valley as far as the storage dam on one side, but there might be a grassed strip with shade, rest benches, and flowering shrubs from the business district along the valley westward, then northward past Marble Cliff, the quarries and the dam and then along the water supply reservoir a considerable distance or even to its upper end. Grass, shade, comfort stations, and seats along the lake shore would make a most attractive walk or drive all the way from the dusty city to the storage reservoir, any part or all of which could be used for a walk, by the thousands who at present seek outdoor exercise on dirty old roads. A return drive less elaborate could be made on the west side of the lake and river past Hayden's Falls (Fig. 17) coming into the city along West Broad Street. Golf grounds, the Wyandotte Club, Country Club and the Columbus Fishing and Gun Club are already along this route, and there might well be an amusement

Fig. 18. A pool, with shady walks, drive and picnic grounds in Schiller Park.

park somewhere well out, perhaps on a part of the large terrace a little above the dam but approached by a car line from the city.

Similar shaded walks and drives with comfortable seats, attractive shrubbery and tree clusters at suitable points, constructed up the Olentangy valley from Fifth Avenue or even Goodale Street, past the State University and the Olentangy amusement park to Worthington, would constitute a delightful place, and would fit admirably into a naturally beautiful setting. This walk would of necessity require an artificial levee part of the way, until beyond the city limits.

From Franklin Park northward, up Alum Creek to Minerva Park, about eight miles, are many beautiful places which could be similarly tied together by a broad boulevard and shady walks. A cross line up a shady ravine, east of Linden, through that suburb and down another ravine, or through Clintonville to the Olentangy drive, or still further north from Minerva Park to Worthington, would complete the northern loop.

A loop is invited in the southeast part of the city from Franklin Park down Alum Creek, past the Driving Park and Infirmary and return to the Scioto Valley, through Schiller Park (Fig. 18) about two miles south of the State House.

Fig. 19. The ancient ill-kept residences and old shops along the Scioto banks which should be removed to make place for a public drive, bordered with grass and shade. (Photo by R. F. Griggs.)

Instead of the unsightly, ancient, tumbled-down, unsanitary houses and shops now crowded along the river (Fig. 19) from Broad Street south, a broad, shady drive or walk on a large levee could be built, which would devote natural scenic beauty to the uses for which it is best adapted, and not strain it beyond recognition to make sites for hovels of squalor. The people living along these alleys would be vastly better off, too, if forced to find more cleanly, homelike quarters in real residence sections.

Of course not all this forecast can come true at once, any more than the present city with its maze of geographic adjustments has arisen in a year. But the progress of the century gone suggests that another century should see most of the mentioned opportunities taken advantage of, both in city and country. With the progress of civilization, culture and industrial development will come closer adjustment to the geographic conditions. More items in the environment will be used, and a larger proportion will be used for the things to which they are best adapted.

Oberlin College, Oberlin, Ohio.

ANNOUNCEMENT.

The 27th Annual Meeting of the Ohio Academy of Science will be held in the Botany-Zoology Building at Ohio State University, Columbus, on April 6th and 7th. There will be an informal meeting of incoming members at the Ohio Union on the evening of April 5th.

OBSERVATIONS ON THE DISTRIBUTION OF WARBLE FLIES IN OHIO.

Don C. Mote.

The following discussion is based on a study of the numbers, dates of occurrence, and distribution in Ohio of the Ox Warble flies (Hypoderma bovis and Hypoderma lineata) as determined from an examination of 628 grubs and 15 adult flies collected for the most part during the years 1914 and 1916. The general object of the study is to determine (1) whether both species

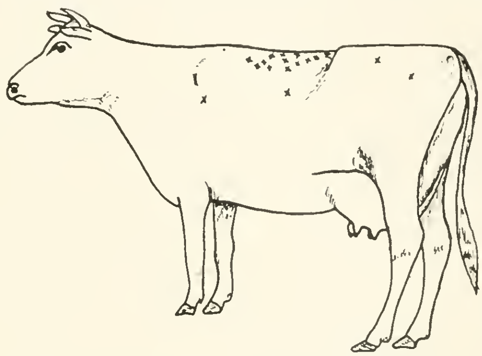


Fig.1. *Larvae were taken from the backs of different cattle at the positions marked X.*

The part of the animal in which the grubs are found during their last stages is the back. Here they may be found distributed for the most part from the loin to just back of the shoulder. Less frequently they may be found on the rump, or some distance down on the side or on the shoulder. The choice of the back region to go through the last stages has some advantages. Here they are less likely to be injured; there is less play of the muscles, and the animal itself is less likely to receive serious injury.

occur within the state; (2) which of them are numerous enough anywhere and at any time to be notably injurious in the grub stage to dairying and the beef cattle industry; (3) the local and regional distribution of the grubs; and (4) to learn, if possible, what are the conditions favoring the increase or decrease in numbers of the species in the not unreasonable hope that this knowledge may help in the solution of the problem of combatting these parasites.

Location of Collections.—Of the 32 counties throughout the state from which collections were obtained, 10 were in northeastern, 10 in northwestern, 10 in southwestern, and 2 in southeastern Ohio. If reports of the occurrence of warble fly grubs not accompanied by specimens are included, then the number of counties infested reach 57; 8 additional counties in northeastern, 5 in northwestern, 1 in southwestern and 9 in southeastern Ohio.

Counties in Which Collections or Reports Were Made.

Numbers of each.

Northeastern Counties			Northwestern Counties			Southwestern Counties			Southeastern Counties		
Counties	Col.	Rpts.	Counties	Col.	Rpts.	Counties	Col.	Rpts.	Counties	Col.	Rpts.
Ashtabula..	2	...	Wood......	1	...	Miami......	1	...	Fairfield...	...	1
Lake.......	...	2	Williams...	...	1	Franklin....	2	...	Perry......	...	1
Cuyahoga..	...	2	Seneca......	...	1	Clarke.....	1	...	Muskingum	1	...
Lorain.....	1	7	Hancock...	2	2	Greene.....	2	3	Guernsey...	...	1
Huron......	...	4	Van Wert..	...	1	Montgom'y	2	3	Noble......	...	1
Medina.....	...	2	Mercer.....	1	...	Preble......	1	...	Belmont....	...	2
Summit....	...	3	Allen.......	...	3	Clinton.....	...	2	Hocking....	...	1
Portage....	1	2	Auglaize....	1	1	Highland...	3	5	Washington	...	2
Trumbull...	2	2	Hardin.....	1	2	Brown......	1	...	Athens.....	...	2
Columbiana	2	2	Marion.....	1	...	Clermont...	1	3	Meigs......	1	...
Stark......	1	2	Delaware...	1	2	Hamilton...	1	...	Jackson....	...	1
Wayne.....	6	7	Union......	1	1						
Richland...	1	2	Logan......	1							
Knox.......	3	1	Shelby.....	1	1						
Holmes.....	...	1	Darke......	...	1						
Coshocton..	...	3									
Tuscarawas	1	1									
Harrison...	...	1									
Totals..	20	44		11	16		15	16		2	12

The localities within these counties from which specimens were obtained were 20 in northeastern, 2 in southeastern, 15 in southwestern and 11 in northwestern Ohio—a total of 48 separate points or farms. If the reports not accompanied by specimens are included, then 44 additional localities in northeastern, 16 in northwestern, 16 in southwestern, and 12 in southeastern Ohio may be added—making a total of 136 herds or farms infested with ox warble flies.

Early in the investigations the two species of warble flies (H. bovis and H. lineata) were recognized. Contrary to expectation, H. bovis was much more abundant. The number of representatives of H. bovis was 404, or 83.5 per cent of the total collection.

Before entering upon a detailed discussion of the distribution of each species, a word concerning the distribution of the warble flies in this and other countries may be of interest.

• Hypoderma bovis found.
▪ Hypoderma lineata found.
+ Herds reported free.
Numbers— Herds reported infested.

In the early entomological notes and observations, the bot fly of the United States was commonly referred to as H. bovis De Geer. In 1891, Dr. Curtice (Journal Comparative Medicine and Veterinary Archives, Vol. XII, pp. 265-274, June 1891) became convinced that the American species was H. lineata DeVilliers and not H. bovis, while Riley (Insect Life, Vol. 4, No. 9 and 10, 1892) after careful examination of all the material at hand, concluded that the older Ox-bot fly, H. bovis, hitherto supposed to be the common species of both America and Europe, is in reality either a very rare insect in this country or possibly does not occur at all. Aldrich (Cat. N. America Diptera, 1905) states that H. bovis is not positively reported from North America.

Later investigators have become accustomed to refer to the North American warble fly as H. lineata.

H. lineata was first described by DeVilliers from Europe. It was later described by Brauer from grubs taken from the back of a Buffalo in Colorado. According to Brauer, the species occurs throughout Europe, having been taken in Switzerland, Norway, Crimea, the Balkans, the Caucasus, England, Ireland, Lower and Upper Austria. H. bovis likewise occurs in these regions and also in Styria and Hungary.

In June, 1910, C. W. Johnson (Psyche, Vol. XVII, p. 231, Dec., 1910) reared an adult fly of H. bovis from a larva collected at Manchester, Vt. In 1912, Dr. S. Hadwen (Bulletin 16, Health of Animals Branch, Canada Department of Agriculture, pp. 20, plate 9) announced the common occurrence of H. bovis at Agassiz, B. C., and in 1914, Dr. C. Gordon Hewitt (Canadian Entomology, Vol. XLVI, pp. 1-2) reported that he had examined specimens of this species from Nova Scotia, Quebec, Ontario, Alberta and Saskatchewan, thus indicating a distribution from the Atlantic to the Pacific in Canada.

In 1915, Bishopp (Annals Ent. Soc. of America, Dec. 1915) reports that probably H. lineata occurs in every state in the Union, although it appears to be more abundant in the southern and central western states; while the so-called European species, H. bovis, predominated over H. lineata both in distribution and abundance in the northeastern states. In the western two-thirds of the United States, H. bovis appears to be found in rather restricted and well separated areas.

While the warble flies are seen to be very generally distributed over the world, they are not prevalent in every country. Some countries are taking measures to prevent the introduction of warble flies. Australia, for instance, has issued a proclamation relating to the importation of cattle from warble infested countries. In order to prevent the introduction of the warble flies, "no cattle shall be imported into Australia from Great Britain, Ireland, the United States of America, or Canada, except those shipped between October and May."

Discussion of H. bovis. Hypoderma bovis appears to be much the most abundant species in the state, comprising nearly 83.5 per cent of all the specimens. In the northeastern section, 257 specimens, or nearly 53 per cent of all the specimens were obtained. This should not be taken to indicate that the northeastern section is more heavily infested than any other. When the collections made in the vicinity of the Ohio Station are excluded, the northeastern and northwestern collections of H. bovis specimens are about equal, that of the latter comprising 106 grubs. It may be pointed out, however, that the fly seems to be more generally distributed in the northeastern section. A study of the map shows much larger number of herds free from infection in the northwestern section than in any other section of the state.

As only one collection of 3 specimens came from Southeastern Ohio, very little can be said of the distribution of bovis in that section. In southwestern Ohio, bovis was taken in five counties. Eight separate collections were made from these five counties, comprising 38 specimens.

It was hoped that a sufficient number of specimens could be obtained to compare the relative annual abundance. But the number of localities represented and specimens obtained the first year are too meager for such a comparison. Many stockmen, however, claim that there were fewer grubs during the late winter and spring of 1916 than of 1915.

The earliest collections containing fourth stage grubs were received early in March from northeastern Ohio. The earliest specimen (one fourth stage grub) came from Ashtabula County. At this date it was the only grub to be found in the cattle's backs. Later (May 3) most of these cattle were reported to be infested. The latest collections were received on June 6 and 10, from southwestern Ohio. In the Ohio Station herd one warble was observed on July 14. On July 20, the grub had emerged. As only H. bovis grubs have been taken from the Station herd for more than three years, it is assumed that this specimen was a representative of H. bovis. Thus H. bovis grubs may be emerging from the first of March until the middle of July. The greatest number of fourth stage grubs were received during April and the next largest number during May. The length of the season in which the grubs make their appearance is of very great importance in deciding what time of year is best to undertake the eradication of the grubs.

Hypoderma lineata.—Only eighty specimens of lineata are represented in the collections, or 16.5 per cent of the total number obtained. This species is most abundantly represented in northeastern and southwestern Ohio, only 2 collections of 1 and 8 individuals coming from the other sections. Eight localities, just as many as is represented by bovis, are represented in the collection from southwestern Ohio, the total number of specimens received being 27. Seven localities are represented in northeastern Ohio, the total number of specimens amounting to 44.

The earliest lineata collection came from Highland county, on March 25. The latest collection, consisting of 2 specimens, came from Brown county on May 11. The largest number of collections and specimens were received during April, only one collection being received after April 20, the one from Brown county.

Seasonal Succession of the Species.—That H. bovis is generally later in emerging from the backs of cattle in the spring than H. lineata, is a fact noted by several investigators. This order of their succession is borne out by a study of the data collected in Ohio. It should be stated that in view of the fact that the grubs were squeezed out, many of them were removed at an earlier date than they would have come out naturally. The figures, then, in Table II do not represent the total number of grubs received or removed from cattle, as many of the grubs were not in the fourth stage and hence could not be classified. However, H. lineata is apparently the earlier fly, as only two fourth stage grubs were received after April 20, and an adult fly has been taken as early as May 16. In the H. bovis life history experiments at Wooster, when the grubs were allowed to come out naturally, 17 out of 21 came out in May.

TABLE II.

Species of Warble Grubs	March	April	May	June	July
H. lineata	8	70	2*	...	...
H. bovis	42	231	115	16	1†

*Prof. Hine has a specimen of an adult fly, H. lineata, taken at Columbus, May 16, 1915. In life history experiments, adults of H. bovis have been obtained in April under laboratory conditions at Columbus, and not until June under natural conditions at Wooster.

†This grub was observed in the back of a dairy cow on July 14. On July 20 it was discovered to have emerged. As none but bovis have been found in these cattle for several years, it is assumed that this grub belonged to H. bovis.

Comparison of Sections of the State.—Perhaps there is little justification for dividing the state into four sections and comparing the warble-fly population of each section. The differences in the number of cattle in each section is not excessive. Northeastern Ohio returned according to the assessors' 1915 report, 414,954 cattle, an average of 17,289 per county. More than 50 per cent of the cattle in this section are dairy cattle, while 17,957 are classed as beef cattle. The total number of cattle in the Northwestern section is 403,140, an average of 14,931 per county, of which 213,295 are classed as dairy cows and 27,786 as beef cattle. More beef cattle are found in the Northwestern section than in any other section, while more dairy cattle are raised in the Northeastern section of the state. The Southwestern section returned a total of 296,000 cattle, an average of 14,800 per county, of which 155,166 are dairy cows, 20,147 beef cattle, and 120,722 other cattle. In the Southeastern section 252,668 cattle were found, an average of 14,862 per county, of which 108,659 were dairy and 11,422 were beef cattle.

As has been shown, the warble fly population, based upon the reports and specimens, is greater for Northeastern Ohio, with Northwestern Ohio a close second. However, a more intensive survey would need be made before drawing any general conclusions. One striking feature brought out by a study of the data is shown in the map, page 171. There appears to be a greater per cent of free herds in Northwestern Ohio than in any other section, especially is this true of the Northwestern tier of counties. At present there is no suitable way of accounting for this, as other factors as well as good care must be at work. Dr. Sheets, of Van Wert county, reports that as a general rule, native cattle are free, only imported cattle being infested. Some stockmen report that they never have had grubs in their cattle, while others state that their cattle have had grubs in the past, but are now free, due to a systematic campaign of squeezing them out.

Relative Attractiveness of Young and Old Cattle.—It is a common observation among stockmen that young stock are more heavily infested than older animals. Whether this is due to the selective action of the flies, or whether the young stock are more accessible, or whether there is any very great difference, are questions that arise in this connection. Many of the reports read as follows: "All cattle infested save those kept in the barn;" or, "all young cattle and dry cows turned out to pasture during spring and summer." It is a general practice to turn young dairy stock out in the spring and leave them out all summer.

The following is a list of animals upon which notes were taken, giving the number of warbles appearing on each animal and the age of the animal:

TABLE III.

Number	Age	Number of Grubs	Number	Age	Number of Grubs
1	15 years	17	1*	2 years	2
2	12 years	1	2	2 years	17
3	10 years	4	3	1 year, 9 months	13
4	10 years	5	4	1 year, 9 months	5
5*	9 years	15	5	1 year, 9 months	5
6	7 years	3	6	1 year, 6 months	4
7	6 years	4	7	1 year, 4 months	2
8	5 years	9	8	1 year, 4 months	1
9	4 years	1	9	1 year, 3 months	2
10	3 years	2	10	1 year	14
11	3 years	12	11	1 year	10
12	3 years	3	12	1 year	8
13	3 years	1			
14	3 years	11			
	Total	88			73
	Average	6.2			6.0

With the exception of two, Nos. 5* and 1*, all the animals belong to one herd. If those animals 2 years old and under are considered young stock, and those over 2 years, old stock, then the reader will note that there is very little difference in warble infestation. However, if the animals in the one herd only are considered, then the infestation is slightly heavier in the young animals.

Date of Publication, March 10, 1917.

THE

Ohio Journal of Science

PUBLISHED BY THE

Ohio State University Scientific Society

Volume XVII APRIL, 1917 No. 6

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TUMORS IN DOGS.

Jonathan Forman and Carlos I. Reed.

I. Carcinomas of the Thyroid Gland.

This paper embraces the anatomical description of fifteen enlargements of the thyroid glands of dogs and an attempt to correlate these with well known types of thyroid carcinoma in the human as well as with the general principles of oncology.

The frequent occurrence of tumors among vertebrates is well recognized. Numerous workers have reported the occurrence of malignant new-growths in both wild and domestic animals. Cancer has been found more frequently among the domesticated animals. The incidence curve of malignancy in dogs approaches that of the human.

In his discussion of the frequency of cancer in dogs, Wolff ('13) cites one series of dogs reported from the Berlin veterinary clinic in which 1.9% of all sick dogs exhibited some form of malignancy. In another series, the incidence was 3%, while in a third series there was an incidence of 5.5%; a fourth series showed an incidence of 7% and a fifth series showed a malignancy incidence of 8%. From these data it was also shown that the greatest incidence of cancer among dogs occurs at about the eighth year of life. Goodpasture and Wislocki ('16), who have made a study of fifteen old dogs, report a remarkable series of multiple tumors. There were fourteen cases each of tumor of the liver, spleen, and adrenals; eight cases each of tumor of the gall-bladder and prostate; five cases each of tumor of the stomach and ovary; four of the subcutaneous tissues; two cases each of the submaxillary gland, testes, and breast; one case each of the following: pancreas, parotid, thymus, skin, hypophysis, blood vessels and bladder. In only one of these cases, that of a malignant tumor arising from the medulla of the right adrenal, was there any metastatic manifestation found and in this case there were metastatic nodules in the liver. All the other tumors were primary. In five dogs of this series there were also multiple carcinomas of the thyroid gland which were primary. In three cases, both lobes were involved.

Several other workers have reported cases of primary carcinoma of the thyroid gland of dogs. Sarcomas are very rare. Wells ('01) and Schoene ('09) have each reported a case occurring in a dog in which the thyroid tumor was composed of connective tissue and epithelium—the so-called sarco-carcinomas.

During the school year of 1915–16 a systematic search was made for tumors occurring in the dogs used in the Laboratories of Physiology and Pharmacology. Especial attention was given to the thyroid gland. Every gland was routinely sectioned and microscopical preparations were made. There are 234 glands in this series. During the first four months of the present school year (1916–17), 37 additional thyroid glands have been routinely examined in the same way, making a total of 271 cases in the complete series. In these 271 thyroid glands, five malignant tumors were encountered. This gives an incidence of 1.8%. During the two previous years, such tumors as attracted attention in these Laboratories were sent to the Pathological Laboratory for examination. Five cancers of the thyroid were observed in this way. At various times specimens of tumors occurring in dogs have been presented to the laboratory. In this series are five cancers of the thyroid gland. No sarcomas of the thyroid were encountered. This study is, therefore, based upon fifteen specimens of carcinoma of the thyroid of dogs. Since the specimens fall into four distinct groups, individual protocols have been omitted and those cases resembling each other closely have been described as a group.

Group 1. Two tumors fall into this group. Each presents a fairly definitely encapsulated nodule in a gland, both of whose lobes are enlarged to about an equal extent. The one was from an old male and the other from a rather old female in a late stage of pregnancy. In the gross, each nodule is buried in the substance of the gland, but its outline can be distinctly made out on the surface before sectioning. Each nodule is surrounded by dense fibrous tissue and composed of a soft and apparently very cellular tissue.

Microscopical examination reveals compressed, but fairly normal thyroid tubules surrounding the nodule. The cells of these tubules are cuboidal. The lumina are irregularly ovoid in shape due to compression. The secretion is small in amount and only faintly stained with eosin. Within a capsule of dense connective tissue can be seen a mass of epithelial cells resting in scant stroma. (Fig. 1). There are, however, a few trabeculæ running through the tumor and these have taken on a mucoid appearance, a change which is frequently seen in the connective tissue supporting the tumors of the thyroid. Among the tumor cells, every stage of transition can be seen from solid cords of cells to tubules containing colloid and resembling closely those of the normal gland. Mitotic figures are difficult to find. On account of the greater lack of differentiation on the part of the epithelium, the more extensive necrosis and the more definite invasion of the capsule, the distinct impression is gained that the second tumor is growing much more rapidly than the first. It is of especial interest since pregnancy usually exerts an inhibitory influence of neoplastic activity. In both specimens the point of invasion of the capsule is adjacent to the cells, showing the greatest lack of differentiation. As was noted in the second specimen a goodly portion of the center of the nodule has undergone necrosis. At the margin of this necrotic area, the cells have arranged themselves concentrically around blood vessels. The intervening tissue is necrotic, so that a peritheliomatous appearance is given to the tumor at these points. In the second specimen, also, tumor cells are observed growing in the lymph spaces. No metastasis is demonstrable in either instance.

The enlargement in these glands is due to a definite cancer not unlike the so-called proliferating struma seen in the thyroid gland of man. Apparently, also, here as in man, the tumor does not belong to the more malignant variety. The presence of a growth in the lymph spaces suggests, however, that metastasis would have occurred at no distant date had the animal been allowed to live.

Group 2. Into a distinct group fall two other cases. Both of these tumors occurred in old males. The gland is extensively involved by the new-growth. Some seven or eight nodules are found in a single lobe. These vary in size from 5 to 20 mm. in diameter. The centers of the nodules in some instances are necrotic. The tumor substance itself is yellowish white. A striking coloring is lent to the gross sectional appearance of the specimen by the necrosis and by the presence of hemorrhage both into the tumor mass and into the gland substance.

Bands of connective tissue separate the masses of tumor cells, giving an alveolar arrangement to the tumor. The stroma in both cases has taken on a mucoid appearance and presents many slit-like cavities from which crystals have been dissolved. There is little in these neoplasms as seen microscopically to remind one of the thyroid gland. In the one specimen, a few tubules which are normal in appearance can be seen (Fig. 2), but the arrangement of the tumor cells in and around these reefs of thyroid tubules makes it seem more probable that these are remnants of the normal gland structure than that the tumor cells should have differentiated in such an oddly shaped zone. In certain areas, the typical tumor cells are small and round with deeply staining nuclei (Fig. 3). In certain other areas, however, the tumor cells have assumed a spindle shape and this makes it difficult to distinguish this tumor from a sarcoma composed of small round and spindle-shaped cells. It would, indeed, be very easy, upon casual examination to mistake the growth for the so-called sarco-carcinoma. One must be careful to distinguish these growths from those tumors of the thyroid in which both the connective tissue and epithelial elements have taken on a neoplastic character. The progression from the areas of an undoubted carcinomatous nature to areas of a sarcomatoid character can be followed without interruption. A study of the pulmonary metastasis which has occurred in one of these cases reveals a typical carcinomatous secondary growth. These facts, it seems, warrant the diagnosis of carcinoma.

Fig. 4 is introduced from a spindle cell carcinoma occurring in the thyroid gland of a horse. The elongated epithelial tumor cells may be seen arranged in a kind of bundle formation so that the resemblance to neoplastic connective tissue cells (a sarcoma) is even more striking than in the canine specimens. Areas can be found in which the carcinomatous cells appear to be distinct from the sarcomatoid groups. If these strands of spindle cells are followed, it is observed that the cells change to spherical shape and then are arranged into more or less definite tubules. So that, while these specimens, upon casual examination appear to be adeno-sarcomas or sarco-carcinomas, a more careful study makes it appear that there is only one type of tumor cells present and that these are epithelial cells. This is in agreement with the observation of Ewing ('16) that "epithelial tumors may from their inception appear like spindle cell sarcomas as, in the spindle cell carcinoma of the thyroid. It is becoming more and more apparent that many so-called sarcomas of the organs are in reality spindle cell carcinomas."

A more decided lack of differentiation of the tumor cells in both specimens and the presence of metastasis in the one instance indicate that this is a more malignant type of cancer as compared to those in Group 1.

Group 3. Ten specimens are placed in this group which appear much the same as carcinoma seen in other organs and as seen most frequently in the thyroid gland of man. A whole lobe and often both lobes are involved in the growth. The tumor substance is of a pearly white color except where it has undergone necrosis or a hemorrhage has occurred into it. The tumor is subdivided into smaller spheroid masses, measuring 1 to 5 cm. in diameter, by strands of fibrous tissue. The gross sectional appearance and the extent of the involvement can be seen in Fig. 9.

The tumor cells vary in size, shape and arrangement. Six of these specimens show a tendency to form tubules. The cells are cuboidal for the most part. In certain tubules, however, they are high columnar. An occasional tubule is well formed and contains colloid.

All stages of transition from the more nearly normal tubules to strands of typical tumor cells, and further still, to masses of cells with no definite arrangement, supported in a delicate stroma. These masses may be separated by bands of dense connective tissue and thus given an alveolar arrangement. It is in these masses, that the greatest variation is seen, both in the same tumor and in different tumors. In seven of the specimens, the cuboidal cell is the predominating one. Occasionally a mass of large spherical cells with clear, lightly staining cell bodies and small dark nuclei are encountered. In three of the specimens, this same type of cell predominates so that these specimens appear to be of the medullary type of carcinoma. In many instances the blood vessels are filled with the growth.

In six of the cases, definite metastatic nodules are present in the lungs (Fig. 10). Unfortunately, a search through the marrow of the bones of each animal could not be made. Since this is a frequent site for the secondary growth of thyroid tumors, no doubt, instances of metastasis might have been found. In the lungs presenting metastatic nodules, many of the vessels are filled with tumor cells. One of these specimens illustrates defense against the tumor cell which has found its way into the circulatory system. That is, there is a proliferation of endothelium and an ingrowth of connective tissue in and around the embolic mass of tumor cells to such an extent that the tumor cells have been completely crowded out. (Figs. 5, 6, 7, 8). These tumors are distinctly malignant. The number of metastases indicates this as well as the histological picture.

Group 4. Another form of thyroid malignancy is illustrated by a single specimen in our series. The greater part of this tumor was not brought to the laboratory, but was used by Drs. Scott and Dodd in an unsuccessful experiment in transplantation. Our description of the specimen, therefore, rests on the findings in four blocks of tissue embedded in celloidin. The growth is composed of whitish nodules and cystic cavities filled with the tumor growth.

Microscopical examination reveals dilated gland lumina into which extend many papillary growths of connective tissue covered with epithelial cells of columnar type. (Fig. 17). The tendency to develop into a papilliferous growth is seen even in the more solid nodules of the tumor. The papillary cystadenoma is encountered occasionally in the human and is usually placed in a class between benign and malignant growths.

Two of the four specimens studied by Muller and Speese ('06), had undergone carcinomatous change. The character of these solid nodules is definitely carcinomatous. This specimen is, therefore, to be classed as a cystocarcinoma papilliferum.

SUMMARY.

These enlargements of the thyroid gland are all due to a new growth of the glandular epithelium. The cells of this new growth do not present the differentiation typical of thyroid epithelium. They have lost for the most part their polarity and normal arrangement. In certain instances these losses are so marked that from individual sections it could not be ascertained that the tissue was at all related to the thyroid gland. All gradations between this and definite tubules containing colloid are observed. The growths are not localized but have infiltrated more or less the surrounding glandular structure. In the more advanced cases, secondary nodules are found in distant parts, particularly in the lungs. Since infiltration and metastasis are late manifestations of most carcinomas, it is not surprising to find that several of these tumors taken from dogs which were apparently healthy should present secondary nodules and that the infiltration seen in the specimens presenting only single small nodule should not be as yet extensive.

The incidence of malignancy in our series is somewhat higher than in the human. In 5,000 goitre patients treated at the Mayo Clinic, ('13), 52 carcinomas were found. It is to be noted that this series of dogs, not selected but taken as they came into the laboratory, and therefore, representing the average healthy dogs of Columbus, present a malignancy incidence nearly equal to that of the Mayo series of humans selected because of diseased thyroid glands. In Ohio (1910–1913), the mortality from goitre was 21.2 per 100,000 persons living. Many of these were non-malignant diseases of the gland since all fatal diseases of the thyroid are returned as goitre.

Because of the source of the material, the exact ages of the dogs could not be determined except in one instance in which by accident the dog was known to be twelve years old. All the others, however, appeared to be old dogs as judged by the general appearance and activity of the animals and the condition of their teeth.

These groups of carcinoma are similar to those already described for thyroid carcinoma in man. This is in agreement with the findings of others concerning the wide zoological distribution of cancer and serves to emphasize the fact that the cancer problem has a wide biologic connection.

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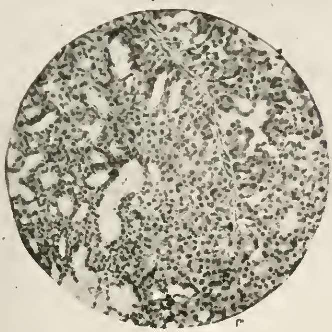
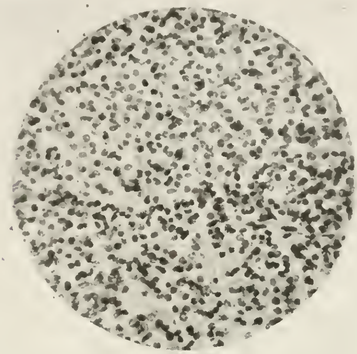


FIG. 1.



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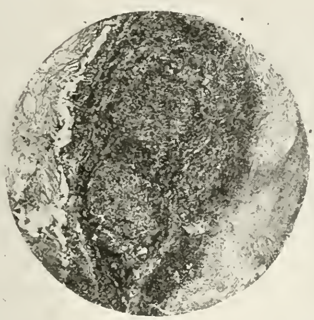

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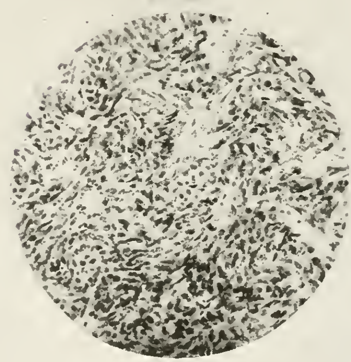

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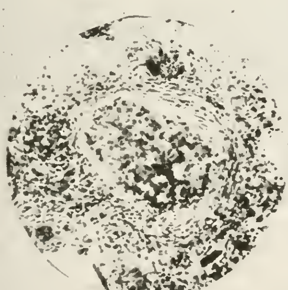

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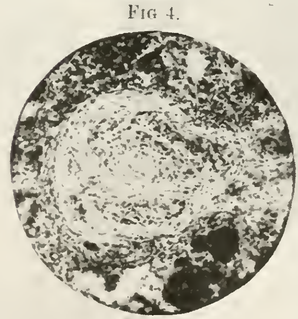

FIG. 6.

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FIG. 9.

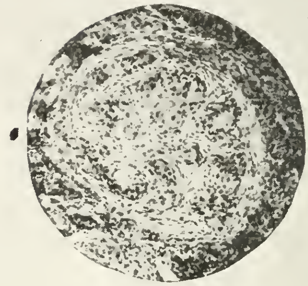
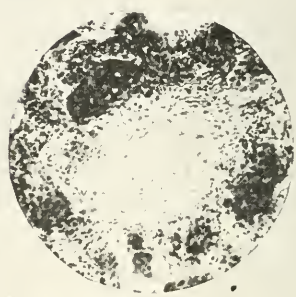


FIG. 7.



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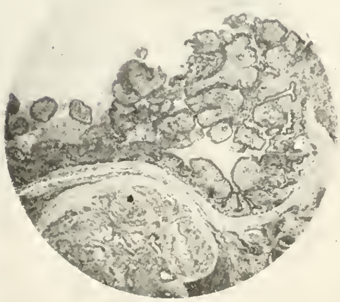

FIG. 11.

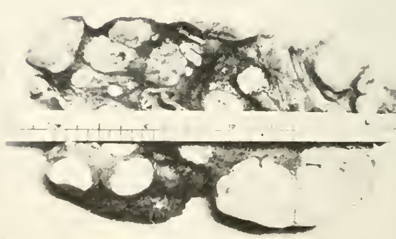

FIG. 10.

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NOTES ON SILURIAN FOSSILS FROM OHIO AND OTHER CENTRAL STATES.

Aug. F. Foerste.

The order of succession of Silurian strata in southeastern Indiana and the adjacent parts of Kentucky, in descending order, is as follows:

Louisville limestone,
Waldron shale,
Laurel limestone,
Osgood clay and limestone,
Brassfield limestone.

The Waldron clay shale has not been traced north of Waldron, St. Paul, and Milroy, the latter village being seven miles south of Rushville, Indiana. The Louisville limestone thins out eastward, beneath the Devonian, there being an unconformity between the top of the Louisville exposures and the base of the Devonian. Typical Louisville limestone can be traced eastward as far as Madison and the outcrops along Big Creek, southeast of Dupont. Between Vernon and Milroy the equivalent of the Louisville limestone is poorly supplied with fossils and rarely exceeds ten feet in thickness. Farther north it has not been recognized as a distinct horizon, separable from the general upper Niagaran section. Neither the Waldron nor the Louisville member has been recognized in Ohio.

The order of succession of Silurian strata in the northern tier of counties in southwestern Ohio, including Preble, Montgomery, Greene, Clarke, Champaign, Miami and Darke Counties, in descending order, is as follows:

Durbin formation	Cedarville dolomite Springfield dolomite Euphemia dolomite
Laurel limestone	
Osgood clay shale	
Dayton limestone	
Brassfield limestone.	

The Euphemia dolomite is the very porous Mottled Zone of Prosser (The Classification of the Niagaran Formations of Western Ohio, Journal of Geology, 1916, pp. 334–365), and was identified by Orton with his West Union formation, of the more southern counties of Ohio. The Euphemia dolomite can not be identified west of New Paris, nor south of Cedarville, Ohio.

The same statement may be made regarding the Springfield dolomite. It also has not been identified west of New Paris nor south of Cedarville. Where the pike crosses the creek, half a mile west of Port William, fourteen miles south of Cedarville, the lower strata belonging to the dolomitic Niagaran series no longer can be identified definitely as Springfield. The Springfield dolomite is regarded as a lithologic phase of the dolomitic Niagaran series. Similar fine-grained strata, but not so well bedded, are known also higher in the section. The Euphemia dolomite is regarded as inaugurating this dolomitic series, and the term Durbin formation is proposed, to include them all: the Euphemia, Springfield, and Cedarville dolomites. Durbin is a railroad station about a mile west of the Mills quarries which are located south of the railroad from Springfield to Troy, about a mile southwest of Springfield, Ohio, and the exposures here form the type section. The Springfield and Cedarville dolomites are well exposed also immediately northeast of Durbin.

The Laurel limestone, containing Pisocrinus gemmiformis and Stephanocrinus, is represented by typical exposures at New Paris, Ohio. At the Carl quarry, three miles southwest of Lewisburg, near Brennersville, there is another typical exposure, containing the same fossils. East of this locality, the Laurel limestone is identified only stratigraphically, the name being employed for those strata which intervene between the Osgood clay and the base of the Euphemia dolomite.

In the vicinity of Osgood, and southward in Indiana and Kentucky, the Osgood formation consists of a clayey section, a relatively thin limestone, frequently fossiliferous, and a second clay section, also thin, and occasionally also fossiliferous. The characteristic Osgood fossils occur chiefly in the Osgood limestone, but, locally, are abundant also in the upper parts of the lower Osgood clay and in the lower part of the upper Osgood clay. Even the characteristic cystids, described by S. A. Miller as species of *Holocystites*, are found in the lower part of the upper Osgood clay (21st Ann. Rept. Indiana Geol. and Nat. Resources, 1897, pp. 248, 252, 254, 257), demonstrating that this upper clay should be referred to the top of the Osgood and not to the base of the Laurel section. Fossils occur at this horizon at several localities between Madison and New Marion, Indiana.

North of Osgood, both the lower and the upper Osgood clays tend to become more indurated. This is true especially of the lower Osgood clay, which becomes a more or less impure limestone northward. The upper Osgood clay, on the contrary, although frequently reduced to a thickness of less than two feet, usually may be recognized as the very characteristic soapstone layer, immediately beneath the base of the Laurel limestone, in Decatur and Franklin Counties. It is this upper Osgood clay or soapstone horizon which is most readily identified, lithologically, in the Niagaran sections near Lewisburg, Ludlow Falls, and Covington, Ohio, as forming a part of the Osgood section in that area. Whatever rock occurs between this clay horizon and the Euphemia dolomite is referred to the Laurel limestone, and, in a similar manner, whatever rock occurs between this clay horizon and the top of the Brassfield limestone is included, along with the clay itself, in the Osgood formation. Since there is little change in the thickness of the Laurel limestone and of the Osgood clay in proceeding from Lewisburg eastward to Ludlow Falls and Covington, it is probable that these members of the Niagaran section extend farther eastward, but no equivalent to the Laurel limestone is present in the sections at Springfield, Yellow Springs, or Cedarville, and the clayey section at those localities evidently is the northward extension of the Crab Orchard clays of southern Ohio and eastern Kentucky, and may not be the exact equivalent of the Osgood clay of Indiana. Between Ludlow Falls and Covington, on the west, and Springfield and Yellow Springs, on the east, no clear exposures of the Niagaran strata immediately below the Euphemia horizon are known. This evidently was the reason why Prosser did not follow his Niagaran sections farther eastward (Journal of Geology, 1916, pp. 334–365).

In the more southern counties of Ohio, chiefly in Highland and Adams Counties, the Niagaran section, in descending order, is as follows:

Cedarville dolomite, with sandy layers near top.
West Union formation $\begin{cases}\text{Lilley member}\\ \text{Bisher member}\end{cases}$
Crab Orchard clay shale
Dayton limestone
Brassfield limestone.

At Hillsboro, Ohio, the West Union formation is separable into two members containing a very different fauna. The upper, or Lilley member, exposed at various localities on Lilley Hill, consists of about twenty feet of massive limestone usually overlaid by two or three feet of clay. It has been identified with certainty so far only in the vicinity of Hillsboro. The lower, or Bisher member, typically exposed northeast of the Bisher dam, contains a very characteristic fossil horizon about nine feet above its base, and several other layers, less abundantly fossiliferous occur between twelve and twenty feet farther up. This lower horizon appears to have a much wider horizontal extension. Along the creek, half a mile west of Port William, about seven miles north of Wilmington, the total thickness of West Union formation is less than five feet. It immediately underlies the Cedarville dolomite, and appears to represent the fossil horizon which at Hillsboro occurs nine feet above the base of the Bisher member. Farther northward, the West Union formation appears to be entirely absent.

In the vicinity of Hillsboro, Ohio, the Crab Orchard formation consists of 62 feet of clay underlaid by the Dayton limestone, 3.5 feet thick. The latter contains *Pentamerus oblongus* at several localities: Two miles west of Peebles, two miles south of Bellbrook, and near Dayton (Ohio Geol. Survey, 1870, p. 280). This Dayton limestone may correspond approximately to the Walcott limestone division of the Clinton formation in Niagaran section at Rochester, New York.

In the upper part of the Crab Orchard clay shale, in northern Kentucky and southern Ohio, thin layers of indurated shale occur which contain *Liocalymene clintoni*, *Beyrichia lata-triplicata*, and other fossils. Fossils have been found at this horizon in the exposures a mile west of Peebles, Ohio, and the horizon probably may be traced as far northward as Hillsboro, Ohio. It evidently corresponds to the typical Clinton of New York, as exposed at Clinton, in that state.

North of Hillsboro, Ohio, the Crab Orchard clay shale section changes rapidly in character. No equivalent to the upper fossiliferous part of the Crab Orchard clay shale may be recognized at Leesburg, 11 miles northward. Here the clay is represented by a more or less indurated and imbedded rock which may soften up under the influences of weathering, but which does not resemble the softer clay sections of more southern areas. The same lithological appearances are presented by the exposures on following the stream westward from the first exposures of the Crab Orchard formation, half a mile west of Port William, 18 miles northwest of Leesburg. They characterize the exposures also west of Cedarville, west of Clifton, and at Yellow Springs. At Centerville, the more or less indurated clayey strata, overlying the Dayton limestone, are interbedded with thin layers which are sufficiently calcareous to suggest impure limestones. Near the Soldiers' Home, west of Dayton, the limestone layers interbedded with the more shaly courses in the equivalent of the Crab Orchard section are more calcareous, and thicker, frequently attaining a thickness of three or four inches, or more, and resemble the underlying Dayton limestone, which is softer and less white here than southeast of Dayton, and at Centerville. At Lewisburg, Ludlow Falls, and Covington, the equivalent of the Crab Orchard section has become a continuous succession of limestones no longer to be readily differentiated from the typical Dayton limestone beneath.

In the present state of our knowledge it seems probable that the Osgood clay of the Lewisburg section belongs above the Crab Orchard clay section of Highland and Adams Counties, in Ohio, and is not merely an attenuated equivalent of the latter.

The Dayton limestone is regarded as forming merely the base of the Crab Orchard formation. The *Liocalymene clintoni* horizon, at the top of the Crab Orchard formation, may belong below the Rochester shale, rather than be equivalent to the latter.

The discrepancies between the Niagaran sections east and west of the present Cincinnati geanticline suggest an origin at least as early as the early Niagaran.

Holophragma calceoloides Lindstrom.

Plate VIII, Figs. 3A–K.

1865. Hallia calceoloides, Lindström. Ofvers. Vet. Akad. Förhandl., XXX, L. C., p. 289, pl. 31, figs. 9-11. Id. Nomina Foss. Sil. Gotl. p. 7.
1879. Cyathophyllum calceoloides, Quenstedt. Petrefactenkunde Deutschlands, Pt. I, vol. 6, p. 410, pl. 156, figs. 90-92.
1885. Cyathophyllum calceoloides, Lindström. List of Fossils of Gotland, p. 19.
1888. Cyathophyllum calceoloides, Lindström. List of Fossil Faunas of Sweden, Pt. II, p. 21.
1896. Holophragma calceoloides, Lindström. Bihang t. K. Sv. Vet. Akad. Handl. vol. 21, Afd. IV, No. 7, pl. VI, figs. 74-86.

Corallum simple, usually not exceeding 35 millimeters in length, but occasionally attaining a length of 40 millimeters. Cardinal side strongly flattened, giving the calice a subtriangular outline (Fig. 3D). Lateral margins of corallum more or less strongly angular. Viewed from the side, the transverse wrinkles are seen to incline from the cardinal side strongly forward and downward, and the cardinal side is straight or only moderately curved for the greater part of its length. Toward the calice, the corallum frequently curves more strongly forward, (Fig. 3B), and the outline of the calice becomes transversely oval or nearly circular (Fig. 3H). At the same time, the lateral diameter of the corallum frequently becomes shorter, and sometimes the antero-posterior diameter also becomes less, suggesting gerontic conditions. The two narrow longitudinal ridges locating the cardinal septum usually are distinctly defined along the lower half of the cardinal side of the corallum, but become less conspicuous along the upper half. The alar septa are located along the lateral angles of the corallum.

From 25 to 30 larger septa line the interior of the calice, alternating with which are an equal number of short septa confined to the upper part of the calice. The cardinal septum is only slightly more conspicuous than the remainder. Those septa which are intermediate between the cardinal and alar septa tend to meet at the bottom of the calice, in the more triangular forms, so as to present the appearance of two groups, one on each side of the cardinal septum (Fig. 3K). In the calices with more circular outlines, this tendency toward grouping is not conspicuous, and it varies greatly in different individuals. Occasionally the second or third one of the larger septa on the right and left of the cardinal septum becomes more conspicuous than the rest. (x in Fig. 3K). Together with the cardinal septum, they form a group of three somewhat more prominent septa, chiefly in specimens retaining their triangular outline even at the aperture of the calice. In most specimens, especially those with a circular outline at the aperture, these septa are not more conspicuous than the rest.

In *Anisophyllum trifurcatum*, Hall, it is the two alar septa which in conjunction with the cardinal septum, form a group of three somewhat more conspicuous septa.

In *Holophragma calceoloides*, the septa are not twisted together at the center, as in *Streptelasma*, and the cardinal septum is not located in a fossula, as in *Zaphrentis*.

Typical *Holophragma calceoloides* occurs in layers *c* and *d* of the Silurian of Gotland. It is recorded from the coast at Wisby, Guisvard, Staf, Nyrefsudd in Tofta, Likkershamm, Kristklint, Hallshuk, on west shore of Kapellshamn.

The specimens here figured and described were obtained in the upper part of the West Union formation, in the Silurian at Hillsboro, Ohio. Here they are most abundant at the Zink or

Corporation quarry, immediately south of the Marshall pike, in the eastern part of the town. At this quarry, the *Pentamerus* bearing dolomite, correlated with the Cedarville dolomite of the more northern sections in southwestern Ohio, is underlaid by two feet of clay shale, and next by fourteen feet of a bluish, apparently argillaceous limestone, rather massively bedded. Fossils are abundant in the clay shale, much less abundant in the upper part of the massive limestone, and comparatively scarce in the middle and lower parts of this limestone. *Holophragma calceoloides* also is common in the two-foot clay shale, and occurs in moderate numbers in the upper half of the underlying massive limestone.

At the Trimble, Beech, or Railroad quarry, a third of a mile north of the Zink quarry, the *Pentamerus* bearing dolomite, correlated with the Cedarville dolomite, is underlaid by clay shale, three feet three inches thick. Below this occurs the full section of the blue massive-bedded limestone seen in the lower part of the Zink quarry. Here its total thickness is 21 feet, and it is underlaid by well-bedded, laminated, cherty limestone in which fossils are few. *Holophragma calceoloides* occurs here both in the clay shale and in the upper half of the underlying massive limestone, but in much smaller numbers than at the Zink quarry.

Holophragma calceoloides occurs also at two localities along the Danville pike, west of Hillsboro. The first locality is a quarry south of the pike, about a quarter of a mile west of the town. Here it occurs in the upper part of the massive blue limestone. The clay shale is absent, and the overlying dolomite does not contain *Pentamerus*. The second locality is a quarry north of the pike, and about an eighth of a mile farther west than the first quarry. Here *Pentamerus* is common at the top of the quarry. Below the *Pentamerus* bearing horizon is a section ten feet thick in which the dolomite contains no *Pentamerus*. Below this ten-foot section occurs the massive blue limestone, containing *Holophragma calceoloides* in its upper half. At neither of these two localities is the *Holophragma* common. At the first locality, south of the Danville pike, the shaly, thin-bedded, cherty rock, seen at the base of the Trimble quarry, is exposed.

The two-foot clay shale layer, and the 21-foot massive blue limestone section at the Trimble, Beech or Railroad quarry, east of Hillsboro, Ohio, contain a fauna quite distinct from that found in the lower third of the West Union formation, northeast of the Bisher dam, a mile southeast of Hillsboro, on Rocky Fork. It is sufficiently distinct to merit a separate designation locally, and hence the name *Lilley* bed or member is here proposed, to include both the clay shale and the underlying limestone, since they contain the same fauna. Both the Zink and the Trimble quarries are located on the western side of Lilley hill, along the eastern edge of Hillsboro. For the underlying part of the West Union formation the term *Bisher* member is proposed, the typical fauna occurring northeast of Bisher dam, a mile southeast of Hillsboro, and outcropping along the hillside northward as far as the lower part of the valley immediately southeast of the town. The most abundant fossil horizon is about nine feet above the base of the formation, another fossiliferous layer occurs from 12 to 20 feet farther up.

Zaphrentis digoniata, sp. nov. Plate VIII, Fig. 1 A, B, C, D, E, F, G.

Corallum strongly compressed laterally, the antero-posterior angle varying from 40 to 45 degrees, and the lateral diameter equalling from 45 to 55 hundredths of the antero-posterior diameter. The two narrow longitudinal ridges locating the position of the cardinal septum are somewhat more conspicuous than the other longitudinal ridges marking the exterior of the corallum, at least along the lower half of the corallum, and are located along the posterior angle. The anterior and posterior angles are equally well defined, and vary from almost acute, in some specimens, to more or less strongly rounded. Frequently the specimens are more acutely angled at the base and more strongly rounded toward the top. The specimens usually do not exceed 35 millimeters in length. The tip of the base of the corallum frequently curves slightly forward, and the transverse striae also slope slightly downward from the rear toward the front, on lateral view.

The calice varies from 10 to 15 millimeters in depth. A deep but narrow fossula is located on the cardinal side of the corallum and extends as far as the center of the calice. The cardinal septum appears to have varied greatly in the extent to which it extended inward from the wall of the corallum toward the center of the calice. If alar fossulae existed, these must have been shallow and inconspicuous. The number of septa apparently varies in different specimens from 30 to 40, alternating with an equal number of much smaller size, which could be described as acute septal ridges.

Zaphrentis digoniata is not rare in the two-foot clay shale and in the upper part of the massive blue limestone, forming the Lilley member of the West Union formation, at the Zink or

Corporation quarry, in the eastern part of Hillsboro, Ohio. It occurs at the same horizon, but in smaller numbers, at the Trimble or Railroad quarry, a third of a mile north of the Zink quarry. Specimens occur also in the upper part of the massive blue limestone exposed in the quarry a quarter of a mile west of Hillsboro, on the Danville pike.

Specimens not to be distinguished from typical *Zaphrentis digoniata*, from the Lilley member of the West Union formation, at Hillsboro, occur in the upper third of the quarry at Cedarville, Ohio, where only the Cedarville dolomite is exposed. Since the upper limits of the Cedarville dolomite can not be determined in the area surrounding Cedarville, nothing more definite regarding the stratigraphic position of these Cedarville specimens can be stated at present. The specimens occur chiefly as casts of the calices, but impressions of the exterior of the entire corallum also occur.

In *Streptelasma angulatum*, Billings, from the English Head and Charleton formations, in the Richmond of Anticosti, and in some of the younger specimens of *Streptelasma robustum*, Whiteaves, from the Richmond of the Red River Valley, in Manitoba, the corallum is more or less strongly angulate along the convex curvature of the corallum. In both species, the anterior outline is distinctly concave, and the posterior or cardinal outline is strongly convex, when the corallum is viewed from the side.

Since no attempt ever has been made to locate the exact horizon of the rich fauna in the quarry at Cedarville, Ohio, in that part of the Silurian section usually referred to the Cedarville dolomite, the following notes may be of service. At the quarry immediately north of the railroad and about a third of a mile west of the railroad depot, the top of the exposed rock is about two feet above the level of the railroad track. The section here is as follows, given in descending order:

Cedarville dolomite, richly fossiliferous........................12 ft.
    Amphicoelia costata horizon
Cedarville dolomite, fossils common........................ 7 ft.
    Horizon 1063 feet above sea level.
Cedarville dolomite, massive, breaking up into irregular layers; fossils few........................ 3 ft.
Cedarville dolomite, massive, crinoidal, fossils few..........7 ft., 6 in.
Cedarville rock, not exposed, covered by water collecting at bottom of quarry; fossils few........................11 ft.

Half a mile west of the quarry, but on the northern side of the Columbus pike, is a house below the level of the pike. A lane leads past the eastern side of the house downward into the ravine formed by Massie Creek. The house if about 1005 feet above sea level, and rock occurs at about the same level along the lane leading toward the creek. Here the following section is shown, in descending order:

Cedarville dolomite, massive.................................38 ft.
Horizon about 967 feet above sea level.
Dolomitic limestone, breaking up into thin layers, and regarded as equivalent to the Springfield dolomite......................13 ft.
Dolomite, massive, showing bedding toward the top, regarded as equivalent to the Euphemia dolomite...................7 ft., 6 in.

The dip of the rock within this half mile, from the exposure on Massie Creek to the quarry north of the railroad in Cedarville, is not known, but is regarded as low. If this be true, the level at which fossils become common in the quarry is about 36 to 40 feet above the *base* of the Cedarville dolomite, as identified along Massie Creek. Since the total thickness of Cedarville dolomite exposed at the eastern Mills quarry, at Limestone City, southwest of Springfield, is only 19 feet, the level at which fossils become common in the Cedarville quarry apparently is about 17 to 20 feet above the top of the highest part of the Cedarville dolomite exposed at the eastern Mills quarry. Since most of the fossils collected in the quarries southeast of Springfield come from the lower, more massive and porous part of the Cedarville dolomite, the level at which fossils become more common in the Cedarville quarry may be estimated at from 25 to 30 feet above the level of the top of the zone from which most of the fossils collected southwest of Springfield have been obtained. This difference in level between the richly fossiliferous zone in the Cedarville quarry and that in the quarries southeast of Springfield accounts readily for the differences in faunal content noted.

At the Mills Quarries, southwest of Springfield, the following order of succession, in descending order, is noted:

Cedarville dolomite:
Porous rock..3 ft.
Less porous rock..................................1 ft., 6 in.
Thin bedded, fine grained rock......................3 ft., 3 in.
Massive, porous, richly fossiliferous rock..................11 ft.
Springfield dolomite, fine-grained, well bedded.................10 ft.
Transition rock, dense, but somewhat mottled..................4 ft.
Euphemia dolomite, porous....................................8 ft.

Cyathophyllum roadsi, sp. nov. Plate IX, Figs. 1 A–J.

Corallum elongate turbinate in its younger stages, with a tendency toward cylindrical form in its later stages. Basal angle usually varying between 20 and 30 degrees, but sometimes the corallum begins as a narrow, sub-cylindrical growth, enlarging more rapidly later, and then becoming subcylindrical again. Corallum sometimes changing its direction of growth in a more or less abrupt or geniculate manner. Epitheca with distinct longitudinal septal furrows, numbering 40, 41, 43, 44, 46, 46, 46, and 51 in the specimens here illustrated. Along the interior of the wall of the corallum there is a corresponding number of septa. These are alternately short and long, the shorter ones usually extending scarcely a millimeter from the wall. In the spaces between the shorter septa and the longer septa on each side dissepiments occur in greater or smaller numbers, dividing the spaces into more or less irregular vesicular compartments. This vesicular tissue usually does not extend more than a millimeter from the wall of the corallum. Even the longer septa usually do not reach the center of the corallum, but terminate as ridges on the upper surfaces of the tabulae, leaving the central parts of the latter more or less free. In some of the specimens the vesicular tissue unites the proximal free margin of the shorter septa to one of the adjacent longer septa in such a manner as to produce the appearance of the bifurcation of the longer septa in a distal direction.

Tabulae distinctly developed and complete, at least as far as the narrow vesicular zone, forming a conspicuous part of vertical sections of the corallum. Tabulae usually irregularly concave. When the calice is deep and funnel-like, the depth equalling or exceeding the width, the tabulae are correspondingly more concave and the vesicular spaces are elongated in a direction more or less parallel to the lateral walls of the calice. When the calice is more shallow, the tabulae are less strongly concave. No fossula has been detected.

Along the basal half of the exterior of the corallum the location of the cardinal and alar septa may be recognized distinctly by means of the septal furrows, as in typical *Zaphrentidæ*. The cardinal septum almost invariably lies along the convexly curved side of the basal part of the corallum. In that part of the corallum where the dissepiments are most abundant, usually within one millimeter of the wall, there appears to be a tendency toward the deposition of steroplasm.

From the Lilley member, forming the upper part of the West Union formation, in the Zink or Corporation quarry, in the eastern part of Hillsboro, Ohio. Named in honor of Miss Katie M. Roads, who for several years has been giving special attention to the fauna of the West Union formation in the vicinity of Hillsboro, Ohio.

Among Silurian forms, this species is sufficiently characterized by the narrow vesicular zone, the broad area occupied by the tabulæ, and the tendency of even the longer septa to terminate before reaching the center of the corallum. The frequency with which the proximal free margins of the longer septa show evidence of twisting or contortion, even when not reaching the center of the corallum, is another characteristic feature.

Acervularia (?) **paveyi,** sp. nov. Plate X, Fig. 10.

Corallites forming astraeiform colonies 12 centimeters or more in diameter. Corallites polygonal, usually more or less six-sided, the transverse diameters varying from 13 to 20 millimeters, with 15 millimeters as a fair average. The walls are thin and distinctly defined. The central part of the calice appears to be surrounded by a cylindrical wall varying from 6 to 10 millimeters in diameter, with 7 or 8 millimeters as a fair average. In general, the cylindrical walls are situated about half way between the center of the calice and the middle part of the surrounding polygonal walls. Between 45 and 50 septa extend from the polygonal walls toward the central part of the calice; of these practically all appear to pass into the space within the cylindrical wall although only a part reach the center of the calice. The septa are connected by dissepiments in the spaces both within and without the cylindrical wall. In the specimen here figured, dissepiments are clearly preserved within several of the circular spaces included by the cylindrical walls, but are much less satisfactorily indicated in the exterior part of the corallites, between the central cylindrical wall and the outer polygonal wall. In none of the corallites is there any evidence of horizontal tabulae within the central space enclosed within the cylindrical wall. In one of the corallites there apparently is evidence of horizontal tabulae resting on vesicular tissue, but in all of the other corallites there is no clear evidence of the presence of tabulae.

From *Strombodes*, the species here described is readily distinguished by the conspicuous development of septa extending vertically throughout the corallites and the absence of numerous infundibuliform tabulæ, resting on a conspicuous vesicular tissue. From true *Acervularia*, it differs in the absence of numerous tabulæ within the central area, enclosed by the cylindrical wall. The continuation of the septa from the exterior prismatic walls of the corallites to within the space enclosed by the central, cylindrical wall, indicates that the structure of the latter needs further elucidation, but this apparently can not be furnished by the silicified specimen at hand. From *Prismatophyllum*, it differs in the presence of the central cylindrical wall, and in the absence of numerous tabulæ within the central cylindrical part of the corallites.

From the Lilley member, forming the upper part of the West Union bed, in the Zink or Corporation quarry, in the eastern part of Hillsboro, Ohio. Named in honor of Henry Pavey, an eminent member of the bar of southwestern Ohio, who has also given considerable attention to the geology of the area surrounding Hillsboro.

Grabauphyllum johnstoni, gen. et sp. nov. Plate XI; Fig. 9.

Corallum composite, composed of large polygonal corallites from 20 to 30 millimeters in diameter. Calices comparatively shallow, varying from 10 to 12, occasionally 15 millimeters in depth. Walls separating the corallites with vertical ribs, evidently corresponding to the septal ridges of other corals. Outer part of the corallites coarsely vesiculate. Near the lower part of the calices this vesiculate tissue extends to a distance of 3 to 6 millimeters from the walls between the corallites toward the center of the calices, leaving a circular or elliptical space, in the center, having diameters varying from 15 to 20 millimeters, in which this coarsely vesicular tissue is absent. On their lower surfaces, the plates forming this vesicular tissue are smooth; on their upper surfaces they frequently show septal lines, more or less denticulate as in some species of *Cystiphyllum*. In the outer zone of the central circular area, for a distance of 3 to 4, sometimes 5 millimeters, radiating septa are numerous and well defined. The number of these septa varies from 45 to 55 in the different corallites. They are connected laterally by numerous short dissepiments. Tabulae are abundant in the central parts of the corallites. These are chiefly elliptical in outline in the specimen at hand, and vary from 6 to 10 millimeters in width, and from 10 to 15 millimeters in length. Viewed from the lower side they appear smooth, but it is probable that septal ridges extended over their upper surfaces for some distances toward the center; how far, can not be determined from the specimen at hand.

Found in the Niagaran dolomite near McCook, 5 miles west of Chicago, Illinois, by William Johnston. Genus named in honor of Prof. Amadeus Grabau, of Columbia University in recognition of his valuable contributions to our knowledge of corals.

The distinguishing features of *Graubauphyllum* are the composite corallum, the outer coarsely vesicular zone, the intermediate septate zone, and the central tabulate area.

It is not unlikely that *Acervularia clintonensis*, Nicholson, may prove to be congeneric. This species was described (Ohio Pal. II, 1875, p. 227, Pl. 23, Figs. 2, 2a) as coming from the Clinton group at Yellow Springs, Ohio. Fortunately, it is known that specimens of fossils from the Cedarville dolomite in early days occasionally were labelled erroneously as coming from the Clinton. For instance, the specimen of *Atrypa nodostriata*, Hall, from the Cedarville dolomite at Yellow Springs, Ohio, which is numbered 12103 in the collections at Columbia University, is there labelled as coming from the Clinton, and in former days I have seen similar erroneous labelling elsewhere. Under these circumstances it is not unlikely that *Acervularia clintonensis* may prove to be a Cedarville dolomite species. It is a much smaller species than *Graubauphyllum johnstoni*. The corallites average about 8 mm. in diameter. The outer zone is described as consisting of loose vesicular tissue in which the septa often are imperfectly developed. The intermediate zone consists of 40 to 46 slender septa, alternately large and small, united laterally by transverse dissepiments. Since no dissepiments are indicated in the central parts of the corallum, this part may correspond to the abundantly tabulate part of *Grabauphyllum*. The present location of the type of *Acervularia clintonensis* is unknown. It is assumed to have been destroyed in the fire which consumed the collections of Toronto University, years ago.

Calostylis parvula sp. nov. Plate VIII, Figs. 2A, B, C, D, E, F; Plate IX, Fig. 5.

Coralla simple, usually not exceeding 25 millimeters in length, but sometimes equalling 35 millimeters. Most of the specimens are curved strongly toward the base, producing a concave outline anteriorly, and convex outline posteriorly, when the corallum is viewed from the side. The wall of the corallum is thin, and is marked by distinct transverse striae and by more or less indistinct longitudinal lines, intermediate in position to the septa on the interior. Frequently the wall has weathered away, especially along the upper part of the corallum, exposing the septa.

Larger septa, about 30 to 35, extend toward the center, and there form a central mass (Fig. 2F), occupying about one-third of the width of the corallum. This central mass probably rises only a very short distance above the bottom of the calice. Within this central mass the proximal parts of the septa can be followed only a short distance since they form an irregularly vesicular growth, transversed by irregularly communicating pores. If any part of this central structure is to be interpreted as equivalent to tabulae, then these tabulae also are penetrated by pores.

Pores also traverse the septa, but vary greatly in number. Between the larger septa, which extend from the wall of the corallum as far as the central vesicular mass, there is an equal number of shorter septa, alternating with the larger ones. In some specimens, the shorter septa extend about half way from the wall of the corallum toward the central vesicular mass (Figs. 2 E, F); in others, they are shorter (Fig. 2 D). The larger and shorter septa are connected laterally by lamellose structures traversed by pores similar to those traversing the septa. These lamellose structures evidently correspond to the dissepiments of other corals.

In some specimens, the proximal edges of the shorter septa appear united to one side of one of the adjacent longer septa, usually the one nearer the cardinal side (Fig. 2F). Between the proximal edges of the shorter lamellae and the central vesicular mass, the number of dissepiments connecting the sides of the longer septa usually is comparatively small.

The pores traversing the central vesicular mass frequently equal a quarter of a millimeter in diameter. Pores of equally large dimensions have been noticed also traversing some of the septa, but the pores vary greatly in size, and some of them scarcely equal a twelfth of a millimeter in diameter.

Calostylis parvula has been found so far only in the upper part of the Laurel limestone in the Reinheimer quarry, at New Paris, Ohio. Here it is associated with *Pisocrinus gemmiformis*, *Stephanocrinus osgoodensis*, *Heliolites subtubulatus*, and *Atrypa reticularis*.

Since the Reinheimer quarry section is the most western one at which all of the Silurian strata occurring north of the Ordovician area in southwestern Ohio have been identified, and since this identification presents some difficulties, the following data may prove of some interest. The section is given in descending order:

Cedarville dolomite.

- Porous dolomite, massive .... 6 ft.
- Thinner bedded dolomite .... 1 ft. 3 in.
- More massive dolomite .... 2 ft.
- Porous massive dolomite, containing *Pentamerus oblongus* and *Phanerotrema occidens* .... 17 ft. 6 in.

Springfield dolomite.

- Rock resembling Dayton limestone, with *Pentamerus oblongus* common within 6 inches of the top .... 5 ft. 6 in.
- Rock resembling overlying layers, but very cherty .... 7 in.

Euphemia dolomite.

- Rock blotchy and porous, weathering darker. The blotches are 2 to 3 inches wide .... 2 ft.
- Transition rock, with white blotches, but not porous .... 8 in.

Laurel limestone.

- Rock resembling Dayton limestone, free of chert .... 8 ft. 4 in.
- Very cherty white limestone, with *Pisocrinus gemmiformis*, *Stephanocrinus osgoodensis*, and *Calostylis parvula* near top .... 16 ft. 9 in.
- Base of Reinheimer quarry. Underlying strata are exposed along ditch leading west from quarry.

Osgood formation.
Represented here by soft limestones, partly thinbedded and interbedded with thin clayey layers...4 ft.

Dayton limestone.
Whitish limestone, poorly exposed.................................7 ft. 6 in.

Brassfield limestone.
Only the top of this limestone is exposed, near the western end of the ditch.

The name Euphemia dolomite is proposed here for that horizon which Prosser, in his paper on The Classification of the Niagaran Formations of Western Ohio (Journal of Geology, 1916, pp. 334–365) called the Mottled Zone. The type locality for the Euphemia dolomite is located at the quarry described by Prosser as the Lewisburg Stone quarry. This quarry lies a mile northwest of Lewisburg. Euphemia is located a half mile north of Lewisburg and is a little nearer to the quarry, so that this name is available for the Mottled zone.

Calostylis has been identified hitherto only from one horizon and area in American strata, namely, in the Waco limestone member, in the lower third of the Alger formation of eastern Kentucky, where *Calostylis spongiosa*, Foerste, is found. This Alger formation corresponds stratigraphically with the so-called Niagara shales of the various reports written by Prof. Edward Orton for the former Ohio Geological Survey. There is no evidence, however, that any equivalent of the Waco member is to be found within 40 miles of the Ohio River, even in eastern Kentucky. Apparently it is only the overlying part of the Alger formation, consisting of the Estill clay, which extends into southern Ohio. It has been assumed at times that the Alger formation of eastern Kentucky and the adjacent parts of Ohio correspond stratigraphically with the Osgood formation of Indiana and the adjacent parts of Ohio, but this assumption never has been verified.

Calostylis denticulata, Kjerulf, the type of the genus, was described from Wisby, on the island of Gotland, Sweden, where it ranges for 18 miles along the shores of the Baltic. It occurs also at Malmo, an island near Christiania, Norway. Judging from the figures of this species presented by Lindstrom, the central vesicular mass is not well developed in young specimens, the septa apparently reaching the center. The tendency of the proximal edges of the shorter septa to unite with the lateral edge of one of the adjacent longer septa also is shown. Two species of *Calostylis* have been described also from the Silurian of Great Britain. Of these, *Calostylis lindströmi*, Nicholson and Etheridge, occurs near Girvan, in Scotland, and *Calostylis* (?) *andersoni*, Nicholson and Lydekker, in Shropshire, England.

Calostylis belongs to an increasing number of peculiar genera whose distribution suggests a former connection of American epicontinental seas during Silurian times with those of the Baltic area, and with Great Britain.

Calostylis belongs to the *Tetracoralla*. This relationship is more apparent in *Calostylis parvula*, here described, than in the type species, owing to the simpler construction of the septa. In *Calostylis denticulata* the septa of the older specimens tend to have a spongy structure. In *Calostylis parvula* the pinnate arrangement of the septa, diagnostic of the *Tetracoralla*, frequently is distinct. (The Relation of the Tetracoralla to the Hexacoralla, W. I. Robinson, 1917. Trans. Connecticut Acad., p. 173.)

Holocystites greenvillensis, sp. nov. Plate IX, Figs. 3A, B, C; Plate X, Fig. 8.

Three specimens, none of which preserves either the base or the summit; each retaining five horizontal rows of plates, each row consisting of eight plates. In each specimen the third horizontal row is located at mid-length, and forms the widest part of the theca. All of the plates, as far as retained, are hexagonal in outline, excepting possibly the uppermost series, which may have been pentagonal. At one side of the upper end of each of these specimens there is evidence of a protuberance which is regarded as locating the anal opening. Orienting the specimens in such a manner as to place this protuberance at the rear, it is noticed that the plates along the middle part of the right side of the theca (Figs. 3 A, B) are narrower, while those on the left side (Fig. 3 C) are wider than the remainder. The thickness of the plates is about half a millimeter. The surface of the plates is distinctly and irregularly granulose, the larger granules equalling about three-eights of a millimeter in width.

Among described species, *Holocystites greenvillensis* resembles most closely the type of *Holocystites abnormis*, Hall (Twentieth Annual Report, State Cabinet of Natural History, New York, 1868, Pl. 12, Fig. 7), however, the plates of the upper two rows are very much narrower, especially on the right side of the theca. Moreover, the general outline is more fusiform, and the outline near the anal protuberance tends to be more or less distinctly concave. In addition, the size is much smaller.

Compartively little is known regarding the genus *Holocystites* at present. If *Holocystites cylindricus*, Hall (Loc. cit. Pl. 12, Fig. 4) be regarded as the type of the genus, then only the six specimens figured by Hall under the terms *Holocystites cylindricus*, *H. abnormis*, and *H. alternatus* are congeneric among described forms referred to this genus. The material at hand is not sufficient to determine whether these six specimens are to be referred to only three species, as done by Hall, or whether they represent six distinct species.

The type of *Holocystites cylindricus* (Loc. cit., Pl. 12, Fig. 4) is labelled as obtained by Dr. Daniel, near Grafton, Wisconsin. It retains seven horizontal rows of plates, with eight plates in each row. At the base, there is a trace of an eighth row, and there may have been more. The oral and anal apertures are not preserved. The surface of the plates probably was ornamented by low, broad pustules. The more or less radiating, short, linear markings figured by Hall probably represent short horizontal pores immediately beneath the epithecal layer of the plates. The interior of the plates may have been traversed by numerous, coarse, vertical pores.

In the second specimen figured by Hall under the term *Holocystites cylindricus* (Fig. 5) the number of plates in the horizontal rows is uncertain. The oral aperture is six millimeters in diameter and was either circular or subpentagonal in form. At a distance of two millimeters from this aperture, on the side opposite to that figured by Hall, is the anal aperture, circular in form, and almost five millimeters in diameter. This anal aperture is located in the lower part of the uppermost row of those plates which are distinctly outlined, but the possibility of a row of very short plates immediately surrounding the oral aperture can not be disproved. This, and the following specimens, are from Racine, Wisconsin.

In the third specimen figured by Hall under *Holocystites cylindricus* (Loc. cit. Pl. 12, Fig. 6; Pl. 12a, Fig. 8) there are eight horizontal rows of distinct plates, with a possibility of a ninth, circum-oral row, consisting of very short plates. Neither the oral nor anal aperture is distinctly indicated. The surface of the plates is covered by low, broad pustules. The segments of the column are only indistinctly indicated.

(*To be continued.*)

SCIENTIFIC DRAWING IN BIOLOGY.

Stephen R. Williams.

Drawing is done with one of three purposes in mind:

1. By the student as a record of his laboratory work.
2. For teaching purposes on blackboard or chart.
3. For reproduction in the illustration of scientific articles.

AS A RECORD OF THE STUDENT'S WORK.

Scientifically not free hand drawing. Free hand drawing is intended to suggest to the observer, to cause his mind to supply what is lacking in the representation. Scientific drawing is a precise record of specific details.

All agree that the mechanical reproduction of details of structures studied is a highly valuable means of aiding the powers of observation, the memory and therefore preserving material with which to think. Reduced to the lowest terms a laboratory drawing is a careful proportional outline of two dimensions of the object studied. It is a graphic record of mental impressions received through the eye. All the important points should be fully labeled in a neat manner. It is then not a question of artistic ability but of ability to measure and to record the data. The alleged inability to draw of which the teacher is often told is merely a confession of unwillingness to be precise in measuring or recording or both.

Boundaries of structures are what is desired, shadows, colors or curvatures or other such phenomena are not needed. These secondary details, if put in, conceal the accuracy or inaccuracy of the student's measurements and therefore of his observations.

A drawing should be to scale and in my opinion, larger than natural size whenever the size of the object and of the drawing paper permit. The beginner is likely to draw what he sees through the microscope too small so that he is unable to put in the details adequately. He should be warned along this line at the first meeting. If the student draws a faint vertical line in the region which is to be the chief axis of his drawing, he may locate the important points of his specimen proportionately on this line. The width of the specimen to the scale of magnification selected may then be laid off at these points. When a sufficient number of points in the outer boundary of the drawing have been located thus by precise measuring, a faint line may be drawn through them, giving the outline of the specimen. The outline should then be compared with the dimensions of the original and any lack of proportion corrected. Then the outlines of appendages or of interior structures may be put in.

Any important line in an object may be projected to the other side of the outline of the object. Any two points in a drawing may be connected by a line and this line continued until it strikes some other important structure. This is a valuable way of checking the correctness of the proportions of the drawing and as the lines need not be actually drawn, the process of checking up can be a very rapid one.

It helps the beginner if he is asked to partially close both eyes as he looks at the specimen being studied, for the important lines and especially the boundary lines persist after the details of color or marking disappear.

All the constructional lines should now be carefully removed. The boundary lines of all structures must be definite continuous clear-cut lines. If the drawing is to be inked over, the pencil boundary should be left faint and does not need to be made so uniform as if the pencil is to be the final instrument.

The lines leading from structures to their names, known as lead lines should be very carefully made. They should be horizontal and parallel to the top and bottom edges of the drawing paper though exceptionally they may be vertical lines. They should be discontinuous or broken lines with the parts of about equal length. This enables one to distinguish lead lines from structural lines at a glance. As a transparent ruler for making lead lines a common 3 x 1 glass slide is very satisfactory.

The drawing should be labeled at the top with an identification mark, either a serial number or the name of the organism from which it was taken and should bear the student's name or initials. The date is also desirable unless this is stamped on by the critic at the close of each laboratory period.

SCIENTIFIC DRAWING FOR TEACHING PURPOSES.

Blackboard Drawing.

Blackboard drawing is most important. It is rapid and is simultaneous with or follows the explanation. This combination affects both sight and hearing and thereby makes mental efforts easier and more successful.

If you have complicated drawings to make, they should be done before the lecture. A thing which takes some time to make and which might be used more than once should be made as a chart which can be left hanging for reference. The simpler drawing constructed as the idea is being presented has great advantages as the student is able to transcribe it into his notes.

Do not shade a black board drawing since the natural order of things is reversed and the dark boundary is being reproduced as white. Make your outlines heavy for easy vision.

For differentiation of structures use such colored chalks as will easily show at the back of the room. It is artistically illegitimate, but you can give an impression of relief by using thicker lines where the shadows should be. This is useful, for example, in drawing cleavage.

A blackboard drawing is for the moment only and need possess little artistic merit. I have seen an elaborate blackboard drawing hamper teaching because it was made so well that no one had the heart to erase it.

Charts.

For making charts one should have a drawing table at least 52 inches wide whose four sides are squared so that a T square 4½ feet long can be used on it. If you use the Metric system of measurement enlargements can be made more easily.

The best chart material is canvas backed bristol board. This can be purchased in various sizes. I have gotten two sizes. Rectangles, 16 inches by 24 inches, convenient for small diagrams and continuous rolled material a yard wide from which charts of any desired length can be made. Heavy Manila paper will do but is likely to tear along the edges after years of putting up and taking down. The smaller charts are easily hung using thumb tacks while the larger ones rolled on wood need some sort of hooks.

For enlarging drawings there are several methods possible.

1. Take an important axis and erect ordinates. Assume a scale of magnification and find the length of the axis magnified and locate the ordinates also magnified. This method reversed will also serve in case one wishes to reduce the dimensions of an object.

2. Use the method of small squares, drawing them faintly but definitely over the drawing to be enlarged, or outline the original drawing on transparent (tracing) paper and draw the squares over this outline.

Then on your chart draw squares whose dimension is the number of times larger than the small squares that you wish the drawing magnified and redraw on the new area, placing the points and lines on the large squares in positions corresponding to those shown in the small squares.

3. A modification of this method is to use a gelatin sheet, draw a net of squares on it with a sharp point. This may be placed over the picture and the outline traced as in No. 2.

If such a transparent outline be elevated and a small aperture arranged above it so that the eye looks from what is essentially one point the outline can be traced as projected on the chart on the drawing table. Large drawings can not be traced in this way because of one's inability to reach lines beyond a certain distance from the eye.

4. Use a Pantograph or multiplying apparatus. A good one costs $6–$8, the cheaper ones are useless.

5. By using a reflectoscope if you have one, you may project your diagram or drawing on the drawing paper pinned to the screen and outline it perfectly.

The order of making a chart is as follows:

1. Lay out the chart.

2. Copy figure with faint lines of a fairly soft pencil (3 H). Clean with a sponge rubber which will not spoil the grain of the paper if water color is to be used.

3. Put in shades. This will be described in the next section of the paper. For large shades use absorbent cotton and the color, and it will give a fairly evenly shaded area.

SCIENTIFIC DRAWING FOR REPRODUCTION.

Photography.

This is very useful for whole objects, gross dissections and the like, being precise and a great time saver.

The common photograph gives no color differentiation as most colors have too near the same value. If you have a print from the negative made on Whatman paper you can color on this. Never try to color from memory, always have the object or a similar one. One is likely to expect too much of microphotography. Diatoms, Desmids, Bacteria, Golgi preparations, anything with clear outlines and single colors will give good results. High powers of things like cell division or tissues cells are not so satisfactory for the average photographer. The investigator himself sees a mental image into the photograph while outsiders are bothered by details and get an unsatisfactory image. A photographic plate does not distinguish between opaque and transparent structures. This can be expressed in water colors in a drawing. A photograph reproduces everything with equal value; a grain of dust, an air bubble, a crack or a fault in the section, all these are faithfully repeated. The microscopic field is not quite flat so that details near the edge will not show. One can photograph only one focus at a time, whereas your drawing is the result of the study of the structure at a number of levels. It gives the results of brain work on the facts before you. Everything in the drawing must be in the slide but everything in the slide does not have to be in the drawing. The drawing should be diagrammatic but not a diagram and is superior to the photograph both in clearness and in truth; in clearness because unnecessary things are omitted and in truth because the essentials are not obscured by unessentials as in the photograph.

Drawing.

A scientific drawing for reproduction should be made with reference to the method of reproduction. Of these there are several types.

It is obvious that those methods of reproduction will be cheaper which are entirely mechanical and can be carried through by the ordinary, intelligent workman. Those, on the other hand, which involve great technical skill in the worker are expensive.

Etching on metal, lithography and wood cutting since they involve skilled technicians are costly reproductions as compared to the half tone method and the method of zinc engraving which utilize photography directly.

For all methods involving photography it is best to have black ink drawings on a white ground. Good pencil drawings can be used, but the ink gives the greater contrast.

In making drawings it is often necessary to transfer to a clean sheet of Bristol board or water color paper. Paste tracing paper with unboiled flour paste (which will not spot paper) on your drawing. Trace over the outlines lightly, then loosen the tracing paper, reverse it on a window pane or on the glass top of a box containing an electric light, go over the outlines with heavy, soft pencil, and by careful pressure you have the outline transferred to the fresh Bristol board. The use of carbon paper for transferring is somewhat dangerous as other blotches may be transferred to the clean sheet beside the lines which you wish. For erasing use sponge rubber or Fabers kneaded rubber so that you will not injure the surface for water colors.

To lay a flat tint use a brown or red sable brush—common camel's hair is not good. The brush should jar to a perfect point, it should be large so as to hold much liquid. It must be elastic so as to spring to position instantly. You must not lay it down flat, always keep brushes in a glass, point up, to preserve the point.

The water color paper or Bristol board must be wet all over first to keep from spotting it with your wash or colors. A camel's hair brush can be used to take up excess of color when laying a tint. If you have too much color, add water and take up with nearly dry camel's hair brush. The evenest washes are those made with Prussian blue, carmine, olive green, indigo, neutral tint, vandyke brown, most of the yellows. Those which dry too quick and so are likely to make spotty work, cobalt, vermillion, ultramarine, most of the greens, most of the blacks, burnt sienna and sepia unless very thin. When one wants very rich reds or browns as in drawing of kidney, it is not obtainable with water color so finish the drawing and then put in the color wanted with pastel (crayon). This rubs badly unless fixed with shellac fixatif.

It is best to lay on several light washes instead of a heavy one to avoid spotting.

For the very finest lines or most delicate stippling in water color you can use a lithographic pen. For pen drawing waterproof ink is best; such as Higgins or Winsor and Newton. To get an even outline keep turning the papers so that you draw in the most favorable direction. Draw only short sections at a time so as to follow the boundary precisely.

Where you have heavy outlines to draw take a broken ebony scalpel handle, sharpen it like a pencil and let it soak a while in ink. Do not try to use it on your drawing first after the ink but on another piece of the same paper. This same thing holds with a ruling pen or a common pen. You can stipple or make small thick lined circles very nicely with this ebony point.

The shadow of an object is darker than the darkest shade on the object. It is tacitly accepted all over the world that the light is to come from the left side. In shading with ink to indicate rough surfaces use short, stubby lines, for smooth surfaces use long, fine lines, and for very light shades use fine, broken lines. These long lines should be drawn parallel to the surface you are shading. Never use over two layers of lines in a shadow and these never at right angles to each other. Shades can be stippled in and they will reproduce well. This requires great care in spacing to give the correct shadows and is hard on the eyes.

A drawing or photograph, can with advantage, be made larger than the size it is to be reproduced. If it is to be reduced to three-fourths of its size, that is known as one-fourth off. If to half the size, it is one-half off. Reduction can be carried only so far before the finer lines will merge into each other. The advantage of reduction is that if the drawing is made large, the lines can be made reasonably wide and uniform. Attempts at very fine lines usually result in lines of uneven width which reproduce poorly. All drawings which are to be on a single plate must be reduced in the same proportion.

This brings up the question of lettering. The letters used with a drawing or photograph that is to be reduced in reproduction must be chosen with the reduction in mind. Any shadows as of edges of paper can be removed from the zinc plate if they are far enough away from structures that must be kept so that the graving tool can cut them away. If none of the natural background of a structure in a photograph is wanted, the structure must be carefully cut out of its setting with a sharp instrument and pasted on a white surface. The lettering can then be placed on this. Cut-out letters of almost any size with gummed backs can be pasted on a plate unless this is to be rolled. Rolling up is likely to spring the letters off from their particular place and so ruin the labeling.

One will learn the method with which he is most successful by trial. Care in making drawings will always be repaid in the appearance of the printed paper. For the beginner ink-drawn text figures will probable be the most satisfactory. Photographs should be printed out by a method which will reproduce successfully. Those papers which have bluish tints should be avoided and also those which are finished with a gloss.

Miami University.

NEW AND NOTEWORTHY TINGIDÆ FROM THE UNITED STATES.

By Carl J. Drake.

In studying numerous American specimens of this heteropterous family I have recently recognized a few forms new to the fauna of the United States. These forms are listed and described herein so that their names will be available for future work in the family.

Acalypta cooleyi spec. nov.

Form elongate. Head long, strongly deflected, armed with two prominent, blunt, porrect spines (one on each side of the median line just above the antenna); a rather long, blunt, straight tubercle on each side of the head between the eye and antenna. Eyes large, prominent, the facets few and large. Antennae moderately long and stout; basal segment greatly swollen, twice as long as the second; second segment moderately swollen, short, obconical; third segment slenderest, a little longer than the other three conjoined; terminal segment moderately swollen, fusiform, a little longer than the first and second together. Pronotum coarsely punctate, tricarinate, the carinae considerably raised and each composed of a single series of areolae. Hood moderately large, reaching slightly over the base of the head, the anterior margin almost triangular. Lateral membraneous pronotal margins moderately broad, reflected, angularly dilated behind the middle, biseriate in greater part, but with two or three extra areolae at the anterior end and with only a single series back of the angle. Posterior process of pronotum triangular, distinctly reticulate. Thorax punctate beneath. Rostral sulcus deep; rostrum reaching slightly beyond the meso-metasternal suture. Elytra extending considerably beyond the apex of the abdomen, broadly rounded at the apex, overlapping on the inner margins, the outer margins straighter than in *A. lillianis* Bueno; costal area with one complete and partial series of areolae at the base and near the posterior end; subcostal area long, narrow, with three rows of areolae; discoidal area reaching a little beyond the middle of the elytra, with five rows of areolae at its widest part; sutural area broad, the inner margin, excepting a few cells at the base, with the areolae regularly arranged. Wings a little longer than the abdomen. Apex of abdomen concealed by the point upon which the insect is mounted. Length, 2.9 mm.; width, 1.2 mm.

Color. General color dark grayish-brown. Head and thorax blackish. Antennae blackish, except third segment grayish-brown. Legs dark grayish-brown, the tips of tarsi becoming darker. Posterior portion of bucculae and rostral sulcus margined with whitish.

One specimen, taken at Bozeman, Montana, June 13, 1913, by Prof. Cooley. Type in the author's collection.

KEY TO THE NEARCTIC SPECIES OF DOLICHOCYSTA.

Size small (length, 2 to 2.21 mm.); hood strongly depressed behind; membraneous pronotal margins narrow, biseriate, very strongly reflected just in front of the middle; elytra with a small tumid elevation, with the costal area uniseriate.......... *D. acuta* n. sp.

Size larger (length, 2.33 to 2.75 mm.); membraneous pronotal margins broader, with three to four series of areolae; elytra with a large tumid elevation, costal area biseriate in greater part.................................. *D. venusta* Champion

Dolichocysta venusta Champion.

Seven specimens, taken at Fort Collins, Colorado, July 23, 1898. The species is new to the fauna of United States. It was described from three specimens, two of which were from Guadalupe, Lower California, the other being without a definite locality. The Colorado specimens are slightly larger than the measurements given by Dr. Champion, but I can find no characters that will separate them from the original description and the excellent figure of the species. It is not very closely allied to *D. acuta* n. sp. described herein.

Dolichocysta acuta spec. nov.

Form ovate, the apices somewhat acute. Head with a blunt process on each side between eye and antenna, the bucculae very large. Eyes large, prominent, granulate. Antennae moderately slender, reaching a little beyond the middle of the pronotum; first segment more swollen and a little longer than the second; third segment slenderest, cylindrical, about twice as long as the fourth; fourth segment swollen towards the tip, clothed with a few rather long hairs. Pronotum not very coarsely punctate, tricarinate, the carinae arranged as follows: median carina most strongly raised, extending from the apex of triangular process to the hood and conjoined with the median raised nervure of the hood; the lateral carinae united with the outer margins of triangular process and extending almost to the outer posterior margin of the hood, sinuate. Membraneous pronotal margins not very broad, thin, biseriate, very strongly reflected just in front of the middle and at this place tangent or nearly tangent with the dorsal surface of the pronotum. Hood moderately large, rather flat, strongly depressed behind, the posterior margin rounded. Rostral sulcus not very deep, the rostrum reaching between the intermediate coxae. Elytra with costal area composed of a single series of large, irregular areolae; discoidal area quadriseriate and reaching slightly beyond the middle of the elytra. Wings not visible. Claspers in the male strongly curved. Length, 2 to 2.21 mm.; width, .9 to 1.1 mm. The outer margin of the elytra is emarginate in the macropterous form and rounded in the brachypterous individuals.

Color. General color dirty white, with a few nervures marked with brown. Antennae and legs dirty white, the tips of tarsi brownish. Pronotum brownish or dirty white. Head, thorax and abdomen reddish-brown or blackish-brown. The color markings vary slightly in different specimens.

Several specimens: Glascow, Montana, Nov. 6, 1915; Fort Collins, Colorado, June 26, July 29, and August 17, 1898; Boulder, Colorado, Sept. 1, 1898. Type in my collection; paratypes in the collections of Prof. Cooley, Dr. Osborn, Prof. Lovett, Dr. Gillette, and the California Academy of Science.

Corythucha padi spec. nov.

Hood large, highly elevated, rather coarsely reticulate, very abruptly constricted about the middle, narrow in front and nearly semiglobose behind. Antennae clothed with a few long hairs, the first segment almost three times the length of the second. Pronotum punctate; median carina moderately raised, composed of one complete series of areolae and with three or four extra cells at the highest part just in front of the middle; lateral margins broad, reniform, evenly and rather closely reticulate, the outer margins armed with short spines; posterior process triangular, not very distinctly reticulate. Rostral sulcus broad, the sides considerably raised, reticulate (usually four areolae on each side). Rostrum reaching between the intermediate coxae. Elytra long, broadly rounded at the apex, the outer margin concave, sinuate, and armed with short spines, except the distal third; costal area broad, with three complete and a partial series of areolae at the base, the cells at the base smaller than the distal ones. Length, 3.8 mm.; width, 2.4 mm.

Color. General color whitish, marked with brown. Antennae testaceous, the apical segment embrowned. Hood brownish, the sides in front whitish. Pronotum brown, the posterior process whitish; median carina whitish, with a brownish spot near the middle; lateral margins whitish, with a small brownish spot about the middle near the outer margin; areolae hyaline. Elytra whitish, with a broad band near the base, another near the apex, a spot on tumid elevation, and more or less of some of the nervures near inner margins brown. Legs testaceous, the tips of tarsi brownish. Body black beneath, the margins of bucculae, rostral sulcus, and posterior margin of prothorax embrowned. Claspers in male brown; middle portion of genital segment in the female embrowned.

Numerous specimens, taken on western choke cherry at Missoula, Montana, May 20, 1916, by Mr. J. R. Parker, and at Corvallis, Oregon, May 25, 1909, by Mr. J. C. Bridwell. Type in my collection; paratypes in the collections of Prof. R. A. Cooley, Prof. A. L. Lovett, Dr. Herbert Osborn, and the California Academy of Science. In some specimens the apical band of the elytra becomes more or less evanescent towards the inner margin. The Oregon specimens are a little lighter in color than the type from Montana, probably being teneral forms. The species is very distinct from the two forms, *C. pruni* and *C. associata*, found on wild cherry in the eastern portion of United States and readily separated from them by the shape and size of the hood which is larger than the former species and smaller than the latter.

NEWS AND NOTES.

The Staff for the 1917 Session of the Lake Laboratory at Cedar Point has been announced as follows: Prof. F. H. Krecker, Ohio State University, Acting Director; Prof. S. R. Williams, Miami University; Prof. Paul S. Welch, Kansas State Agricultural College; Prof. M. E. Stickney, Denison University; Prof. Chas. H. Otis, Western Reserve University. Prof. Herbert Osborn will also be at the Laboratory at frequent intervals.

The session will open on Monday, June 18, and will continue until Friday, July 27. As usual students desiring to do independent work will have the opportunity of remaining longer. The courses to be given this year are Aquatic Zoology, Prof. Krecker; Invertebrate Zoology, Prof. Williams; Entomology, Prof. Welch; Plant Ecology, Prof. Otis; Systematic Botany, Prof. Stickney. Prof. Osborn will devote his time to research and will also be able to direct the work of students carrying on investigation in entomology. Anyone who wishes to obtain further information should write to Prof. F. H. Krecker, Department of Zoology, Ohio State University.

Date of Publication, April 16, 1917.

THE

OHIO JOURNAL OF SCIENCE

PUBLISHED BY THE

OHIO STATE UNIVERSITY SCIENTIFIC SOCIETY

VOLUME XVII MAY, 1917 No. 7

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THE ALGÆ OF MICHIGAN.*

EDGAR NELSON TRANSEAU.

The following notes on the algæ of Michigan are based primarily upon collections made during the summer of 1915. Under the direction of the Michigan Biological Survey, the writer visited the ponds, lakes and streams on the west side of the lower peninsula during the last week of May and the first week of June. A second trip was made during the first two weeks of August to Mackinaw and points on the northern peninsula. The writer also examined some collections made by Mr. T. L. Hankinson in the course of his work on the fishes of Michigan. Several collections from Isle Royale were furnished by Dr. Wm. S. Cooper, and collections from the vicinity of Douglas Lake were sent me by Dr. Alexander Ruthven, Director of the Survey.

The list includes only the species which could be identified to the specific name. Many species belonging to the genera Spirogyra, Zygnema, Nostoc and Oedogonium were present in a vegetative condition.

As no work on the algæ of Michigan has been reported in recent years, the records for species are for the most part new to the state.

*Contribution from the Botanical Laboratory, Ohio State University, No. 96.

In addition to the records, there are some indications regarding the distribution of the freshwater algæ that are of interest. Taken in connection with the extensive collections made by the writer in central Illinois, it is very evident that as one goes northward the variety and abundance of the green algæ decrease notably. The genera Spirogyra and Oedogonium are represented by but few species north of Berrien County. In Illinois the same number of collections made at corresponding dates would have contained many more species. The genus Microspora is poorly represented in Illinois, but increases in abundance and variety in the upper part of the lower peninsula and in the northern peninsula. The Blue Green Algæ also form an increasingly conspicuous part of the algæ of the northern parts of the state.

The occurrence of Zygnema cyanospermum Cleve at Manistique and Mackinaw is of interest, as this species has been previously reported only from Greenland.

The study of the distribution of algæ, in both Michigan and Illinois, shows that the bulk of the algæ grows in pools, ditches, ponds and swamps. This has an important bearing on the matter of fish culture in Michigan lakes. The lakes with large shallow-water areas and swampy margins are the lakes in which algæ are most important. Those without such margins, and with sand beaches are comparatively free of algæ. As the algæ furnish the primary food of all fishes, it is readily seen that only those lakes with an abundant algal flora can ever support a large number of fish. The secondary food supply of fishes is made up of crustacea; Chironomous, mosquito and other insect larvæ. These too depend absolutely on the algæ. It is evident, therefore, that a quantitative survey of the algæ of a lake is a sure indication as to whether a lake is worth stocking with fish or not.

Lakes with rapidly sloping sand beaches are the best for summer resorts because of their comparative freedom from mosquitoes. They are not adapted to the growing of fish, however, and it is useless for the state to stock this type of lake with fish fry, as the food supply is adequate for only a limited number of fish.

MYXOPHYCÆ.

CHROOCOCCACEÆ.

Chroococcus minutus (Kütz) Näg. Previously recorded by Collins from Maine. On soil in bog near Carp Lake, Emmet Co., Aug. 9, 1915.

Chroococcus turgidis (Kütz) Näg. Carp Lake, Emmet Co., Aug. 9, 1915; Twin Lake, Muskegon Co., June 2, 1915.

Aphanocapsa grevillei (Hass.) Rabenh. Indian River, Manistique, Aug. 11, 1915.

Gloeocapsa atrata (Turp.) Kütz. Trout Lake, Chippewa Co., Aug. 10, 1915. Previously reported from Alaska.

Gomphosphaeria aponina Kütz. Railroad ditch, Manistique, Aug. 11, 1915; bog pool, Mackinaw, Aug. 9, 1915.

Coelosphaerium kuetzingianum Näg. Seney, Aug. 12, 1915.

Aphanothece stagnina (Spreng.) A. Br. Walnut Lake, Oakland Co., May, 1906 (Hankinson).

Aphanothece saxicola Nägeli. Pond, Manistique, Aug. 11, 1915.

Merismopedium glaucum (Ehrenb.) Näg. Trout Lake, Chippewa Co., Aug. 10, 1915; bog near Carp Lake, Emmett Co., Aug. 9, 1915.

Merismopedium elegans A. Br. Carp Lake, Emmet Co., Aug. 9, 1915; Twin Lake, Muskegon Co., June 2, 1915.

Merismopedium tenuissimum Lemmerman. Carp Lake, Aug. 9, 1915.

OSCILLATORIACEÆ.

Oscillatoria chalybea Mertens. Seney, Aug. 12, 1915.

Oscillatoria princeps Vaucher. Whitefish Point, Aug., 1913, (Hankinson); Trout Lake, Aug. 10, 1915.

Lyngbya estuarii (Mert.) Liebman. Breedsville, Van Buren Co., June 4, 1915; Bangor Lake, Van Buren Co., June 4, 1915; Caloma Junction, Berrien Co., pasture pools, June 4, 1915.

Microcoleus lacustris (Rabenh.) Farlow. Seney, Aug. 15, 1915; Manistique, Aug. 11, 1915.

NOSTOCACEÆ.

Anabaena flos-aquæ (Lyng.) Bréb. Walnut Lake, Oakland Co., June 24, 1916, (Hankinson).

Anabaena variabilis Kütz. Railroad ditch, New Buffalo, May 31, 1915.

Anabaena circinalis Rabenh. Trout Lake, Aug. 10, 1915.

SCYTONEMACEÆ.

Scytonema ocellatum (Dillwyn) Thuret. Walnut Lake, May 19 1906. (Hankinson).

Tolypothrix tenuis Kütz. Twin Lake, June 2, 1915; Lake Rowland, Houghton Co., 1905. (Hankinson); Caloma Junction, June 4, 1915.

Tolypothrix lanata (Desvaux) Wartmann. Bog near Carp Lake, Emmet Co., Aug. 9, 1915.

Tolypothrix limbata Thuret. Pasture pools, Caloma Junction, June 4, 1915; railroad ditch, Mackinaw, Aug. 9, 1915.

STIGONEMACEÆ.

Stigonema informe Kütz. Railroad pools, Mackinaw, Aug. 9, 1915.

RIVULARIACEÆ.

Rivularia compacta Collins. Whitefish Point, Aug., 1913, (Hankinson). Previously reported from Massachusetts and Connecticut.

Rivularia natans (Hedwig) Welwitsch. Carp Lake, Aug. 9, 1915; Trout Lake, Aug. 10, 1915.

Rivularia pisum Ag. Trout Lake, Aug. 10, 1915; Breedsville, June 4, 1915; Carp Lake, Aug. 9, 1915; Walnut Lake, 1906. (Hankinson).

CHLOROPHYCEÆ HETEROKONTÆ.

TRIBONEMACEÆ.

Chlorobotrys regularis (West) Bohlin. Railroad pool, Mackinaw, Aug. 9, 1915.

Ophiocytium cochleare (Eichwald) A. Br. Railroad ditch, Breedsville, June 2, 1915; Carp Lake, Aug. 9, 1915; stagnant pool, Seney, Aug. 12, 1915.

Conferva minor Klebs. Railroad ditch, Breedsville, June 2, 1915.

Conferva bombycina Ag. Railroad ditch, New Buffalo, May 31, 1915; Seney, Aug. 12, 1915; Spring, Manistique, Aug. 11, 1915; Saugetuck, June 1, 1915; Isle Royale, 1911, (Cooper).

Conferva bombycina forma **tenuis** (Hazen) Collins. Railroad ditch, Breedsville, June 2, 1915.

Conferva utriculosa Kütz. Railroad pool, New Buffalo, May 31, 1915; Seney, Aug. 12, 1915; Spring, Manistique, Aug. 11, 1915; Saugetuck, June 1, 1915; Orchard Lake, Aug. 15, 1915.

AKONTÆ.

DESMIDIACEÆ.

Netrium digitus (Ehrenb.) Itzigs. & Rothe. Bog near Caffey, Mackinaw Co., Aug. 13, 1915.

Penium margaritaceum (Ehrenb.) Bréb. Small stream, New Buffalo, May 31, 1915.

Penium spirostriolatum Barker. Bog north of Twin Lake, June 2, 1915.

Closterium angustatum Kütz. Bog near Caffey, Aug. 13, 1915.

Closterium striolatum Ehrenb. Bog near Caffey, Aug. 13, 1915; railroad ditch, New Buffalo, May 31, 1915.

Closterium cuspidatum Bailey. Twin Lake, June 2, 1915. Probably should be in another genus. The terminal spines are 15-20μ in length, chromatophore with 6 prominent ridges and several pyrenoids in each half. Outer margin about 180° of arc; greatest diameter about 85μ, length between apices 165μ.

Closterium pseudodianæ Roy. Pond near Orchard Lake, Aug. 15, 1915.

Closterium intermedium Ralfs. Bog east of Caffey, Aug. 13, 1915.

Closterium rostratum Ehrenb. Pond near Orchard Lake, Aug. 15, 1915.

Closterium ehrenbergii Menegh. Bog near Saugetuck, Allegan Co., June 1, 1915; Caffey, Aug. 13, 1915; pond near Orchard Lake, Aug. 15, 1915.

Closterium kuetzingii Bréb. Bog near Caffey, Aug. 13, 1915; Seney, Aug. 12, 1915.

Closterium lineatum Ehrenb. Bog near Saugetuck, June 1, 1915.

Closterium leibleini Kütz. Bangor Lake, June 4, 1915.

Closterium acerosum (Schrank) Ehrenb. Breedsville, June 4, 1915.

Closterium didymotocum Corda. Twin Lake, June 2, 1915.

Pleurotaenium nodosum (Bail.) Lund. Twin Lake, June 2, 1915.

Pleurotaenium coronatum (Bréb.) Rabenh. Twin Lake, June 2, 1915.

Pleurotaenium truncatum (Bréb.) Nag. Twin Lake, June 2, 1915.

Pleurotaenium ehrenbergii (Bréb.) DeBary. Bog pool, Seney, Aug. 12, 1915; Twin Lake, June 2, 1915.

Pleurotaenium ehrenbergii var. **elongatum** West. Pond near Orchard Lake, Aug. 15, 1915.

Pleurotaenium trabecula. Bog north of Blaney, Schoolcraft Co., Aug. 12, 1915.

Pleurotaenium trabecula (Ehrenb.) Näg. var. **rectum** (Delp.) W. & G. S. West. Twin Lake, June 2, 1915.

Euastrum gemmatum Bréb. Twin Lake, June 2, 1915.

Euastrum ansatum Ralfs. Twin Lake, June 2, 1915.

Euastrum bidentatum Näg. Seney, Aug. 12, 1915.

Euastrum denticulatum (Kirchn.) Gay. Twin Lake, June 2, 1915; bog near Carp Lake, Aug. 9, 1915.

Euastrum pinnatum Ralfs. Bog east of Caffey, Aug. 13, 1915.

Euastrum didelta (Turp.) Ralfs. Bog near Carp Lake, Emmet Co., Aug. 9, 1915.

Euastrum crassum (Bréb.) Kütz. Bog near Carp Lake, Aug. 9, 1915; bog near Twin Lake, June 2, 1915.

Euastrum verrucosum Ehrenb. Railroad ditch, New Buffalo, May 31, 1915.

Euastrum verrucosum var. **planctonicum** W. & G. S. West. Railroad ditch, New Buffalo, May 31, 1915.

Micrasterias oscitans Ralfs. Twin Lake, June 2, 1915; Trout Lake, Aug. 10, 1915.

Micrasterias oscitans var. **mucronata** (Dixon) Wille. Bog near Carp Lake, Aug. 9, 1915.

Micrasterias radiata Hass. Twin Lake, Muskegon Co., June 2, 1915.

Micrasterias rotata (Grev.) Ralfs. Bog near Caffey, Mackinaw Co., Aug. 13, 1915; bog pond near Mackinaw City, Cheboygan Co., Aug. 9, 1915; bog north of Blaney, Aug. 12, 1915.

Micrasterias crux-melitensis (Ehrenb.) Hass. Bog pond near Mackinaw City, Aug. 9, 1915.

Micrasterias pinnatifida (Kütz) Ralfs. Twin Lake, June 2, 1915.

Micrasterias papillifera Bréb. Twin Lake, June 2, 1915.

Micrasterias papillifera var. **glabra** Nordst. Twin Lake, June 2, 1915.

Micrasterias apiculata (Ehrenb.) Menegh. Twin Lake, June 2, 1915.

Micrasterias americana (Ehrenb.) Ralfs. Railroad ditch, New Buffalo, May 31, 1915.

Micrasterias denticulata Bréb. var. **angulosa** (Hantzsch) W. & G. S. West. Twin Lake, June 2, 1915.

Micrasterias torreyi (Bailey) Ralfs. Twin Lake, June 2, 1915.

Micrasterias truncata (Corda) Bréb. Bog near Carp Lake, Aug. 9, 1915; railroad pool near Seney, Aug. 15, 1915; bog near Caffey, Mackinaw Co., Aug. 13, 1915.

Cosmarium subcostatum Nordst. Carp Lake, Aug. 9, 1915.

Cosmarium taxichondrum Lund. Twin Lake, June 2, 1915.

Cosmarium cyclicum Lund. Carp Lake, Aug. 9, 1915.

Cosmarium botrytis Menegh. Carp Lake, Aug. 9, 1915; bog pond near Mackinaw City, Aug. 9, 1915.

Cosmarium portianum Arch. Twin Lake, June 2, 1915.

Cosmarium pachydermum Lund. Bog north of Balney, Aug. 12, 1915.

Xanthidium antilopaeum (Bréb.) Kütz. Twin Lake, June 2, 1915.

Staurastrum meriani Reinsch. Small stream, New Buffalo, Berrien Co., May 31, 1915.

Staurastrum punctulatum Bréb. Small stream, New Buffalo, May 31, 1915.

Staurastrum arctiscon (Ehrenb.) Lund. Twin Lake, June 2, 1915.

Arthrodesmus triangularis Lagerh. forma **triquetra** W. & G. S. West. Twin Lake, June 2, 1915.

Cosmocladium constrictum (Arch.) Josh. Pool near Seney, Schoolcraft Co., Aug. 12, 1915.

Cosmocladium pulchellum (Arch.) Josh. Twin Lake, June 2, 1915.

Sphaerozosma excavatum Ralfs. Twin Lake, June 2, 1915.

Spondylosium papillatum W. & G. S. West. Trout Lake, Chippewa Co., Aug. 10, 1915.

Spondylosium pulchellum Archer. Twin Lake, June 2, 1915; bog near Caffey, Aug. 13, 1915.

Hyalotheca dissiliens (Sm.) Breb. Railroad pool, Manistique, Aug. 11, 1915; Twin Lake, June 2, 1915; bog near Saugetuck, June 1, 1915; bog north of Blaney, Aug. 12, 1915.

Desmidium baileyi (Ralfs) De Bary. Railroad pool, Seney, Aug. 12, 1915.

Desmidium swartzii Ag. Railroad pool, Seney, Aug. 12, 1915; Manistique, Aug. 11, 1915; Twin Lake, June 2, 1915; bog north of Blaney, Aug. 12, 1915.

Desmidium cylindricum Grev. Twin Lake, June 2, 1915.

Gymnozyga moniliformis Ehrenb. Bog east of Caffey, Aug. 13, 1915; Twin Lake, June 2, 1915.

ZYGNEMACEÆ.

Spirogyra affinis (Hass.) Kütz. Small stream, Saugetuck, June 1, 1915. Very typical material. Previously reported from Jamaica and Alaska.

Spirogyra varians (Hass.) Kütz. Slow stream near Douglas Lake, July 21, 1914; railroad pool, New Buffalo, May 31, 1915; estuary, Holland, June 3, 1915; bog north of Blaney, Aug. 12, 1915.

Spirogyra dubia Kütz. Bog stream, Saugetuck, June 1, 1915; stagnant pool, Orchard Lake, Aug. 16, 1915.

Spirogyra jugalis (Dillw.) Kütz. Trout Lake, Aug. 10, 1915.

Spirogyra nitida (Dillw.) Link. New Baltimore, Aug. 8, 1915.

Spirogyra ellipsospora Transeau. New Baltimore, Aug. 8, 1906 (Hankinson); Saugetuck, June 1, 1915.

Spirogyra fluviatilis Hilse. New Baltimore, Aug. 8, 1906 (Hankinson); White Fish Point, Aug. 17, 1914 (Hankinson). Vegetative material, probably of this species, was found in all parts of the state.

Spirogyra reflexa Transeau. Railroad pools, New Buffalo, May 31, 1915. Previously recorded only from prairie ponds in south central Illinois. This material is of particular interest as it contains aplanospores as well as zygospores.

Spirogyra protecta Wood. Stream pool, Breedsville, Van Buren Co., June 4, 1915. This material contained a few aplanospores, together with the zygospores.

Spirogyra tenuissima (Hass.) Kütz. Railroad ditch, New Buffalo, May 31, 1915.

Spirogyra majuscula Kütz. Lake, Bangor, June 4, 1915.

Spirogyra maxima (Hass.) Wittr. Van Etten Creek, Oscoda, Iosco Co., Aug. 12, 1916, (Hankinson).

Mougeotia calcarea (Cleve) Wittr. Carp Lake, Emmet Co., Aug. 9, 1915. This material contains zygospores abundantly. The diameter of the vegetative cells varies from 8 to 10 microns. Previously recorded from Illinois, but there found only with aplanospores.

Mougeotia bicalyptrata Wittrock. Carp Lake, Emmet Co., Aug. 9, 1915. Occurring with the last, with vegetative cells 10 to 12 microns in diameter. The zygospores resemble in every particular the type material for this species. It is evidently closely related to M. calcarea, and perhaps should be recognized as a variety rather than as a distinct species.

Mougeotia parvula Hassall. Small stream, New Buffalo, May 31, 1915.

Mougeotia gracillima (Hass.) Wittrock. Bog north-east of Twin Lake, June 2, 1915.

Mougeotia elegantula Wittrock. Twin Lake, June 2, 1915.

Mougeotia viridis (Kütz.) Wittr. Bog stream, Saugetuck, June 1, 1915. This material contains scattered aplanospores as well as zygospores, and adds another species to the list in which both spore forms have been found.

Mougeotia robusta (DeBary) Wittr. var. **biornata** Wittrock. Railroad pool, New Buffalo, May 31, 1915.

Mougeotia (?) genuflexa (Dillw.) Ag. Common in many of the collections. The dimensions and genuflexing habit are characteristic for this species, but I have not found any spores.

Mougeotia quadrangulata Hass. Railroad pool, Mackinaw City, Aug. 9, 1915; pond, Saugetuck, June 1, 1915.

Debarya decussata Transeau. Trout Lake, Chippewa Co., Aug. 10, 1915. Abundant in all the collections from this lake. The material contained only zygospores and vegetative filaments.

Zygnema cyanospermum Cleve. Railroad ditch, Manistique, Aug. 11, 1915; railroad pool, Mackinaw City, Aug. 9, 1915. Previously reported only from Greenland.

ISOKONTÆ.

VOLVOCACEÆ.

Gonium pectorale Müller. New Buffalo, May 31, 1915.

Pandorina morum (Müll.) Bory. New Buffalo, May 31, 1915; Breedsville, June 4, 1915.

Eudorina elegans Ehrenb. Seney, Aug. 12, 1915; small stream, New Buffalo, May 31, 1915.

PALMELLACEÆ.

Palmodactylon varium Näg. Seney, Aug. 12, 1915. Previously reported only from Maine.

Tetraspora lubrica (Roth) Ag. Breedsville, June 4, 1915; Saugetuck, June 1, 1915. All of the specimens seen were less than four inches in length. In Illinois specimens a foot in length are common and lengths of four feet are attained.

Tetraspora lubrica var. **lacunosa** Chauvin. Pool in swamp near Douglas Lake, July 10, 1914. (Ruthven).

Tetraspora cylindrica (Wahl.) Ag. Rocky shores of Isle Royale, July, 1911. (Cooper).

Tetraspora limnetica W. & G. S. West. Bog stream near Blaney, Aug. 12, 1915. No pseudocilla present. Cell diameter, 4μ.

Apiocystis Brauniana Nägeli. Lake, Bangor, June 4, 1915; Trout Lake, Aug. 10, 1915.

Gloeocystis gigas (Kütz) Lagerh. Ponds, New Buffalo, May 31, 1915; railroad ditches, Breedsville, June 4, 1915; bog near Caffey, Aug. 13, 1915.

DICTYOSPHAERIACEÆ.

Dictyosphaerium pulchellum Wood. Trout Lake, Chippewa Co., Aug. 10, 1915.

Ineffigiata neglecta W. & G. S. West. Railroad pools, Manistique, Aug. 11, 1915; Twin Lake, Muskegon Co., June 12, 1915; bog north of Twin Lake, June 2, 1915.

PROTOCOCCACEÆ.

Coelastrum microporum Nägeli. Carp Lake, Emmet Co., Aug. 9, 1915; railroad pool, Seney, Aug. 12, 1915.

Coelastrum sphericum Nägeli. Twin Lake, June 2, 1915; Seney, Aug. 12, 1915; Carp Lake, Aug. 9, 1915.

Coelastrum cambricum Archer. Twin Lake, June 2, 1915; Carp Lake, Aug. 9, 1915; bog near Carp Lake, Aug. 9, 1915.

Coelastrum scabrum Reinsch. Railroad pool, Mackinaw City, Aug. 9, 1915; bog near Carp Lake, Aug. 9, 1915. Not previously reported from America.

Coelastrum proboscidium Bohlin. Railroad ditch, New Buffalo, May 31, 1915.

Sorastrum spinulosum Nägeli. Seney, Aug. 12, 1915.

Crucigenia rectangularis (A. Br.) Gay. Railroad ditches, New Buffalo, May 31, 1915. Previously reported from Greenland, Massachusetts and Illinois.

Scenedesmus bijugatus (Turp.) Kütz. Carp Lake, Emmet Co., Aug. 9, 1915; Manistique, Aug. 11, 1915; New Buffalo, May 31, 1915.

Scenedesmus denticulatus Lagerheim. Carp Lake, Aug. 9, 1915.

Scenedesmus obliquus (Turp.) Kütz. New Buffalo, May 31, 1915; Carp Lake, Aug. 9, 1915.

Scenedesmus quadricauda (Turp.) Bréb. Manistique, Aug. 11, 1915; Twin Lake, June 2, 1915; Carp Lake, Mackinaw, Aug. 9, 1915.

Dimorphococcus lunatus A. Br. Twin Lake, June 2, 1915. Not previously reported from America.

Ankistrodesmus falcatus (Corda) Ralfs. New Buffalo, May 31, 1915.

Ankistrodesmus falcatus var. **spiralis** West. New Buffalo, May 31, 1915.

Quadrigula closterioides (Bohlin) Printz. New Buffalo, May 31, 1915; Twin Lake, June 2, 1915. Not previously reported from America.

Kirchneriella lunaris var. **dianæ** Bohlin. Twin Lake, June 1, 1915.

Oocystis elliptica West. Twin Lake, June 1, 1915; railroad pool, Manistique, Aug. 11, 1915. Not previously reported from America.

Oocystis crassa Wittrock. New Buffalo, May 31, 1915.

Nephrocytium agardhianum Nägeli. Railroad ditch, Manistique, Aug. 11, 1915.

Nephrocytium obesum West. Railroad ditch, Manistique, Aug. 11, 1915. Not previously reported from America.

Zoochlorella conductrix Brandt. Twin Lake, June 2, 1915, in Hydra.

HYDRODICTYACEÆ.

Pediastrum tricornutum Borge. Twin Lake, Muskegon Co., June 2, 1915. Previously reported from Greenland.

Pediastrum duplex Meyen. Trout Lake, Aug. 10, 1915.

Pediastrum duplex var. **clathratum** A. Braun. Trout Lake, Aug. 10, 1915.

Pediastrum vagum Kütz. Twin Lake, June 2, 1915.

Pediastrum tetras (Ehrenb.) Ralfs. Twin Lake, June 2, 1915.

Pediastrum boryanum (Turp.) Menegh. Carp Lake, Emmet Co., Aug. 9, 1915; railroad ditch, Manistique, Aug. 11, 1915.

SIPHONEÆ.

Vaucheria dillwynii (Web. & Mohr) Ag. Cedar Swamp, on soil, near Douglas Lake, Aug. 17, 1914. (Ruthven.) Reported previously from Maine and New Jersey.

Vaucheria sessilis (Vauch.) De Candolle. Pool in swamp, Douglas Lake, Aug. 17, 1914. (Ruthven).

Vaucheria geminata (Vauch.) DeCandolle. Pool in swamp, Douglas Lake, Aug. 17, 1914. (Ruthven).

Vaucheria geminata var. **racemosa** (Vauch.) Walz. Pool in pasture, Douglas Lake, July 13, 1914; Breedsville, June 4, 1915.

Vaucheria geminata var. **depressa** nov. var. Similar to the type, except that the fertile branch is shorter, and the oogonial branches are longer and depressed, bringing the oogonia down to the level of the main filament or below.

Filamentis antheridiis et oogoniis ut in typo; ramo sporifero curto; oogoniis 2-4, pedicellatis; pedicellis oogonii longis, recurvatis et depressis.

New Buffalo, May 31, 1915; previously collected at several stations in central Illinois. In none of these collections have forms been found intergrading with the species.

Vaucheria orthocarpa Reinsch. New Buffalo, May 31, 1915. Previously reported from California.

Dichotomosiphon tuberosus (A. Br.) Ernst. Walnut Lake, 1906, (Hankinson).

CLADOPHORACEÆ.

Chaetomorpha chelonium Collins. Walnut Lake, 1906 (Hankinson). Record based on the type material.

Rhizoclonium hieroglyphicum (Ag.) Kütz. White Fish Point, 1913 (Hankinson; Holland, June 3, 1915.

Rhizoclonium crassipellitum W. & G. S. West. Estuary, Holland, June 3, 1915. Although not previously reported from America, the specimens seem best classified under this name. The filaments are unbranched, 40-48μ in diameter, with cell walls 8-12μ in thickness.

Cladophora callicoma Kütz. Little Traverse Bay, Aug. 21, 1916. (Hankinson).

Cladophora glomerata (L.) Kütz. Manistee River, Manistee, Aug. 29, 1916. (Hankinson); Swift stream, Caloma Junction, June 4, 1915.

Cladophora fracta (Dillw.) Kütz. Estuary, New Buffalo, May 31, 1915; lake, Holland, June 1, 1915.

Pithophora varia Wille. Alma, Gratiot Co., Oct., 1905.

ULOTRICHACEÆ.

Ulothrix zonata (Web. & Mohr) Kütz. Isle Royale, July 30, 1910 (Cooper); White Fish Point, Aug. 1913 (Hankinson). On rocky shores along all the Great Lakes.

Ulothrix tenuissima Kütz. Trout Lake, Aug. 10, 1915. Previously reported from New York and Alaska.

Geminella interrupta Turp. Railroad ditches, New Buffalo, May 31, 1915. New to America.

Radiofilum irregulare (Wille) Brunthaler. Carp Lake, Emmet Co., Aug. 9, 1915. Not previously reported from America.

Radiofilum flavescens G. S. West. Twin Lake, June 2, 1915. Not previously reported from America.

HERPOSTEIRACEÆ.

Herposteiron confervicola Nägeli. New Buffalo, May 31, 1915; lake, Bangor, June 4, 1915; ditch, Mackinaw City, Aug. 9, 1915; bog pool, Manistique, Aug. 11, 1915.

CHAETOPHORACEÆ.

Chaetophora elegans (Roth) Ag. New Buffalo, May 31, 1915; Saugetuck, June 1, 1915; railroad ditch, Breedsville, June 4, 1915; Trout Lake, Chippewa Co., Aug. 10, 1915; bog pools, Manistique, Aug. 11, 1915.

Chaetophora incrassata Hazen. Indian River, Manistique, Aug. 11, 1915; Vermillion Lake, Chippewa Co., Aug. 1, 1913 (Hankinson); Trout Lake, Aug. 10, 1915; slow stream, Douglas Lake, July 3, 1914 (Ruthven); Carp Lake, Aug. 9, 1915; New Buffalo, May 31, 1915; bog stream, Saugetuck, June 1, 1915. All the specimens are small when compared with the specimens from Illinois.

Stigeoclonium amoenum Kütz. Ditch near Douglas Lake, July 3, 1914 (Ruthven); Saugetuck, June 1, 1915.

Stigeoclonium lubricum (Dillw.) Kütz. Lake Rowland, Houghton Co., 1915 (Hankinson).

Stigeoclonium aestivale (Hazen) Collins. Lake Rowland, Houghton Co., 1905 (Hankinson), (fide Collins).

Stigeoclonium tenue (Ag.) Kütz. Carp Lake, Emmet Co., Aug. 9, 1915.

Stigeoclonium glomeratum (Hazen) Collins. Bog stream, Saugetuck, June 1, 1915; bog north of Blaney, Aug. 12, 1915.

Draparnaldia plumosa (Vauch) Ag. Walnut Lake, Oakland Co., May 1, 1906. (Hankinson); ditch, Douglas Lake, May 1, 1906 (Hankinson); stream, New Buffalo, May 31, 1915; Carp Lake, Aug. 9, 1915.

MICROTHAMNIACEÆ.

Microthamnium exiguum Reinsch. Bog near Caffey, Mackinac Co., Aug. 13, 1915; bog pool, Seney, Aug. 12, 1915.

Gongrosira lacustris Brand. Au Sable River, Grayling, Crawford Co., Aug. 24, 1916 (Hankinson). Not previously reported from America.

COLEOCHAETACEÆ.

Coleochaete irregularis Pringsheim. New Buffalo, May 31, 1915.

Coleochaete nitellarum Jost. Twin Lake, Muskegon Co., June 2, 1915. On Chara sp.?

Coleochaete scutata Brébisson. Railroad pool, New Buffalo, May 31, 1915; pond east of Manistique, Aug. 11, 1915.

Coleochaete pulvinata A. Br. Trout Lake, Chippewa Co., Aug. 10, 1915.

CYLINDROCAPSACEÆ.

Cylindrocapsa geminella Wolle. Saugetuck, June 1, 1915; ditch at Breedsville, June 4, 1915.

MICROSPORACEÆ.

Microspora stagnorum (Kütz.) Lagerh. Beach pools, Isle Royale, Aug. 1, 1910 (Cooper).

Microspora amoena (Kütz) Rabenh. Pools, New Buffalo, May 31, 1915; Twin Lake, June 2, 1915; bog, Saugetuck, June 1, 1915.

Microspora crassior (Hansg.) Hazen. Bog pool, Saugetuck, June 1, 1915; ditch, Breedsville, June 4, 1915.

Microspora pachyderma (Wille) Lagerh. Pool, New Buffalo, May 31, 1915.

OEDOGONIACEÆ.

Oedogonium acrosporum DeBary. Railroad pool, New Buffalo, May 31, 1915; pool, Seney, Aug. 12, 1915.

Oedogonium borisianum Wittrock. New Buffalo, May 31, 1915.

Oedogonium concatenatum Wittrock. New Buffalo, May 31, 1915.

Oedogonium crenulato-costatum Wittrock. Carp Lake, Emmet Co., Aug. 9, 1915.

Oedogonium crassum Wittrock. New Buffalo, May 31, 1915; bog north of Blaney, Aug. 12, 1915.

Oedogonium crispum Wittrock. New Buffalo, May 31, 1915.

Oedogonium crispum var. **inflatum** Hirn. New Buffalo, May 31, 1915. Variety new to America.

Oedogonium cryptoporum vulgare Wittrock. New Buffalo, May 31, 1915.

Oedogonium cyathigerum Wittrock. Saugetuck, June 1, 1915.

Oedogonium fragile Wittrock. New Buffalo, May 31, 1915.

Oedogonium gracillimum Wittr. & Lund. New Buffalo, May 31, 1915.

Oedogonium braunii Kütz. Railroad pool, Seney, Schoolcraft Co., Aug. 12, 1915.

Oedogonium grande Kütz. New Buffalo, May 31, 1915; Saugetuck, June 1, 1915.

Oedogonium grande var. **angustum** Hirn. Ditch, Breedsville, June 4, 1915.

Oedogonium irregulare Wittrock. Saugetuck, June 1, 1915.

Oedogonium laeve Wittrock. Saugetuck, June 1, 1915.

Oedogonium paludosum var. **parvisporum** Hirn. New Buffalo, May 31, 1915.

Oedogonium pratense Transeau. Railroad ditch, Mackinaw City, Aug. 9, 1915.

Oedogonium rufescens Wittrock. New Buffalo, May 31, 1915; Saugetuck, June 1, 1915.

Oedogonium rugulosum Nordstedt. New Buffalo, May 31, 1915.

Oedogonium americanum sp. nov. Dioecious, macrandrous; oogonia single, globose to depressed-globose, pore superior; oospore globose, ellipsoid-globose, or depressed-globose, filling the oogonium or only partly filling it, spore wall of three layers, median layer scrobiculate; male filaments somewhat smaller than the female; antheridia 1-5-celled, frequently alternating with vegetative cells; sperms two, division horizontal; basal cell of filament elongated; terminal cell obtuse.

Diam. veg. cells, female, 28-48μ; length 40-100μ

Diam. veg. cells, male, 24-30μ; length 40-100μ.

Diam. oogonia, 40-76μ; length 48-70μ.

Diam. oospore, 38-74μ; length 46-56μ.

Diam. antheridial cells, 20-28μ; length 4-12μ.

Oedogonium dioicum, macrandrium; oogoniis singulis, globoso-ellipsoideis vel globosis vel depresso-globosis, poro superiore apertis; oosporis globoso-ellipsoideis vel globosis vel depresso-globosis, oogonia complentibus vel fere complentibus, membrana triplici; episporio (in latere exteriore) laevi, mesosporio scrobiculato, endosporio laevi; plantis masculis paullo gracilioribus quam femineis; antheridiis 1-5-cellularibus, saepe cum cellulis vegetativis alternis; spermatozoidis binis, divisione horizontali ortis; cellula fili basali forma, ut vulgo, elongata, cellula terminali apice obtusa; crassit, cell, veget. plant. fem. 28–48μ, altit. 40–100μ; crassit, cell, veget. plant. masc. 24–30μ, altit. 40–100μ; crassit oogon. 40–76μ, altit. 40–70μ; crassit oospor. 38–74μ, altit. 46–56μ; crassit cell. antherid, 20–28μ, altit. 4–12μ.

New Buffalo, May 31, 1915. Originally found in pool on Newmans farm, northeast of Charleston, Illinois, May 21, 1914.

Oedogonium undulatum (Bréb.) A. Br. White Fish Point, Chippewa Co., July, 1913. (Hankinson).

Oedogonium undulatum var. **americanum** nov. var. A new variety with vegetative cells as in the type, but with oogonia much larger, diameter 58-68μ; length 60-80μ; oospore 48-60μ x 48-56μ.

Var. cellulis vegetativis ut in typo; oogoniis comparate ad cellulas vegetativas magis tumidis, crassit, 58–68μ, altit. 60–80μ; oosporis oogonia complentibus vel fere complentibus, crassit. 48–60μ, altit. 48–56μ.

Trout Lake, Aug. 10, 1915.

Bulbochaete crassiuscula Nordst. Mackinaw City, Aug. 9, 1915.

Bulbochaete crenulata Pringsheim. New Buffalo, May 31, 1915.

Bulbochaete insignis Pringsheim. New Buffalo, May 31, 1915.

Bulbochaete rectangularis Wittrock. New Buffalo, May 31, 1915.

Bulbochaete varians Wittrock. New Buffalo, May 31, 1915.

NOTES ON SILURIAN FOSSILS FROM OHIO AND OTHER CENTRAL STATES.

Aug. F. Foerste.

[*Concluded from April Number.*]

In the type of *Holocystites abnormis* (Fig. 7) six horizontal rows of plates are indicated distinctly. Several accessory plates are intercalated between the fourth and fifth rows from the top. There is a possibility of a series of very short circum-oral plates. The more or less circular oral aperture apparently had a diameter of five or six millimeters. At a distance of about 4 mm. from the oral aperture, there is an anal protuberance, about 5 mm. in diameter, interrupting the uppermost row of plates. The anal aperture lies along the left margin, but on the rear surface of the specimen as figured by Hall. The granules of this figure represent the internal casts of the numerous vertical pores on the interior of the plates. The surface probably was ornamented by low and rather numerous pustules.

In the second specimen figured by Hall under *Holocystites abnormis* (Fig. 8) accessory plates are present between the fifth and sixth, and between the sixth and seventh rows from the top. The protuberance along the upper left-hand margin of the figure is due, at least in part, to imperfection of preservation.

In the type of *Holocystites alternatus* (Loc. cit. Pl. 12, Fig. 9; Pl. 12a, Fig. 6; see also Pl. 4, Fig. 4, in the present paper) there appears to have been a more or less circular aperture about six mm. in diameter. About 6 mm. from this aperature is the anal protuberance, about 5.5 mm. in diameter. From this protuberance the gut appears to have extended downward, vertically, close to the inner wall of the theca for at least 5 mm. The cast outlining the gut is most distinctly defined on the right side. It appears possible to distinguish certain of the horizontal rows of plates as primary, and others as secondary. The primary plates are larger and appear to number eight in each horizontal row. The secondary plates are smaller and number about 16 in each row; these secondary plates alternately truncate the primary plates or occupy the angles between the latter. In addition to the primary and secondary plates there is a series of accessory plates, of which a pair, instead of a single plate, truncates the primary plates. With this interpretation in mind, the anal protuberance may be said to be located between the first and second rows of primary plates. These are followed, in descending order, by the first row of secondary plates, the third row of primary plates, another row of secondary plates, a fourth row of primary plates, a partial row of accessory plates, a third row of secondary plates, another partial row of accessory plates, a fifth row of primary plates, and a broken end beyond which there may have been additional rows of primary plates. The surface of the plates probably was marked by low pustules. The interior of the plates evidently was traversed by numerous coarse pores, more or less perpendicular to the surface.

With this group of *Holocystites*, from the Racine limestone of the Silurian of Wisconsin, *Holocystites greenvillensis* is correlated chiefly on account of the presence of horizontal rows of plates, successive rows alternating, and consisting of eight plates each. The anal protuberance is located between the first and second rows of the distinctly outlined plates. The general outline is similar, and there appears to have been a similar absence of arms.

The specimens of *Holocystites greenvillensis* here figured were found in the Cedarville dolomite, about four and a half miles east of Greenville, Ohio, at Brierly's quarry, on Greenville Creek. No exposures exist here at present, the site having long been covered by soil washed in by rains, and rising waters. The elevation here is 980 feet above sea level. At the Lewisburg Limestone Quarry, a mile northwest of Euphemia, the base of the Cedarville limestone is about 975 feet above sea level. For 19 miles south of Euphemia the Brassfield limestone dips between 4 and 5 feet toward the north. Euphemia being about 17 miles south of the Brierly quarry, east of Greenville, this suggests a dip of fully 70 feet northward within that interval, provided the amount of dip does not change. Hence, at the Brierly quarry, the base of the Cedarville dolomite should be about 905 feet above sea level, and the strata formerly exposed in the Brierly quarry should be about 75 feet above the base of the Cedarville limestone, and therefore above the level of the highest strata exposed at Cedarville, Ohio. The Brierly quarry in former days furnished a large number of crinoids and cystids, some of which were listed by A. C. Lindemuth in his Report on the Geology of Darke County, in Volume III, of the Ohio Geology, (p. 515) in 1878. Here the species described in this paper as *Holocystites greenvillensis* was identified as *Holocystites abnormis*.

Most of the species described by S. A. Miller from the Osgood formation of Indiana as *Holocystites* evidently belong to

Jaekel's genus, *Trematocystis.* The remainder belong to closely allied genera. None belong to true *Holocystites.*

There is no evidence that *Holocystites ovatus, H. scutellatus, H. winchelli, H. sphæricus,* or *H. jolietensis,* from the Racine of Wisconsin and Illinois, are closely related to the Osgood forms of *Trematocystis.* Although apparently not congeneric with *Holocystites* as here defined, they nevertheless may prove closely related.

Hallicystis imago, Hall. Plate XI, Fig. 2.

The type of *Apiocystites imago,* Hall, numbered 2025, is preserved in the American Museum of Natural History, in New York City. It is figured in the Twentieth Report of the New York State Cabinet of Natural History, on plates 12 and 12a, and the arrangement and outline of the plates has been diagrammed by Schuchert in his paper *On Siluric and Devonic Cystidea and Comarocrinus,* published in the Smithsonian Miscellaneous Collections in 1904. No occasion for further comment on the type specimen would remain were it not for the fact that it presents certain features not noted in any of the preceding studies.

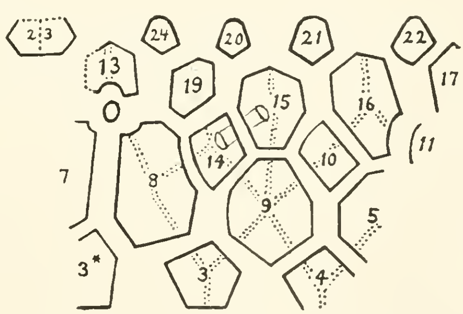


FIG. 1. Plate diagram of type of Hallicystis imago, Hall. The dotted lines crossing the plates indicate the direction of the faint angulations. The double character of plate 23 can not be determined from this type.

In studies of the *Callocystidæ* it is evident that plate 3 supports plates 7, 8, and 9, and thus takes the place of two plates, one alternating with the bases of plates 7 and 8, and the other alternating with the bases of plates 8 and 9. This is true also of the specimen of *Hallicystis imago* diagrammed by Schuchert in the publication cited above.

In the *type* of *Apiocystis imago*, however, plate 3 is represented by two plates. The one alternating with the bases of plates 8 and 9 is completely preserved, and the other, alternating with the bases of plates 7 and 8, is preserved for at least two-thirds of its width. Plates 9 and 5 are in contact with the bases of plates 15 and 16 respectively, being truncated by the latter. Plates 8 and 19 also truncate each other. Plate 24, on the contrary, does not appear to truncate plate 13, and the division of plate 23 into two distinct plates could not be verified in this type specimen, even the outlines of this plate being obscure. The pectinirhombs on plates 14 and 15 apparently were small and discrete, the intervening distance being about 5 millimeters. The cast of the anal orifice is protuberant, and the gut passed from this orifice downward and a little toward the right for a distance of at least 5 mm., the right margin of the cast of the passage along the interior of the theca being more sharply defined on the right side.

Apparently there are obscurely defined remnants of the ambulacral ray No. 5, which terminates at the top of plate 19. There are also weakly defined depressions between plates 20 and 21, and between plates 21 and 22, terminating at the tops of plates 15 and 16 respectively, which suggest the former presence here of rays No. 4 and 3. If these observations are correct, they would confirm Schuchert's reference of *Hallicystis* to the *Apiocystinæ*.

The exterior of the thecal plates apparently was moderately angulated; the direction of the angulations is indicated on the diagram by means of dotted lines. On the basal plates, the median angulation is rather prominent at its lower end.

Hallicystis imago occurs in the Racine dolomite, in the Niagaran division of the Silurian, at Racine, Wisconsin.

Callocystites jewetti-elongata, var. nov.
Plate XI, Figs. 6A, 6B, 3.

The internal cast of the theca, (Figs 6 A, B), presenting distinct outlines of all of the plates excepting those on the anal side, is at hand. Even on the anal side sufficient traces remain to warrant the diagram here presented, which evidently is that of a typical *Callocystites*. The line of separation between plates 13 and 24 is unknown, and the double character of plate 23 can not be determined. That half of the pectinirhomb which is on plate 15 is triangularly lunate, and its nearest part is one millimeter from the intermediate suture line; the other half is nearer, but its outline is indistinct. That half of the pectinirhomb which is on plate 5 is slightly incurved on the proximal side, and its nearest part is slightly over 3 mm. from the intermediate suture line; the other half is 3 mm. from the suture line, but its outline is distinctly preserved.

Found in the Cedarville colomite at Cedarville, Ohio.

Compared with typical *Callocystites jewetti*, from the Rochester shale of New York and Ontario, the theca is slightly longer and narrower, being less inflated at mid-length. Moreover, the halves of the pectinirhomb on plates 1 and 5 are much more widely separated from each other. It also is probable that if perfect specimens were at hand that other differences might be noted but the Cedarville specimen evidently is closely related to the Rochester shale species.

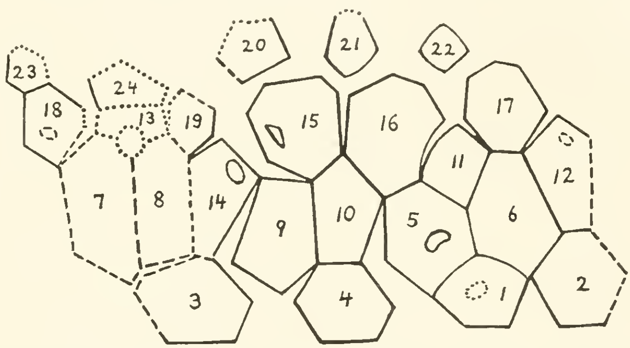


FIG. 2. Plate diagram of Callocystites jewetti-elongata. Poorly preserved outlines indicated by broken lines. The suture lines between plates 13, 19 and 24 are unknown.

At the eastern Mills quarry, southeast of Springfield, Ohio, another fragment of *Callocystites* (Fig. 3) was found in the Cedarville dolomite which evidently also is closely related to *Callocystites jewetti*. The specimen is a fragment of a cast of the exterior of the theca and shows the characteristic deeply and coarsely pitted surface; the sharply elevated margin and elliptical outline of that half of the pectinirhomb which is located on plate 14, and the less strongly elevated margin and more triangular outline of that half which is on plate 15. Plates 9 and 10 are pentangular, 9 with the angle directed downward, 10 with the angle directed upward. The smooth depressed linear area left by the falling off of the ambulacrum is unbranched, and its median part passes somewhat diagonally toward the left of the suture line between plates 9 and 10. Parts of plates 4, 16, 19, 20, and 21, also are present. There is a possibility of this cast of the exterior of the theca being identical specifically with the cast of the interior from the Cedarville dolomite, at Yellow Springs, described in the preceding lines.

Callocystites sphaeroidalis, sp. nov. Plate XII, Fig. 5.

Theca globular; only the cast of the exterior of a single specimen is known, but this includes almost half of the specimen. That half of the pectinirhomb which belongs to plate 15 is present and assists in orienting the specimen. Plate 15 truncates plate 9, and plate 16 truncates plate 5; moreover, there is evidence of the complete series of deltoids, 20 to 24, forming the fourth row in *Callocystites.* A crack extends along the left margin of plate 22, along the right margin of the ambulacrum on plate 16, across the left corner of plate 11, and then across plate 5 in a direction parallel to its left margin, where in contact with plate 10. A slight displacement has taken place along this crack, the left part of the specimen being slightly depressed and pushed under the right part. The ambulacrum crossing plate 16 divides dichotomously near the center of this plate, one branch (d) following the line of contact between plates 10 and 5, while the other branch (c) crosses the middle of the latter plate. In addition to this there appears to be evidence of a third branch (x) of the same ambulacrum, passing along the right hand margin of plate 5, intruding slightly on plates 11 and 6. The bifurcation for the third branch takes place near the left angle of plate 11. This second bifurcation of the ambulacrum, although not observed heretofore in *Callocystites*, is to be expected in view of the repeated bifurcations in the later forms included under *Sphaerocystites.* That half of the pectinirhomb which is present on plate 15 possesses about 15 dichopores; it is semilunate in form, there is no evidence of a prominent border, and it is not in contact with the margin of the plate. The surface of the thecal plates is ornamented by small granules, about 4 in a length of 2 millimeters.

Found in the Cedarville dolomite, in the eastern Mills quarry, southwest of Springfield, Ohio.

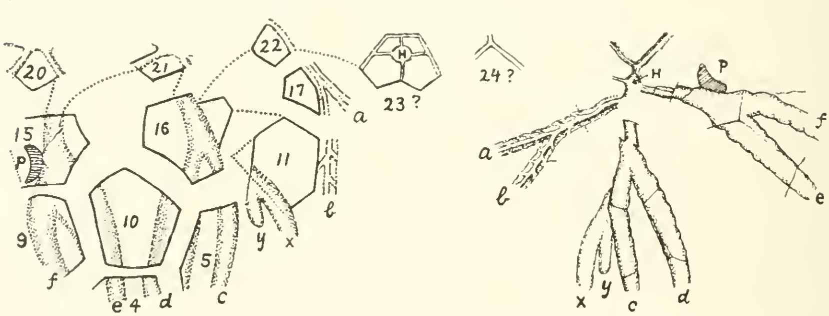


Figure 3. Callocystites sphaeroidalis. Plate diagram on left side, and diagram of ambulacra on right, both only partially preserved; the latter was drawn from a cast of the exterior and, therefore, is inverted from right to left. H, hydropore; p, pectinirhomb; a, b, branches of left posterior ray; c, d, branches of left anterior ray; x, y, apparently supplementary branches; e, f, branches of the anterior ray; the left anterior and anterior rays are indicated only by the grooves left by the fallen-off ambulacrals.

The specimen here described differs from both *Callocystites jewetti*, Hall and *Callocystites canadensis*, Billings, from the Rochester shale, in its globular rather than olive-shaped form, and in its granulose rather than deeply pitted surface.

No comparison with the type of *Hemicosmites subglobosus*, Hall (Twentieth Report, New York State Mus. Nat. Hist., pl. 12, fig. 13, 1868) is possible, for me, since, after repeated attempts, I am unable to orient this type so as to identify the plates. It is evident that the description of the species published by Hall was not based on this type, but upon material similar to that used by Schuchert in his description of *Coelocystis subglobosus*.

The specimen diagrammed by Schuchert as a typical specimen of *Coelocystis subglobosus* agrees so closely with the plate diagram of *Callocystites jewetti* that I am unable to determine upon what features the generic distinction is to rest, unless it be the small size and considerable distance between the discreet halves of the pectinirhombs and the slightly different position and form of plate 24 and of the immediately adjacent deltoids. Since only the internal casts of *Hemicosmites subglobosus*, Hall, and *Cœlocystis subglobosus*, Schuchert, are known, further comparisons are impossible at present.

Lampterocrinus inflatus-minor, var. nov. Plate X, Figs. 2A, B.

1868. Lampterocrinus inflatus, Hall, 20th Rep. New York State Cab. Nat. Hist., p. 328, pl. 10, fig. 6.
1900. Lampterocrinus inflatus, Weller, Bull. Chicago Acad. Sci., Nat. Hist. Surv., 4, pt. 1, p. 81, figs. 2, 3.

General shape of the calyx as in *Lampterocrinus inflatus*, apparently with similar pendant, laterally compressed, tubular arms. Ventral disk greatly inflated posteriorly, but the center of radiation of the ambulacra appears to be more nearly central. Height of calyx 22 millimeters, of which the tegmen forms a little more than a third.

Infrabasals, basals, and radials and first costals as in *Lampterocrinus inflatus*. The median part of the second costals curves strongly outward and forms part of the lower side of the pendant arms. The second costals evidently are followed directly by the distichals. Interbrachials apparently as in *Lampterocrinus inflatus*. First anal plate larger than the first plate in the interbrachial areas, higher than wide, followed by three plates of which the middle one is conspicuously longer. The upper half of this middle plate is surrounded by a semicircular series of five plates, of which the end plates reach about the same level as the top of that middle plate which the five plates in question surround.

Found in the Euphemia dolomite, in the Jackson quarry, about two miles south of Covington, Ohio. Differing from *Lampterocrinus inflatus*, from the Racine dolomite of Wisconsin and Illinois, in its much smaller size and in the less conspicuous elevation of the inflated part of the tegmen on the left side of the posterior interambulacral area.

Habrocrinus benedicti, Miller. Plate X, Figs. 5A, B.

1894. Saccocrinus benedicti, Miller, 18th Ann. Rep. Dep. Geol. Nat. Res. Indiana, p. 283, pl. 5, figs. 1, 2.
1908. Habrocrinus benedicti, Slocom, Field Columbian Mus., 2, Geol. Ser., p. 295, pl. 87, figs. 6, 7.
1902. Periechocrinus chicagoensis, Weller, Bull. Chicago Acad. Sci., Nat. Hist. Surv., 4, p. 131, pl. 13, figs. 7, 8.

Basals, three; radials, five, forming a single transverse row along with the first plate of the anal interradial area. Each radial followed by two costals; the first, hexagonal; the second, pentagonal, leaving room for distichals, but not for palmers before reaching the base of the free arms. At these arm bases the upper part of the dorsal cup projects strongly as in *Habrocrinus benedicti*. Traces of ornamentation, similar to that characteristic of the latter species, remain. The general appearance of the specimen, including that of the base, is similar to *Habrocrinus chicagoensis*, as figured by Weller.

Found in the lower part of the quarry west of the river at the Wire Works, in the eastern part of Muncie, Indiana, where it is associated with *Halysites labyrinthicus*, *Petalocrinus* sp., *Leptæna rhomboidalis*, *Pentamerus oblongus*, *Gypidula rœmeri*, *Uncinulus stricklandi*, *Platyceras niagarense*, *Phanerotrema occidens*, and *Calymene celebra*. It underlies a horizon, consisting of about a foot and a half of clay shale and very thin bedded limestone, in which there is a recurrence of the Waldron fauna, including the following species: *Duncanella borealis*, *Favosites forbesi-occidentalis*, *Favosites spinigerus*, *Hallopora elegantula*, *Diamesopora osculum*, *Trematopora singularis*, *Eucalyptocrinus* sp., *Atrypa reticulari-newsomensis*, *Anastrophia internascens*, *Camarotœchia acinus*, *Leptæna rhomboidalis*, *Rhipidomella hybrida*, *Rhynchotreta cuneata-americana*, *Schuchertella subplana*, *Spirifer crispus-simplex*, *Whitfieldella nitida*, *Cypricardinia arata*, *Diaphorostoma niagarense*, and *Dalmanites verrucosus*. The clay shale containing this recurrence of the Waldron fauna occurs 45 feet below the level of the railroad track following the western side of the river, at the quarry. Its elevation is approximately 900 feet above sea level.

According to the well record presented by E. P. Cubberley, on page 241 of the Eighteenth Annual Report of the Geological Survey of Indiana, cited above, the thickness of Silurian rock underlying Muncie, Indiana, is 265 feet. This would place the clay shale in the Muncie quarry, containing the recurrence of the Waldron fauna, about 220 feet above the base of the Silurian. Considering the fact that at St. Paul, in the northwestern part of Decatur County, Indiana, the thickness of the Laurel limestone, which directly underlies the true Waldron shale, is 50 feet; that of the underlying Osgood formation, about 8 feet, and that of the Brassfield limestone, if present at all, certainly not more than 20 or 30 feet as the extreme, it is impossible to regard the clay shale layer in the Muncie quarry as identical with the Waldron shale of the more southern parts of Indiana, although evidently containing a recurrence of the Waldron fauna. In fact, it is possible that the fauna exposed in the quarry at Muncie belongs stratigraphically above any Niagaran strata included in the Louisville limestone in southern Indiana, and also above any Niagaran strata referred to the Cedarville dolomite in western Ohio.

Several facts suggest that the clay shale horizon in the Muncie quarry is of later age than the typical Waldron shale. The entire thickness of rock exposed beneath it is massive, without well marked bedding planes, and is strongly dolomitic. Moreover, *Phanerotrema occidens* so far has not been found below the level of the Louisville limestone and Cedarville dolomite.

The rock immediately above the clay shale horizon in the Muncie quarry, for a thickness of 25 feet, is very porous and massive, strongly resembling the Cedarville dolomite of Ohio lithologically. It contains a *Fistulipora* resembling *Fistulipora neglecta-maculata* in general appearance, also a species of *Conchidium*, *Dalmanites verrucosus*, and the unnamed species of *Bumastus* from northern Indiana described by Kindle under *Illænus insignis*.

Above the massive, very porous rock, in the Muncie quarry, there is a series of thin bedded limestone, the individual layers of which are 3 to 4 inches thick, the total of the layers exposed equalling 12 feet. This is the richly fossiliferous part of the exposures at Muncie. It is best exposed, for purposes of collecting, directly east of the quarry, on the opposite side of the river. Here it contains: *Cladopora* sp., *Halysites labyrinthicus*, *Favosites niagarensis*, *Favosites spinigerus*, *Spirorbis* sp., *Anastrophia internascens*, *Atrypa reticularis-niagarensis*, a strongly convex form of *Dalmanella elegantula*, *Leptæna rhomboidalis*, *Pentamerus compressa*, *Platystrophia biforata*, *Spirifer* cf. *radiatus*, *Uncinulus stricklandi*, *Calymene celebra*, and the *Bumastus* of northern Indiana described by Kindle under *Illænus insignis*.

Pentamerus compressus, Kindle and Berger, is a very different species from *Pentamerus cylindricus*, Hall, and belongs to a much higher horizon. *Pentamerus cylindricus* occurs about 50 feet above the base of the Louisville limestone in the area northeast of Louisville, along the Ohio River. It is unknown in northern Indiana, where the form identified as *Pentamerus oblongus cylindricus* is only a variation of *Pentamerus compressus*. *Pentamerus compressus* was described from the Noblesville dolomite at Delphi, Indiana, and it is to this horizon that the upper part of the exposures at Muncie are referred.

Habrocrinus sp. Plate X, Fig. 6.

Basals three; in the cast they diverge strongly producing a lateral outline of about 110 degrees for the base of the calyx. The five radials and the first plate of the anal series are closely similar in size and shape, differing only in the fact that those plates which are directly above the basals are hexagonal in outline, while the intermediate plates are heptagonal. Costals, two, slightly smaller than the radials; the first, hexagonal; the second, heptagonal, supporting a pair of distichals, followed by a second pair. The latter are separated by at least one inter-distichal plate. Apparently no palmers enter into the formation of the dorsal cup; for this reason the specimen here described is referred to *Habrocrinus*.

The first plate of the anal interradial area is followed by three plates, of which the middle one is hexagonal, and the two lateral ones are pentagonal in outline, in each case with a horizontal suture-line at the top. These are followed by a second set of three plates, of which the two lateral plates are hexagonal, and the middle plate is irregularly octagonal in outline. The two sets of three plates just described are subequal in size, and are only moderately smaller than the adjacent costals. The two lateral plates of the second set are each followed by a plate irregularly hexagonal in form, which is only moderately smaller than the plate upon which it rests. The middle, irregularly octagonal plate of the second set, however, is followed by three much smaller plates of which the middle one is hexagonal, and the two lateral ones are pentagonal in shape, one of the angles of the latter being directed upward. These three smaller plates are followed by a transverse series of five plates, also of distinctly smaller size, and the latter by other plates whose arrangement can not be determined from the specimen at hand.

From the Cedarville dolomite, at the eastern Mills quarry, one mile southwest of Springfield, Ohio.

The tegmen of the specimen from Springfield, Ohio, here described, is not preserved. This prevents the elucidation of the following anomalous structure. Apparently an anal tube extends from the upper margin of the right posterior interbrachial area diagonally upward and toward the left. Possibly the right side of the tegmen was crushed in and a part of the anal tube preserved in such a position as to give the present misleading appearance.

The specimen here described differs from *Habrocrinus ornatus*, Hall and Whitfield, from the Cedarville dolomite at Yellow Springs, Ohio, in several important particulars. The form of the dorsal cup is more obovate-globose, and the arrangement of the plates in the anal interradial area is different.

In *Habrocrinus ornatus*, Hall and Whitfield, the first anal plate supports a transverse set of three plates whose upper margins are sufficiently near the same level to cause the next set, consisting of five instead of three plates, also to form a transverse row. The latter is followed by another transverse row consisting also of five subequal plates, and the latter are followed by five plates of smaller size, beyond which extend the basal plates of the anal tube.

In *Habrocrinus benedicti*, Miller, from the Laurel limestone at St. Paul, Indiana, the first anal plate supports a transverse set of three plates, followed by a transverse set of five plates of which the middle and two end plates occupy a distinctly higher position, and the latter are followed by two additional zigzagging sets of five plates. At the bases of the free arms the upper margin of the dorsal cup projects outward. The same general form and arrangement of plates is found in *Habrocrinus chicagoensis*, Weller, from the Racine of Bridgeport and Joliet, Illinois.

In *Habrocrinus howardi*, Miller, the first plate of the anal interradial area is followed by two sets of transverse plates of plates each, and these by a transverse set of five plates which are not in line; but the middle three plates of the last set are not conspicuously smaller than the end plates, the base of the calyx is truncated, and the upper part of the dorsal cup projects strongly at the bases of the free arms.

In *Habrocrinus farringtoni*, Slocom, from the Racine near Lemont, Illinois, the arrangement of the plates of the anal interradial area agrees with that of *Habrocrinus benedicti.*

In *Habrocrinus lemontensis*, Slocom, from the Racine near Lemont, Illinois, the small size and quadrangular form of the first costals is sufficient to distinguish this species from any other described form of *Habrocrinus.*

Periechocrinus tennesseensis, Hall and Whitfield. Plate X, Fig. 3.

Saccocrinus tennesseensis, Hall and Whitfield, Geol. Surv. Ohio, Pal. 2, 1875, p. 125, pl. 6, fig. 10.

This species was described and figured from a specimen collected by Prof. Edward Orton in the Cedarville limestone at Cedarville, Ohio, but it is evident that he regarded a specimen in the Troost collection, from the Brownsport division of the Niagaran in western Tennessee, as the type. (Wood, Bull. U. S. Nat. Mus., 64, 1909, p. 76, pl. 6, fig. 10).

In the Ohio specimen figured by Hall and Whitfield, the sides of the calyx diverge at an angle of about 20 degrees, the basal plates diverging apparently at an angle of 105 degrees. At the summit, the calyx is quite abruptly truncated, the tegmen being comparatively flat.

In another specimen, here figured, from the same horizon and locality at Cedarville, Ohio, the lower radials and interradials are slightly broader; and the lateral diameter of the calyx is slightly greater; otherwise it agrees closely with the type.

Periechocrinus cylindricus, sp. nov. Plate X, Figs. 1A, B.

Calyx, above the basals, sub-cylindrical, the sides diverging at angles of about 10 degrees, or less. The convex basals diverge so as to form an angle of about 90 degrees with the basal part of the calyx. The top of the calyx is abruptly truncated, the tegmen being comparatively flat, as in *Periechocrinus tennesseensis*, to which the species may be regarded as closely related. Four arms for each ray.

Area of attachment for the column very small, not exceeding 2 millimeters in diameter. Three basals, convex. Radials and first plate of the anal series considerably elongated, the length in extreme cases equalling twice the width. The suture line between the radials and the first one in each of the series of costals is very narrow, the latter also being conspicuously elongated and tapering to a narrow width at the base. As in other species of *Periechocrinus*, there are two costals, two pairs of distichals, and four pairs of palmers in each ray. The first interbrachial plate is large, the first and second pairs of interbrachials become rapidly smaller, and the third and following pairs are conspicuously smaller than the rest. Length of largest specimen here figured, 66 millimeters; lateral diameter at top of calyx, 30 millimeters; antero-posterior diameter, 23 millimeters; specimen probably compressed in a direction from front to rear.

Cedarville dolomite, at the eastern Mills quarry, a mile southwest of Springfield, Ohio.

Dalmanella springfieldensis, sp. nov. Plate XI, Figs. 5A–E.

Pedicel valve strongly convex, the convexity equalling from five-tenths to six-tenths of the width in the more convex specimens. The beak is strongly incurved. Some of the specimens tend to be angulate along the median line, but this is not a constant feature. Specimens rarely exceed 12 millimeters in length. Casts of the interior indicate the presence of strong dental lamellae, which extend forward from the hinge-line for a distance of two to two and a half millimeters.

Brachial valve only moderately convex or comparatively flat and with the greater convexity about one-third of the length of the valve from the beak; depressed along the median line. Length varying from slightly less to slightly more than the width. Casts of the interior indicate the presence of a small and narrow cardinal process, of strong crural processes, and, in mature specimens, of strongly defined muscular impressions. The median elevation separating the muscular impressions is strongly defined, especially posteriorly where it separates the posterior adductor impressions. The anterior adductor impressions are not strongly differentiated from the posterior impressions, nor are they strongly limited anteriorly, but laterally both sets of impressions are clearly defined.

Surface marked by narrow radiating striae, about 5 to 6, sometimes 7 occurring in a width of 2 millimeters.

From the Cedarville dolomite, at the eastern Mills quarry, southwest of Springfield, Ohio.

This species is characterized by its small size, the great convexity of its pedicel valve, and the tendency toward elongation of the latter. The second specimen figured by Nettelroth (Kentucky Fossil Shells, 1889, Pl. 32, Figs. 55, 56, 57) from the Louisville limestone of Kentucky, evidently is closely similar, and the first figured specimen (Ibid., Figs. 52, 53, 54) illustrates one of the less elongated specimens of the same species.

Dalmanella elegantula, Dalman, (Kongl. Svenska Vet.-Akad. Handl., 1828, p. 117, Pl. 2, Figs. 6 a-g) is a much more triangular shell. For the Waldron shale species, so well figured by Hall (28th Rep. New York State Mus. Nat. Hist., 1879, P. 150, Pl. 21, Figs. 11–17) the term *Dalmanella waldronensis* is here proposed.

Stropheodonta (?) sp. Plate IX, Fig. 4.

Valve convex anteriorly, the present flattening of the shell posteriorly assumed to have been due, in part at least, to pressure; assumed to be a cast of the exterior of the pedicel valve. The original convexity may have equalled 3 millimeters. Radiately striated with coarse and fine striae. The coarser striae tend to be from three-quarters of a millimeter to nearly a millimeter apart, additional striae being intercalated at about one-third of the length of the shell, and also at two-thirds the length of the shell from the beak. Between these coarser striae there are much finer striae, about four or five occurring between each pair of coarser striae. Shell wrinkled concentrically in a peculiar zigzag manner, excepting along the hinge-line where the wrinkles are obliquely inclined in such a manner as to suggest an acute prolongation of shell at the postero-lateral angle. The zigzag wrinkling suggests the crossing of two sets of wrinkles at angles varying from 70 to 90 degrees on different parts of the valve. Since the specimen consists of a natural cast of the exterior of the valve, no evidence regarding its interior is offered.

Found nine feet above the base of the Cedarville dolomite, at the Lewisburg Stone Company quarry, located a mile northwest of Euphemia, a village directly north of Lewisburg, Ohio. This is the type locality for the Euphemia dolomite. Here the following section is exposed, in descending order:

Cedarville dolomite, lower part very porous	14 ft. 6 in.
Springfield dolomite, dense, bedded	7 ft. 9 in.
Euphemia dolomite, rock very porous, and mottled or with whitish blotches	4 ft 6 in.
Laurel limestone, whitish, resembling Dayton limestone	8 ft. 10 in.
Osgood clay, middle part shaly, upper and lower part more indurated	4 ft.
Dayton limestone, light blue, dense	8 ft.
Brassfield limestone, estimated from drill-hole at	22 ft.

Strophomenoid shells ornamented with zig-zag wrinkles, or with two systems of wrinkles crossing at various angles, have been known for many years. This type of ornamentation however, probably is not limited to a single genus.

In 1848, Barrande described from the Silurian strata of Bohemia, under the name *Leptæna stephani* (Brachiopoden der Silurischen Schichten von Böhmen, Vol. 2, Pl. 20, Figs. 7 a-h) a form which appears to be a *Stropheodonta* with an ornamentation similar to that of the Devonian species *Stropheodonta patersoni*, Hall, but with a greatly elongated hinge-line and with a remarkably strong curvature antero-posteriorly.

That *Leptæna loveni*, Verneuil (1848, Leptæna a crochet perfore, Bull. Soc. Geol. France, p. 31 of reprint, Pl. 4, Fig. 5), from the Silurian of Gotland, is not a true *Strophomena* is shown by the general concavity of the brachial valve and convexity of the pedicel valve. The species probably is more stropheodontoid than strophomenoid although it presents some anomalous characteristics, and probably should be relegated to a distinct genus. Its surface ornamentation is somewhat similar to that of *Leptæna stephani*, Barrande, but the transverse markings are described as zig-zag in direction.

Orthis loveni, Lindstrom (Gotlands Brachiopoder, Oversigt af K. Vet. Akad. Forhandl., 17, 1861, P. 369, Pl. 13, Fig. 12), from the Silurian of Gotland, is a species of *Rhipidomella* closely resembling *Rhipidomella hybrida* and does not present the transverse zig-zag ornamentation here in question (Hall and Clarke, 1894, Pal. New York, 8, Pt. 2, P. 359).

Strophomena julia, Billings (Palæozoic Fossils, Canada, 1865, P. 127, Fig. 105, a, b) from the Jupiter River division of the Silurian on Anticosti Island, also appears to be a stropheodontoid species, judging from the very narrow deltidium and the interior of the brachial valve. The transverse undulations cross each other more or less in zig-zag manner.

Similar forms of shells, probably stropheodontoid in character, were described by Kindle (Mus. Bull. 21, Canada Geol. Surv., 1915, P. 13, 14, Pl. 1), from the Silurian dolomite of the lower Saskatchewan River valley in Manitoba, Canada, under the terms *Leptæna sinuosus* (Figs. 1–4) and *Leptæna parvula* (Figs. 5–9). Transverse wrinkles cross each other more or less in zig-zag manner.

Orthis (?) *glypta*, Hall and Clarke (1894, Pal. New York, 8, Pt. 2, P. 359, Pl. 84, Figs. 8, 9), from the Racine dolomite near Milwaukee, Wisconsin, with diagonally intersecting wrinkles, also may be a stropheodontoid, rather than an orthoid shell.

Of the forms here cited, *Leptæna stephani*, Barrande, has little in common with the remaining species. The remainder may be congeneric. Too little is known at present, however, regarding their internal markings to verify this suggestion. Although apparently stropheodontoid in character, they may form a distinct genus, not because they have a similar surface ornamentation, but because these Silurian representatives of the stropheodontoid group may present characteristics not shared with the typical late Devonian species of *Stropheodonta*.

Stricklandinia (?) louisvillensis, Nettelroth. Plate X, Figs. 7A,B.

1889. Stricklandinia louisvillensis, Nettelroth, Kentucky Fossil Shells, p. 65, pl. 34, figs. 31-34.

Brachial valve from 20 to 23 millimeters in length, with maximum convexity between one-fourth and one-third of the length of the valve from the beak. This convexity equals about 5 millimeters, and there is a tendency toward flattening anteriorly. Low and broad plications mark the valve medially and along the anterior margin, where frequently they are three millimeters in width, varying to two millimeters on the sides of the valve. In one specimen the plications along the median part of the valve are conspicuously narrower than the remainder. Toward the beak and along the postero-lateral parts of the valve the plications become obsolete. The hinge-area apparently was low, and the beak did not curve beyond the plane of junction of the two valves. Two sharp parallel narrow ridges, about one millimeter apart and eight millimeters in length, extend forward from the beak, on the interior of the valve, and are interpreted as crural ridges, terminating posteriorly at what appear to be triangular crural plates.

Three valves, from the Cedarville dolomite at the eastern Mills quarry, southwest of Springfield, Ohio, of which two are figured here, closely resemble the type of *Stricklandinia louisvillensis*, preserved in the U. S. National Musuem.

The two parallel crural ridges of the brachial valves here described do not suggest a spiriferoid shell, nor would they be expected in a species of *Stricklandinia*. They might occur, however, in a pentameroid shell. It is evident that more material is needed for the elucidation of the affinity of these shells. Nothing is known of the interior of typical *Stricklandinia louisvillensis*, as found in the Lousiville limestone at Louisville, Kentucky. Only the exterior of the type is known, and in this the beaks of both valves are closely appressed and no delthyrium is seen. Its generic relationship remain uncertain.

Two pedicel valves, having about the same size and form as *Stricklandinia louisvillensis*, and marked by similar low broad plications, were found in the Cedarville dolomite at Cedarville, Ohio. They differ however, in other particulars. The cardinal area has a height of at least three millimeters; the beak has a correspondingly greater prominence, and probably extended considerably beyond the beak of the brachial valve although only moderately incurved. The sides of the open delthyrium form an angle of about 40 degrees. There is a faint depression along the median part of the shell, its sides forming an angle of about 20 degrees with each other. This depression is almost flat, or is occupied by a single, almost obsolete, low, broad plication. Two thin dental plates extend forward from the beak for a distance of 6 mm. Where they rest on the interior of the valve, they form an angle of about 30 degrees with each other. Midway between them there is a low but thin and sharp median ridge, as in some species of *Spirifer*, and the general aspect of these pedicel valves is spiriferoid. In this respect they differ from the ventral valve of the type of *Stricklandinia louisvillensis*, so that it is possible that the pedicel valves are even generically distinct from the brachial valves described above, notwithstanding their general resemblance. (Figs. 7 A, B, on plate XII.)

Dictyonella reticulata, Hall. Plate X. Figs. 4A, B.

The first published figures of *Dictyonella reticulata*, from the Waldron shale, at Waldron, Indiana, occur in the Twentieth Report on the New York State Cabinet of Natural History, page 275, 1867. Here Figures 1 and 2 indicate the presence, on the brachial valve, of a median fold distinctly defined from the beak to the anterior margin, the sides of the fold forming an angle of 30 degrees. These figures are reproduced in the Eleventh Report on the Geology and Natural History of Indiana, 1881, where they form Figures 53 and 54 on Plate 26. An examination of the series of type specimens, preserved in the American Museum of Natural History, and there numbered 1,944, indicates the presence of four individuals, including all of those figured in the Indiana report. In none of these is the median fold as distinctly defined as indicated in the figures mentioned above; in fact, it is readily distinguished only under cross illumination, and then only anteriorly, the posterior part, toward the beak, being almost obsolete. Moreover, the angle made by the sides of the median fold, if the lateral slopes of the latter be included, is nearer 35 degrees. The specimen first figured by Hall, regarded as the type of the species, is illustrated in the present publication by Figure 7 on Plate XI.

In *Dictyonella corallifera*, Hall, figured on Plate 58, of the second volume of the Paleontology of New York, from the Rochester shale of New York, both the median fold on the brachial valve and the corresponding sinus on the pedicel valve are distinctly defined from the beak to the anterior margin.

The fold is higher and narrower, and therefore, more convex, the angle made by the sides averaging 20 degrees or less. The specimen illustrated by Figure 5c in the Paleontology of New York is represented by Figure 8 on Plate XI of the present publication.

At Harrods Creek, about five miles northeast of Louisville, Kentucky, a specimen of *Dictyonella* was found in the Upper Osgood clay, which here forms a layer about three and a half feet thick, 20 feet below the level of the traction bridge, about 200 yards up stream from the bridge. Here it is associated with *Cyathophyllum calyculum*, *Eucalyptocrinus*, *Hallopora elegantula*, *Orthis flabellites*, *Rhipidomella hybrida*, *Leptæna rhomboidalis*, *Atrypa reticularis*, and *Diaphorostoma niagarensis*. The Upper Osgood clay is underlaid by the Osgood limestone, six feet thick, with one of Miller's species of "*Holocystites*" (*Trematocystis* ?) at the base. This is underlaid by the Lower Osgood clay, consisting, in descending order, of massive, indurated clay rock, 9 feet thick, spalling where exposed to weathering; chiefly purplish clay, 3 feet thick; and more indurated clay rock, 8.5 feet thick. In the underlying Brassfield limestone *Orthis flabellites* is associated with *Rhinopora verrucosa*.

The *Dictyonella* found in the Upper Osgood clay is scarcely distinguishable from the *Dictyonella reticulata* occurring in the Waldron shale. It possesses the same low median fold, not strongly defined laterally, and becoming more or less obsolete toward the beak. The surface markings are closely similar, and, although appearing more circular on some parts of the shell, are equally quadratic on others. (Figs. 4 A, B, on plate X.)

It is interesting to note that this Osgood form of *Dictyonella* finds its nearest relative in the Waldron species, *Dictyonella reticulata*, rather than in the Rochester form, *Dictyonella corallifera*.

Camarotoechia roadsi, sp. nov. Plate XII, Figs. 6 A-E.

General outline rotund subtriangular, especially when viewed from the side of the pedicel valve. Pedicel valve only moderately convex in appearance since the antero-lateral parts have almost the same elevation as the umbonal parts of the valve. Brachial valve strongly convex, especially anteriorly, along the median fold, where the median parts are conspicuously elevated above the lateral parts of the valve. Median fold with four plications, the lateral ones narrower and at a somewhat lower elevation. Lateral plications, on each side, five or six, sometimes seven. Median sinus with three plications. The plications are relatively low and rounded and are separated by shallow grooves; posteriorly they usually are inconspicuous and in some specimens are almost obsolete. The cuneate muscular area of the brachial valve evidently was slightly raised above the general level of the inner surface. This muscular area is traversed by a median septum which divides posteriorly into a narrow spondylium. A similar but broader muscular area, without a median septum, characterizes the pedicel valve. The dental lamellæ of the pedicel valve extend downward so as to rest upon the inner surface.

From the richly fossiliferous limestone layer about nine feet above the base of the West Union formation, in the valley on the southeastern margin of Hillsboro, Ohio. Named in honor of Miss Katie Roads.

Camarotœchia roadsi belongs to a group of species characterized by low rounded plications tending to become obscurely defined or even almost obsolete posteriorly. Compared with *Camarotœchia obtusiplicata*, Hall, from the Rochester shale of New York, the outline is more triangular, the plications are lower and more nearly obsolete posteriorly.

Rhynchonella pisa, Hall and Whitfield, was described by them as "globular in full-grown specimens" and therefore figures 18 and 19, accompanying the original description, must be regarded as illustrating the type. The angulate course of the plications of the brachial valve in figure 19 explains why "the more ventricose forms resemble very closely small specimens of *Rhynchonella nucleolata*, Hall," a typical species of *Uncinulus* according to the present system of classification. The type of *Rhynchonella pisa* was obtained from the same horizon as *Camarotoechia roadsi*, in the lower or Bisher member of the West Union formation, at Danville, southwest of Hillsboro, Ohio.

Trochurus phlyctainodes, Green. Plate XI, Figs. 1A-D. Plate XII, Figs. 1A-D.

1837. Calymene phlyctainodes, Green, Amer. Jour. Sci., 32, p. 167.

Median lobe of glabella most strongly arched from front to rear at a point one-sixth of its length, measured along its surface, from the posterior end; widest one-third of its length from the rear, narrowing to four-fifths of this width anteriorly, and to three-fifths of this width posteriorly. Compound anterior lateral lobes widest slightly anterior to mid-length, equalling in width the immediately adjacent part of the median lobe; strongly defined from the median lobe by deep furrows at least a millimeter in width, equally well defined from the third lateral lobes by almost equally deep but narrower furrows; viewed from the rear, these lobes lie distinctly below the general surface of the median and third lateral lobes. Third lateral lobes equalling in width the posterior end of the median lobe, pyriform with the narrow end directed toward the median axis of the glabella; distal end about four millimeters from the suture line at the palpebral lobe. Occipital lobes small, triangularly ovate, with the narrower end directed toward the axis of the glabella, the width equalling three-fourths of the length, sharply defined from the third lateral lobes and from the occipital segment by narrow furrows. In width, these occipital lobes equal almost one-half of the width of the third lateral lobes, but they are low and much less conspicuous. Occipital segment subtriangular when viewed from the front, owing to the prolongation of the median parts into a spine. The length of this spine can not be determined from the specimen at hand since only the basal portion remains. Immediately anterior to the occipital segment and posterior to the median lobe the surface of the glabella is strongly depressed. Anteriorly the median and compound anterior lateral lobes are strongly defined from the border of the cephalon by a deep furrow, fully a millimeter and a half in width anterior to the median lobe. The facial suture is about 3 mm. distant from the lateral margins of the compound anterior lateral lobes, as far as the very small palpebral lobe, beyond which it curves almost rectangularly outward, its further course not being shown by the specimen at hand. General surface of the glabella thickly covered with tubercles of various sizes. Some of the larger of these probably supported short spines. Several of these may have been scattered along the middle third of the median lobe and one or two may have been present near the middle of the third lateral lobes. It is certain that the two conspicuous spines near the anterior end of the median lobe, and the single conspicuous spine at the distal end of the third lateral lobes, figured by Weller (Trilobita of Niagaran limestone in Chicago area, Chicago Acad. Sciences, 1907, pl. 22, figs. 1-4) from the species of *Trochurus* occurring in the Chicago area are absent in the Ohio specimen here described.

From the Cedarville dolomite at the eastern Mills quarry, southwest of Springfield, Ohio.

The type of **Trochurus phlyctainodes,** (Plate XII, Figs. 1 A-D), described by Green under *Calymene*, was found within two miles of Springfield, Ohio, in limestone used to construct the National Pike. To anyone acquainted with the Springfield area it is evident that the only limestone within a convenient distance from the National Pike is located west of Springfield, north of Mad River, within a mile of the eastern Mills quarry at Limestone City, and that the so-called limestone was the rock known at present as the Cedarville dolomite. Casts of this type, numbered 54 in the series of casts prepared by Green, are preserved in the U. S. National Museum at Washington, at the American Museum of Natural History in New York City, and elsewhere. In these casts, the narrow median lobe of the glabella, humped posteriorly and narrowing slightly anteriorly, closely resembles that of the Mills quarry specimen, here figured and described, thus presenting the most characteristic feature displayed by the latter. The compound anterior lateral lobes and the anterior outlines of the third lateral lobse also are similar but it is evident that the posterior part of the third lateral lobes was cut away in cleaning the original specimen, thus producing a straightness of outline which is entirely misleading. Moreover, the transverse furrow between the posterior end of the median lobe and the connecting ridge joining the third lateral lobes, and the furrow between this connecting ridge and the occipital segment, both are unnaturally deep, and narrow, showing distinct tool marks in some of the casts. Evidently the cleaner thought that these furrows should agree in sharpness and depth with the furrows separating the compound anterior lateral lobes from the median and third lateral lobes. In a similar manner, the posterior margin of the occipital segment shows evidence of the cleaners tool, and it is not at all unlikely that in the original of the cast, before cleaning, this segment was subtriangular in outline, as in the Mills quarry specimen here figured. Compared with the latter, the ornamentation on the surface of the cast is much coarser, and there is no evidence of numerous smaller papillæ among the coarser pustules; this, however, could scarcely be regarded as a specific distinction, in the absence of other well-marked differences. There is no trace of occipital lobes, nor of any remnant of the anterior border visible in these casts.

Trochurus hanoverensis, Miller and Gurley (Plate XII, Figs. 2 A-D), from the Laurel limestone at Madison, Indiana, was found by rock breakers while repairing the Hanover pike. Compared with *Trochurus phlyctainodes*, the median lobe is much wider, and its curvature from front to rear is more regular, its outline forming almost three-fourths of a circle. There appears to have been a strong spine near the lateral extremity of each of the third lateral lobes. The occipital lobes are low and inconspicuous. The posterior margin of the occipital segment is unknown.

Trochurus byrneasnus, Miller and Gurley, (Plate XII, Figs. 3 A-E), occurs in the Laurel limestone at Madison, Indiana, associated with *Trochurus hanoverensis*, *Sphærexochus romingeri*, and a large *Encrinurus* pygidium. No *Pentamerus oblongus* occurs at this horizon. *Trochurus byrnesanus* is characterized by a narrow median lobe with subparallel sides; its dorsal outline is nearly straight and anteriorly it is strongly curved downward and backward, the outline between this bend and the anterior border of the cephalon being gently convex. Seen from above, the compound anterior lateral lobes have about the same width as the median lobe, and the transverse furrow limiting the posterior margin of these three lobes is almost straight. The lateral extremities of the third lateral lobes are elevated apparently into short spines. Only one side of the occipital segment is preserved and its median termination is unknown.

Trochurus nasutus, Weller, from the Racine division of the Niagaran near Milwaukee, Wisconsin, differs chiefly in the anterior prolongation of the median lobe into a spine. The lateral extremities of the third lateral lobes are not elevated nor conspicuously spinose. The occipital lobes are not conspicuous.

Trochurus welleri, Nov. sp. (*Corydocephalus phlyctainodes*, Weller, 1907, Bull. Chicago Acad. Sci., Nat. Hist. Surv., 4, pt. 2, p. 234, pl. 22, figs. 1–4), from the Racine division of the Niagaran near Lemont, Illinois, resembles *Trochurus hanoverensis* in the more even curvature of its median lobe from front to rear; however, the anterior marginal part is not curved as far backward, and the curvature is only moderate near the posterior end of this lobe. In addition to the conspicuous spines terminating the lateral ends of the third lateral lobes, there is a conspicuous pair of spines on the median lobe, anteriorly. Named in honor of Prof. Stuart Weller, of Chicago University.

Trochurus halli, Nov. sp. Plate XII, Figs. 4A-D; (*Arges phlyctainodes*, Hall, 1852, Pal. New York, 2, p. 314, pl. 70, figs. 2a-2c), from the Rochester shale near Albion, New York, is closely related to *Trochurus byrnesanus.* It differs chiefly in the curvature of the median lobe of the glabella, from front to rear; this curvature is greater anteriorly, but it is not strongly accentuated antero-dorsally, nor accompanied by a straightening of the dorsal outline as in that species. Viewed from the dorsal side, the anterior part of the median lobe is less prominent, the furrows separating the third lateral lobes from the compound anterior lateral ones diverge more to the front laterally, and there is no indication of spines terminating the lateral ends of the third lateral lobes. Named in honor of James Hall, the great founder of American Paleozoic Paleontology.

A line of progression should extend apparently from *Trochurus halli*, in the Rochester shale, through *Trochurus byrnesanus*, in the Laurel limestone, to *Trochurus nasutus*, in the Racine division of the Niagaran.

Trochurus hanoverensis, from the Laurel limestone and *Trochurus welleri*, from the Racine evidently belong to another group. From one of the earlier members of this group, *Trochurus phylctainodes* could have diverged by a more bulbous development of the posterior end of the median lobe and a greater downward extension of the anterior parts of the cephalon.

Prof. Percy E. Raymond has called to my attention that *Corydocephalus* is antedated by *Trochurus* as follows: *Trochurus* was founded by Beyrich in 1845 (Ueber Bohm. Tril. p. 31, pl. 1, fig. 14) on *Trochurus speciosus*, sp. nov. (Beyrich), this species being illustrated by a figure of the pygidium, the name *Trochurus* (wheel) alluding to the general appearance of the pygidium (a wheel with spokes). Unfortunately Beyrich described under *Trochurus speciosus* also the head of a *Staurocephalus.*

His attention being called to his error privately by Barrande, Beyrich figured the proper cephalon for his species in 1846, and definitely designated the pygidium as the type. *Corydocephalus* was not defined by Hawle and Corda until 1847 (Prodr. Mon. Bohm. Tril., p. 139, pl. 7, fig. 4), and was based on the same species, although the specimen he figured was regarded by him as a new species (*C. flabellatus*, sp. nov. Corda). Barrande described the same species in 1846 as *Lichas palmata*, owing to Beyrich's error in his original description of *Trochurus speciosus*.

Appendix: Two Species of Ordovician Fossils.

Lingulops cliftonensis, Foerste. Plate X, Fig. 9.

1903. Lingulops cliftonensis, Foerste, Jour. Geol. vol. 11, p. 38.

Pedicel valve 6 millimeters long, 3.5 millimeters wide, with an elliptical outline similar to that of *Lingulops norwoodi*, James, from the upper part of the Cynthiana formation, at West Covington, Kentucky. The distinct part of the muscular area is thickened over its entire surface, forming a low platform, with an elevation of about a sixth of a millimeter along its anterior margin. The lateral margins of this platform diverge at an angle of about 25 degrees. The oblique anterior margins converge at an angle of about 85 degrees. The width of the platform at its antero-lateral angles is 1.8 millimeters. The median muscular scar, with parallel margins as in *Lingulops norwoodi*, has a width of slightly less than half a millimeter. That part of the anterior margin of the platform which is in front of the median scar curves acutely forward and unites with the narrow median septum, at least a millimeter in length, which extends forward to within less than a millimeter from the anterior margin of the valve. Anteriorly, the median muscular scar bears a faint median striation. Posteriorly, the lateral muscular scars of the platform are limited at a point 2.5 millimeters from the acute anterior termination of the median scar. Half a millimeter farther back lie the posterior margins of the three crescentic lobes of the faint muscular impression characteristic of the genus *Lingulops*. Of these lobes, the median is equal to or is slightly larger than the two lateral lobes. The faint lateral impressions, on each side of the platform, appear to be similar to those of *Lingulops norwoodi*.

From the preceding description it is evident that *Lingulops cliftonensis* resembles *Lingulops norwoodi* much more closely than was suspected at the time of the original description of the species. The presence of the anterior median septum was not known until recently, when the shell of the type specimen was removed, so as to expose fully the natural cast of the interior of the valve. From the latter species, *Lingulops cliftonensis* differs chiefly in the more acute anterior termination of the muscular platform. Apparently the lateral walls of this platform are more divergent. It is doubtful whether the elevation of the median and lateral muscular scars upon a platform may be regarded as a distinguishing feature, since the growth of this platform may be merely a gerontic feature.

Lingulops cliftonensis occurs in the lower or limestone division of the Fernvale member of the Richmond group as exposed at Clifton, Tennessee. For the strata included in the Fernvale member the present writer proposed the name Leipers Creek bed, the term bed being used in the same significance as the term member (Bull. Geol. Soc. Am. Vol. 12, 1901, pp. 432, 433). Although the term Leipers Creek bed preceded that of Fernvale in time of publication, the latter was so much better defined by Ulrich and Hayes (Columbia Folio, 1903), and has entered so fully into literature that no possible good can come of any attempt to revive the term Leipers Creek bed.

Lingulops cliftonensis is of interest chiefly as being another species occurring in Richmond strata, closely allied to species occurring at a lower horizon than the Eden group, but not known either from the Eden or from the Maysville group of strata.

Schuchertella higginsportensis, Foerste. Plate IX, Figs. 2A, B.

1912. Strophomena higginsportensis, Foerste, Bull. Sci. Lab. Denison Univ., 17, p. 37, pl. 2, figs. 3 A, B; pl. 10, fig. 4.

1914. Strophomena higginsportensis, Foerste, Jour. Cincinnati Soc. Nat. Hist., 21, p. 130, pl. 1, fig. 9.

The pedicel valves, illustrated in the publications cited above, are similar to those of *Schuchertella subplana*, Conrad, widely distributed in the Niagaran rocks of North America, in the small size and general form of the muscular area. The deltidium is well developed. The exterior of the valve is moderately convex toward the beak, and comparatively straight from the beak to the anterior and lateral margins.

More recently, a single brachial valve, exposing the interior, has been found. This also differs distinctly from *Strophomena*. The cardinal process is short and bilobed. The lobes diverge from each other, and each lobe bears on its upper surface a distinct groove, the two grooves converging toward the beak, as in some species of *Schuchertella*. The margin of the crural plates curves outward laterally, and terminates in a curve rising toward the cardinal margin. The dental sockets are distinct. There is no evidence of a deltidial fold passing across the top of the cardinal process as in *Schuchertella subplana*. There may be a low and broad, but indistinct median elevation anterior to the cardinal process, but it is certain that no other structure is noted.

The brachial valve here described was found in slabs that had dropped from the *Eridorthis* horizon at Ivor, Kentucky. At this locality the Fulton clay, characterized by the presence of *Triarthrus becki*, Green, occurs 70 feet above the level of the railroad track. A single specimen of *Eridorthis* once was found in the layer of limestone immediately beneath the Fulton clay, but the species is much more common in some of the overlying horizons, although, owing to the steepness of the quarry-face, the exact location of this horizon is difficult to determine here.

At the quarry west of Point Pleasant, Ohio, the Fulton clay, containing *Triarthrus becki*, is about 55 feet above the level of the pike. The immediately underlying layer of limestone is strongly ripple marked, and a single specimen of *Eridorthis* was found imbedded in its upper surface. Loose limestone slabs, containing a greater number of specimens of *Eridorthis*, were found at 14, 20, and 27 feet above the base of the Fulton layer. Evidently *Eridorthis* must be abundant somewhere above these horizons.

At the quarry in the northeastern part of New Richmond, Ohio, the Fulton clay, containing *Triarthrus becki*, has a thickness of at least five feet. A specimen of *Eridorthis* was found at the top of the immediately underlying layer of coarse grained limestone. *Eridorthis*, associated with a *Leptæna*, provisionally identified as *Leptæna gibbosa*, James, is comparatively abundant in a thin layer of limestone occurring within one foot above the base of the Fulton clay. *Eridorthis* occurs in situ also in a four inch layer of conglomeratic limestone, located about 29 feet above the base of the Fulton clay. This may have been the horizon which furnished the loose slabs, containing *Eridorthis*, in the quarry west of Point Pleasant, Ohio, and this also may have been the approximate horizon for the specimen of *Schuchertella higginsportensis*, obtained at Ivor, Kentucky.

Schuchertella has not been identified hitherto from strata below the Silurian. It may be that when the material now congregated under *Schuchertella* is studied more closely that species here described as *Schuchertella* may be separated from that genus, but at present this reference to *Schuchertella* appears at least more logical than its former reference to *Strophomena*.

The exterior of a brachial valve, figured here (Fig. 2B) as belonging to *Schuchertella higginsportensis*, is characterized by about 21 stronger radiating striæ, separated by an equal number of finer striæ. Intercalated with these two sets is a third set of still finer striæ, about 40 in number, and finally, toward the margins, there are still finer striæ, visible only under a lens, so that the total number of radiating striæ must equal about 150. These are crossed by numerous, fine, sharp, concentric lines. The median depression, seen in the figure, is regarded as due to pressure, resulting in flattening and moderate distortion.

EXPLANATION OF PLATES.

Plate VIII.

Fig. 1. Zaphrentis digoniata. A, right side; B, anterior side; C, basal view, with corallum inclined so as to show more of the right side; D, E, two silicified specimens, showing the cardinal fossula, sides of calice weathered away. F, view of cast of interior of calice; G, lateral view, showing cast of cardinal fossula. A-E, from top of West Union formation, in Zink quarry, at Hillsboro, Ohio.

Fig. 2. Calostylis parvula. A, specimen showing pores in central area and through the septa; also showing lateral connections or synapticula between the outer part of the septa; also shown enlarged in figure 5, on plate II. B, C, lateral views of two specimens. D, E, calicular views of two specimens. F, view of E, enlarged 4 diameters, showing pores in the central vesicular mass, and several distinct synapticula on the left side of the figure. From the upper part of the Laruel limestone at the Reinheimer quarry, southwest of New Paris, Ohio.

Fig. 3. Holophragma calceoloides. A, B, right side of two specimens; C, D, anterior views; E, F, G, posterior views. H, anterior view with specimen inclined so as to show interior of a nearly circular calice; I, same specimen, enlarged 4 diameters. J, K, similar views of a specimen with a more flattened cardinal side. In both H and J the anterior margin of the calice is weathered away. From the top of the West Union formation, in the Zink quarry, at Hillsboro, Ohio.

In all figures, a indicates the location of the alar septa; c, of the cardinal septum; f, the cast of the cardinal fossula; x, the slightly more prominent lateral septa in some specimens of Holophragma.

Aug. F. Foerste.

Plate IX.

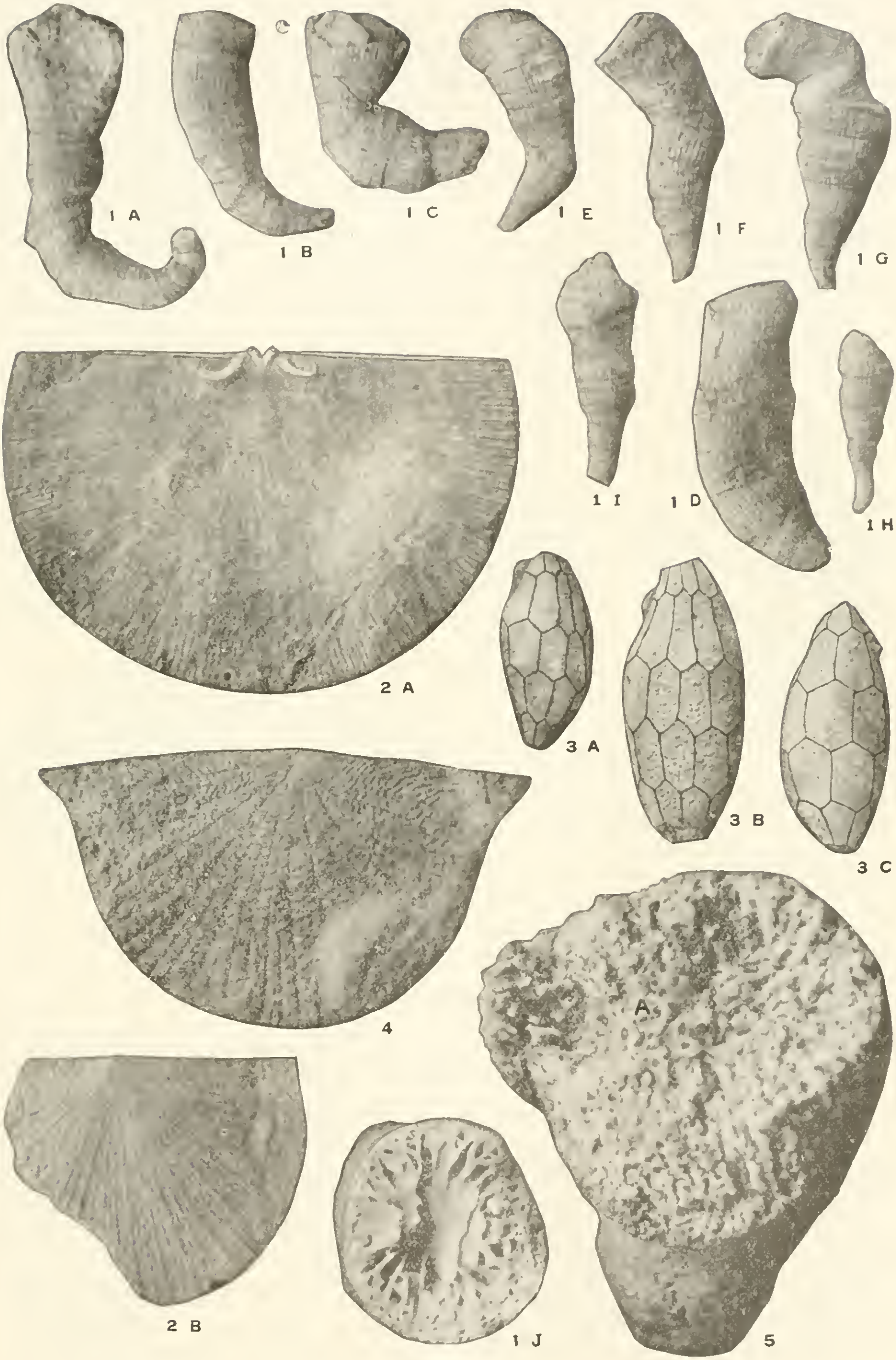
Fig. 1. Cyathophyllum roadsi. A, B, C, D, left sides; E, F, G, right sides of coralla; H, I, nearly straight individuals. Specimens B, E, F, and H retain their areas of attachment. J, internal structure revealed by a transverse break; with transverse tabula at center, with the edge of another beneath on the right, and fragments of two more above on the left; with septa radiating toward the center, and with dissepiments numerous near the outer wall where there is a tendency toward filling by stereoplasm; magnified 2.5 diameters. From the upper part of the West Union formation at Hillsboro, Ohio.

Fig. 2. Schuchertella higginsportensis. A, interior of brachial valve; exterior of another valve regarded as belonging to the same species; both enlarged 2.5 diameters. From the Eridorthis nicklesi horizon, above the Fulton clay, at Ivor, Kentucky.

Fig. 3. Holocystites greenvillensis. A, B, left sides; C, right side of theca; three specimens, imperfect at top and bottom, with anal opening between first and second row of plates from the top, that of specimen B diagrammed on plate III in figure 8. From the Cedarville dolomite, 4.5 miles east of Greenville, Ohio, on Greenville creek at the Brierly quarry.

Fig. 4. Stropheodonta sp. Cast of exterior of a valve, enlarged 2.5 diameters, assumed to have been the convex or pedicel valve since the cast is distinctly concave anteriorly. The postero-lateral angles are not preserved and may not have been acute, as indicated. From the Cedarville dolomite at the Lewisburg Stone Company quarry, a mile northwest of Lewisburg, Ohio.

Fig. 5. Calostylis parvula. Same specimen as fig. 2A, on plate I, enlarged 4.5 diameters. The presence of pores passing through the central mass of septa and tabulae is seen near A, especially toward the right. Disseppiments or synapticula connecting the septa are visible along the lower weathered part. From the upper part of the Laurel limestone at the Reinheimer quarry, southeast of New Paris, Ohio.



Aug. F. Foerste.

Plate X.

Fig. 1. Periechocrinus cylindricus. A, internal cast, retaining outlines of one of the sets of interradial plates on the left, beginning with *ir*. B, another cast, retaining outlines of anterior brachial series, immediately above radial *r*, and also of the adjacent interradial sets of plates. From Cedarville dolomite, at the eastern Mills quarry, southwest of Springfield, Ohio.

Fig. 2. Lampterocrinus inflatus-minor. A, posterior view of internal cast, with tegmen strongly inflated on left side of posterior interradial area; *pb*, posterior basal, with infra-basals beneath. B, view of right anterior interradial area; the inflated posterior part of tegmen not seen on account of tilting; *Ar*, anterior radial. From euphemia dolomite, at Jackson quarry, two miles south of Covington, Ohio.

Fig. 3. Periechocrinus tennesseensis. Interior cast; *Ar*, anterior radial. From the Cedarville dolomite at the eastern Mills quarry, southwest of Springfield, Ohio.

Fig. 4. Dictyonella reticulata. A, brachial valve; B, same, enlarged 2.5 diameters. From upper Osgood clay, at Harrods Creek, 5 miles northeast of Louisville, Kentucky.

Fig. 5. Habrocrinus benedicti. A, anterior view, *Ar*, anterior radial; plates absent from upper part of body. B, view of internal cast of tegmen, with base of anal tube; right posterior ray terminating in two arms. Found in lower part of quarry in eastern part of Muncie, Indiana, on west side of river, above the horizon of the Cedarville dolomite of Ohio.

Fig. 6. Habrocrinus sp. Posterior view, with upper right-hand part crushed in, accompanied apparently by a displacement of the anal tube whose present location is indicated by the dotted lines; *X*, first anal plate. From the Cedarville dolomite at the eastern Mills quarry, southwest of Springfield, Ohio.

Fig. 7. Stricklandinia louisvillensis. Two brachial valves.

Fig. 8. Holocystites greenvillensis. Diagram of plates surrounding the anal area, enlarged.

Fig. 9. Lingulops cliftonensis, Foerste. Pedicel valve, enlarged. Richmond group, at Clifton, Tennessee.

Fig. 10. Acervularia (?) paveyi. Radiating septa apparently interrupted half way from center by a cylindrical wall, the actual presence of which has not been fully verified. From the upper part of the West Union formation at Hillsboro, Ohio.

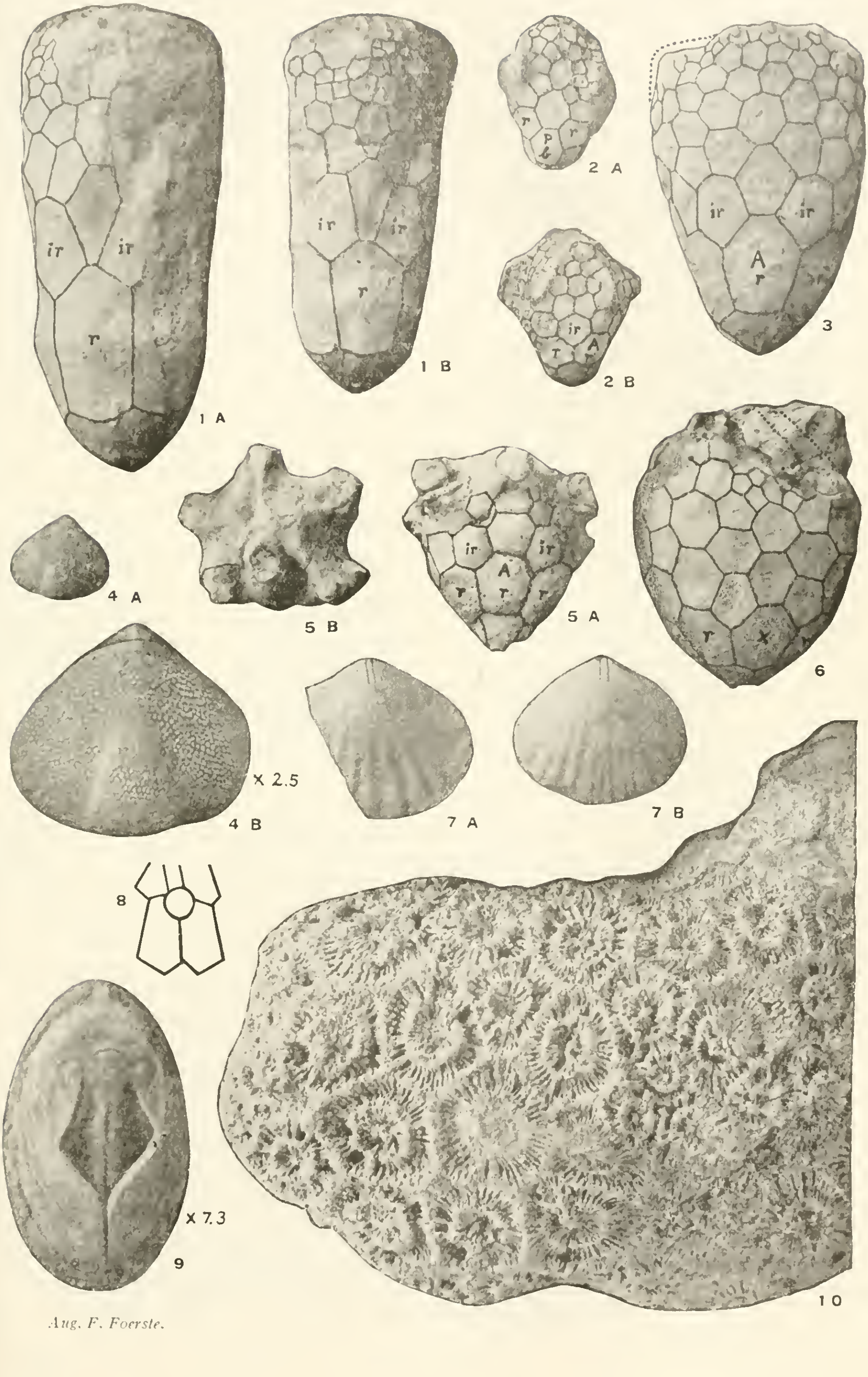


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Plate XI.

Fig. 1. Trochurus phlyctainodes. A, dorsal view of cranidium with subtriangular occipital segment, exposing occipital lobes near the lateral extremities of this segment; B, same, tilted so as to show the anterior border; C, anterior view; D, lateral view; b, anterior border; s, probably spinose tip of occipital segment; e, angle of facial suture at palpebral lobe; x, broken margin of fixed cheek, outline unknown. In figure A, the fixed cheek extends beyond the margin of the third lateral lobes; in B, the third lateral lobes form the bulbous outlines at the rear, and that part of the facial suture extending from the anterior border to the palpebral lobe is not preserved; in D, the occipital lobe is indicated. Cedarville dolomite, at eastern Mills quarry, southwest of Springfield, Ohio.

Fig. 2. Hallicystis imago, Hall. Type, numbered 2025 in the American Museum of Natural History in New York City. Left margin imperfect, broken off. Indication of path of gut leading from anal orifice downward and toward the right. Pectinirhomb on plates 14 and 15 visible on right margin. Racine dolomite, at Racine, Wisconsin.

Fig. 3. Callocystites jewetti-elongata. Impression of cast of exterior of part of a specimen showing the pectinirhomb on plates 14 and 15, the depressed linear area left by the dropping off of one of the ambulacralia, and the distinctly pitted surface. Cedarville dolomite, at eastern Mills quarry, southwest of Springfield, Ohio.

Fig. 4. Holocystites alternatus, Hall. Type, numbered 2020, in the American Museum of Natural History. Tilted so as to show the plates around the anal aperture; this tilting greatly shortens the length of the lower plates in the figure. The path of the gut was downward and slightly toward the right from the Anal orifice, A. Racine dolomite, at Racine, Wisconsin.

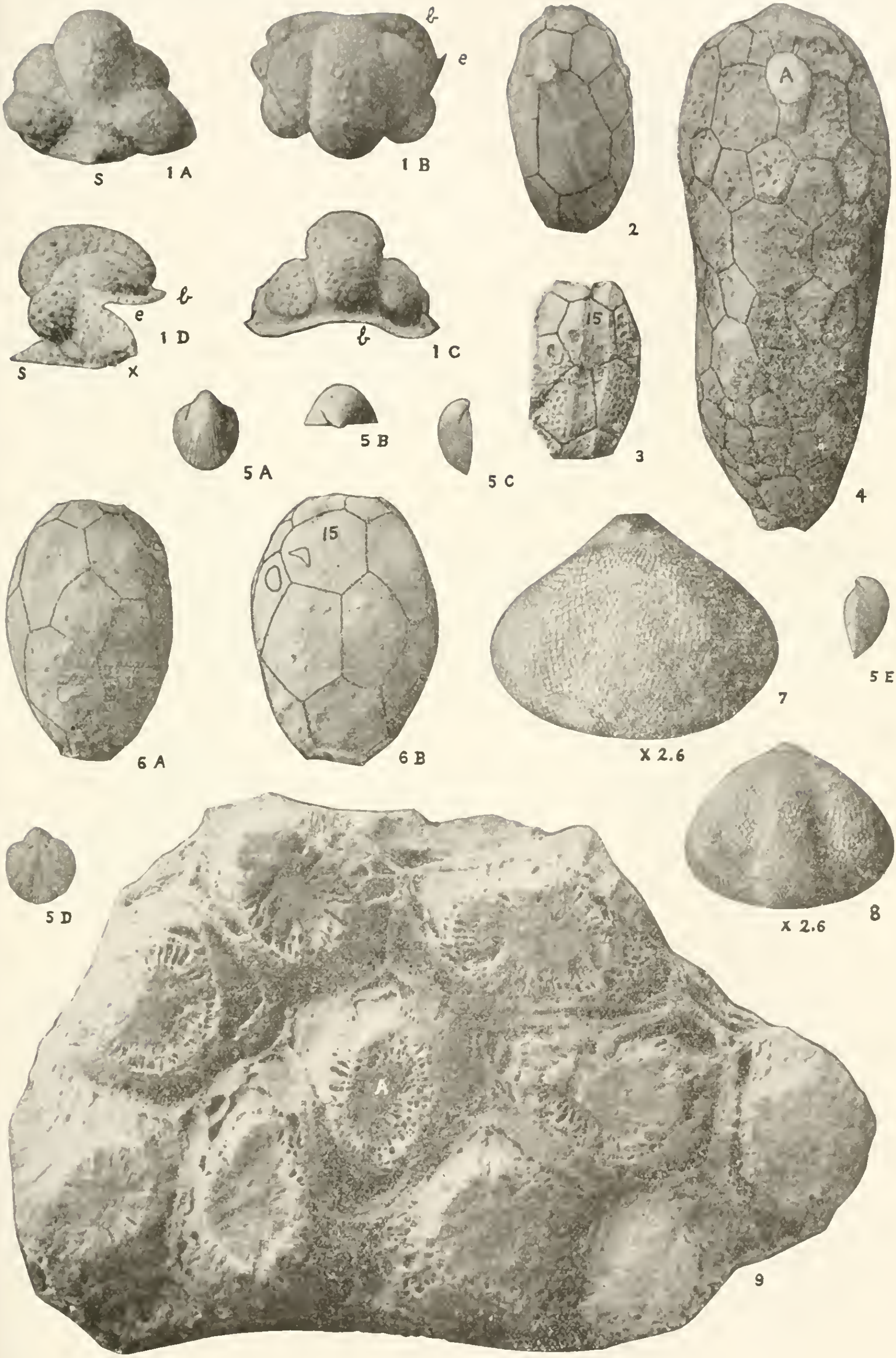
Fig. 5. Dalmanella springfieldensis. A series of internal casts; A, pedicel valve; B, anterior view; C, lateral view of another specimen, all showing the prominent dental lamellae. D, brachial valve with beak of pedicel valve at top; E, lateral view of the same specimen. Cedarville limestone, at eastern Mills quarry, southeast of Springfield, Ohio.

Fig. 6. Callocystites jewetti-elongata. A, view of cast of interior, showing pectinirhomb on plates 1 and 5, of which only the half on 5 is well preserved; the location of the pectinirhomb on plates 12 and 18 is indicated at the upper right-hand margin. B, same specimen, showing pectinirhomb on plates 14 and 15. Cedarville dolomite, at Cedarville, Ohio.

Fig. 7. Dictyonella reticulata, Hall. Type, numbered 1944 in the American Museum of Natural History. Brachial valve, and beak of pedicel valve, enlarged 2.6 diameters. From the Waldron shale at Waldron, Indiana.

Fig. 8. Dictyonella corallifera, Hall. Type, numbered 1790, in the American Museum of Natural History. From the Rochester shale at Lockport, New York. Original or figure 5c on plate 58 of New York Paleontology, vol. 2, enlarged 2.6 diameters.

Fig. 9. Grabauphyllum johnstoni. Interior structure, near upper surface of corallum, seen from beneath. Central tabulae, smooth beneath; intermediate zone of septa connected by disseppiments well shown at A; exterior zone of cysts and walls separating corallites seen above and toward the right of A. Niagaran dolomite, quarry near McCook, five miles southwest of Chicago, Illinois.



Aug. F. Foerste.

PLATE XII.

Fig. 1. Trochurus phlyctainodes, Green. Cast of type prepared by Green and numbered 54 in his series of casts of Trilobites. Original found in the Cedarville limestone at Springfield, Ohio. In this, and in the following series of figures of species of Trochurus A represents the dorsal view of the cephalon; B, anterior view of the dorsal part, secured by tilting the cephalon until the anterior border is horizontal; C, anterior view of cephalon, with the anterior border transverse to last position; D, lateral view, with dorsal side on left in figures 1, 3 and 4, but forming upper outline in figure 2.

Fig. 2. Trochurus hanoverensis, Miller and Gurley. Type, numbered 6141 and preserved in the Walker Museum of Chicago University. From the Laurel limestone at Madison, Indiana.

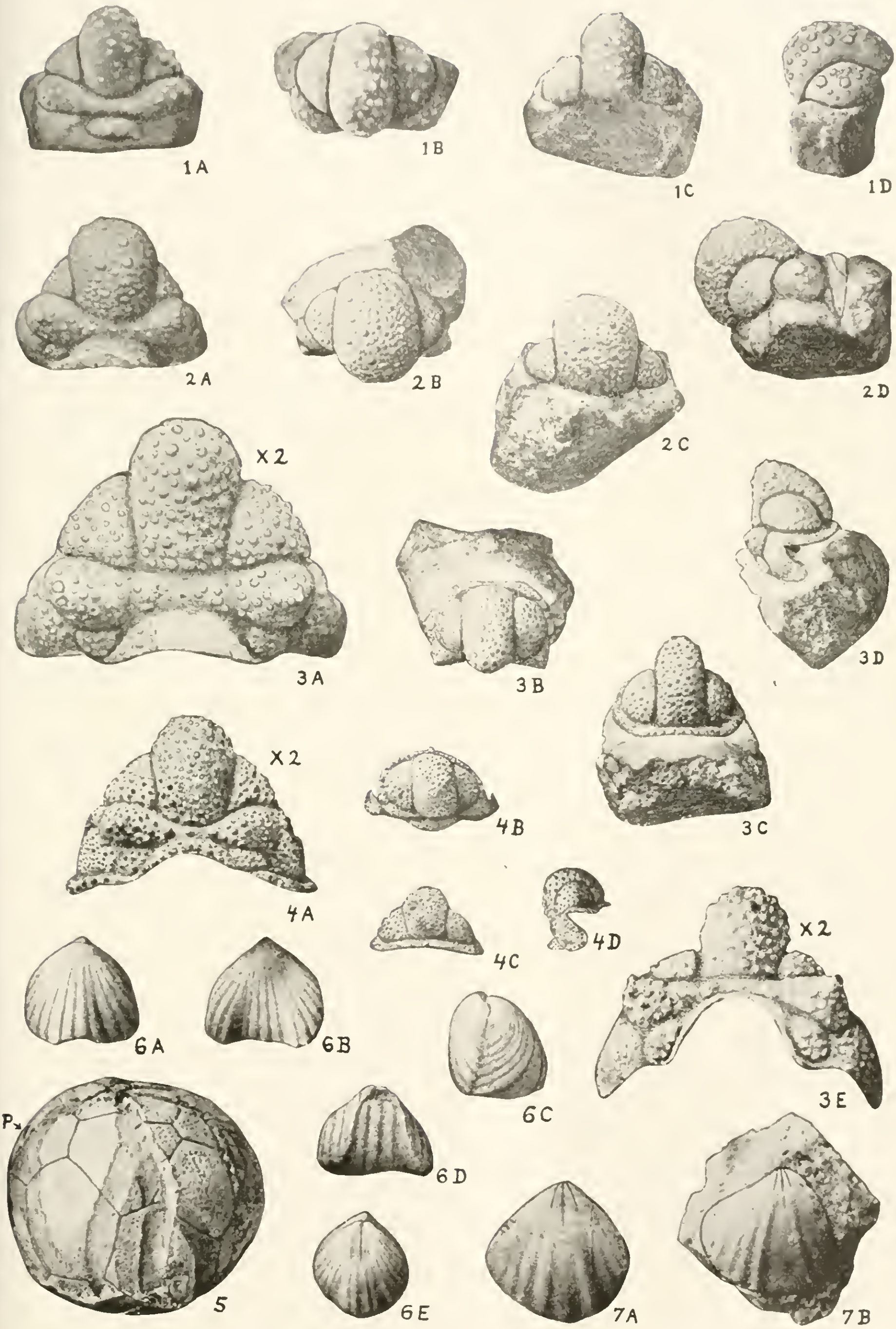
Fig. 3. Trochurus byrnesanus, Miller and Gurley. Type, numbered 6839 and preserved in the Walker Museum at Chicago University. From the Laurel limestone at Madison, Indiana. A, E, enlarged two diameters. In E, the cephalon is tilted toward the front so as to show the upper outline of the third lateral lobes, a direct view of the occipital lobes, and the posterior part of the fixed cheeks, their raised granulated posterior border, however, being absent.

Fig. 4. Trochurus halli. Original of figures 2 a, b, c, on plate 70 of volume 2 of the Paleontology of New York, numbered 1826 in the American Museum of Natural History in New York City. A, enlarged two diameters. From the Rochester shale, near Albion, New York.

Fig. 5. Callocystites sphaeroidalis. From an impression of a cast of the exterior, crossed by a crack as described in the text; p, location of the discrete half of the pectinirhomb on plate 15. From the Cedarville dolomite at Springfield, Ohio.

Fig. 6. Camarotoechia roadsi. A, brachial valve; B, pedicel valve; C, lateral view; D, anterior view showing depth of sinus; E, cast of interior of brachial valve of a second specimen, showing muscular area and median septum. From the lower part of the West Union formation on the southeastern margin of Hillsboro, Ohio.

Fig. 7. Prosserella (?) sp. Two casts of the interiors of pedicel valves, showing vertical lamella supporting the teeth, and also a median septal ridge. From the Cedarville dolomite at Cedarville, Ohio.



Aug. F. Foerste.

DESCRIPTIONS OF NORTH AMERICAN TABANIDÆ.

James S. Hine.

Tabanus annularis n. sp.

Eyes hairy. General color nearly black, thorax very hairy and obscurely striped, abdomen dorsally with the posterior margin of each segment narrowly reddish gray, wings hyaline with the veins dark, first two segments of the antenna and tip of the third dark, remainder of the third segment brown with a prominent basal process. Length, 10 to 12 millimeters.

Male—Eyes very distinctly hairy, legs black with the exception of the tibiæ, each of which has the basal half or more reddish brown.

Female—Eyes plainly hairy, front of normal width, sides parallel, frontal callosity as wide as the front and shining black, ocelligerous tubercle present, denuded; otherwise front and the face gray pollinose. Legs, especially the femora, more reddish brown than in the other sex.

Holotype male, one other male and a female in the Ohio State University collection, taken at Ocean Springs, Mississippi, April 18, 1916, by Max Kisluik. The female is a poor specimen of rather diminutive size. Both sexes have the color of the body exactly the same.

The most distinctive character of this species is the elongate basal process of the third antennal segment. In this respect the species agrees with hirtioculatus Macquart.

Tabanus dæckei n. sp.

Eyes hairy. Antennæ largely brown, apical two-thirds or more of the third segment black, palpi pale, proboscis black, thorax dark brown without stripes, legs reddish brown, slightly darker in some places than in others, wings brownish hyaline; abdomen brown with a dorsal black stripe and venter darkened towards the apex. Length, 14 millimeters.

Female—Frontal callosity nearly square not so wide as the front, an unconnected line above and ocelligerous tubercle shining black. Otherwise front and the face gray pollinose.

Male—Like the female in coloration, head small, eyes distinctly hairy.

Holotype female from Cape May, New Jersey, June 7, 1904. Allotype from Fort Lee, New Jersey, June 3, both collected by E. Dæcke. One other female taken at Wallops Island, Virginia, June 2, 1913, by W. L. McAtee. In Ohio State University collection.

This species is some like Tabanus epistatus O. S., but is smaller the wings are differently colored and the antennæ are shorter. The difference in length of the antenna in the two species is largely in the basal part of the third segment. This is short and wide in dæckei but elongate in epistatus. The frontal callosity has a geminate appearance and is not joined to the spot above in dæckei, but is entire and joined to a linear prolongation above in epistatus.

Tabanus petiolatus n. sp.

Female—Eyes naked, front rather narrow, frontal callosity dark brown decidedly longer than broad tapering above and continuing into a linear prolongation which reaches nearly to the last fourth of the front; remainder of the front and the face gray pollinose, cheeks with numerous white hairs, palpi pale, proboscis dark, antenna black with just a little brown at the base of the third segment, basal process of the third small and acute. Thorax dark brown above with gray stripes, scutellum dark on the disk but with a pale posterior margin, pleuræ of the thorax and the coxæ gray pollinose and with some white hair. Wing hyaline with a very faint brownish tinge, first posterior cell closed and with a distinct petiole, anterior fork of the third vein angulate near the base and with a very short fork or none. The holotype has this very short fork on one side but none on the other. Front femur, apical third of front tibia and front tarsus black, base of the front tibia pale, middle and hind legs pale brown, femora above and tarsi dark, dorsum of abdomen dark brown, nearly black, with a middorsal row of prominent gray triangles and the incisures gray-margined on each side; venter grayish brown, last segment nearly black and most of the other segments darkened at the middle. Total length, 15 millimeters.

Holotype female and two other females taken from a horse at Lecompte, Louisiana, Augusta 25, 1906. In Ohio State University Collection.

This species suggests melanoceras, but is smaller and lighter colored and the first posterior cell is closed and long petiolate.

Tabanus uniformis n. sp.

Eyes naked; general color of the body brown with gray pollinose markings, proboscis dark, palpi brown, antenna brown with more or less darker color on the apical two-thirds of the basal portion of the third segment which bears a short basal prominence. Thorax with rather distinct stripes above, scutellum and pleuræ uniformly gray, legs brown throughout but in some specimens the tips of the tarsi are somewhat darker than the other parts; wings hyaline, cross-veins, furcation of the third vein and in some specimens some of the longitudinal veins margined with rather obscure brown. Abdomen brown above, slightly darker towards the apex, a middorsal row of gray triangles which are rather small and of uniform size throughout, venter brown darker toward the apex and sparsely gray pollinose. Total length, 19 to 22 millimeters.

Female—Front moderately wide, slightly narrowed below, frontal callosity shining brown, above with a narrow prolongation which is somewhat expanded apically, remainder of the front and the face gray pollinose.

Male—Colored like the female, head of normal size, eyes with small facets below and with an extended area of enlarged facets above, antenna somewhat slenderer than in the other sex.

Holotype female in the Ohio State University collection taken in Jackson County, Kansas, by J. H. Schaffner. Allotype from Missouri. Twenty other specimens from Kansas, Mississippi, Louisiana and Alabama.

The species has been in my collection for several years and for a time it was labeled molestus. It appears entirely distinct from molestus, however, for it is a browner insect, the femora are not black, the abdominal triangles are generally smaller and of uniform size, and the wings are quite differently colored.

Tabanus nantuckensis n. sp.

Female—Eyes bare, front wide, subcallus denuded and shining black, frontal callosity shining black and decidedly broader than high. Whole body and all the appendages black with the exception of the extreme base of the anterior tibia which is pale, and the wings which have the anterior half or more brown. The division between the brown and black of the wings is not regular but approximately all the posterior cells, the discal cell and the axillary cell are wholly brown, while the basal cells and the anal cell have their apexes narrowly brown. Total length, 20 millimeters.

Holotype female taken by Benjamin Albertsen, of Philadelphia, on Nantucket Island, Massachusetts, August 14, 1916. In Ohio State University collection. I have five other females and have seen two others, all taken on the same island by the same collector.

It is near atratus in many respects and might be considered as a variety of that species, but the smaller size and different wings give it a very different appearance.

There is reason to believe that this insect has become isolated on the island for it has not been taken elsewhere so far as I can find. Mr. Albertsen writes that he has taken several specimens through a series of years and has found that they are uniformly the same. With a knowledge of these facts I have chosen to consider this and atratus separate species.

NEWS AND NOTES

The Third Annual Meeting of Entomological Workers of Ohio was held at Ohio State University on February 2d, 1917, with thirty members in attendance. The program consisted of reviews of projects and reports on investigations of members of the Ohio Experiment Station, the State Division of Orchard and Nursery Inspection and the Department of Entomology of the University. The following program was presented:

Distribution of Ohio Broods of Periodical Cicada with Reference to Soil, H. A. Gossard.

General Reports from Heads of Department Organizations:

H. A. Gossard, Ohio Experiment Station.

N. E. Shaw, State Division of Orchard and Nursery Inspection.

Herbert Osborn, Department of Zoology and Entomology, Ohio State University.

H. A. Gossard, Review of Projects.

J. S. Houser, Review of Projects.

W. H. Goodwin, Review of Projects.

R. D. Whitmarsh, Review of Projects.

D. C. Mote, Review of Projects.

J. L. King, Review of Projects.

Richard Faxon, Nursery Imports.

F. D. Heckathorn, Winter Work in Nurseries and Surroundings.

H. E. Evans, An Inspector's Itinerary for a Year.

H. J. Speaker, Report of Control of Gypsy Moth Outbreak.

C. L. Metcalf, Predaceous Insects.

C. J. Drake, Notes on Aquatic and Semi-aquatic Hemiptera of Ohio.

Herbert Osborn, Problems with Meadow Insects.

T. L. Guyton, Aphididæ of Ohio.

A permanent organization was effected and the following officers elected for 1917–18:

N. E. Shaw, Chairman.

J. S. Houser, Secretary.

C. L. Metcalf, *Secretary.*

Date of Publication, May 5, 1917.

THE

Ohio Journal of Science

PUBLISHED BY THE

Ohio State University Scientific Society

Volume XVII JUNE, 1917 No. 8

TABLE OF CONTENTS

XENIA AND OTHER INFLUENCES FOLLOWING FERTILIZATION.*

Adolph E. Waller.

Occurrence of Xenia.

A great deal of confusion between near and remote influences from alien pollen has come about as the result of laxly grouping together under the topic "xenia," a miscellaneous assortment of phenomena more or less closely associated with fertilization and embryo development. Xenia is hybridization exposed. The effect of foreign pollen is made immediately apparent in the endosperm of some angiosperms. Maize has come to be the classic example for illustrating xenia, but Von Rumker (1) in 1911, and others have called attention to its occurrence in rye. Though known best through the cultivated plants, it is possible to have xenia in any of the angiosperms in which differences exist in the color or composition of the endosperm. In many species differences really present may not be known because the endosperms are covered by other, often opaque,

*Contribution from the Botanical Laboratory, Ohio State University, No. 97; Read in New York City before the thirteenth annual meeting of the American Genetic Association, December 28, 1916.

parts of the seeds. In these plants xenia would not become patent until the seeds were cut open and the endosperm tissue disclosed.

In members of the Graminaceæ, and especially in the cultivated cereal crops with their superior development of endosperm, xenia has been observed for a long time. Until recently it has been marveled at, not only by agriculturists, who probably first saw the phenomenon, but also by botanists, who noted, yet were unable to account for it. Many of the latter were unwilling to credit the possibility of an immediate effect of pollen and they attempted to explain what they saw as the result of previous hybridization.

Origin of the Name.

The word xenia, (Gr. xenios), means hospitality. When in 1881, Focke (2) first named the influence of foreign pollen, he evidently had in mind only the genial, (or xenial), relations existing between guest and host and in his own words, regarded this variation from the normal form as a present from the plant given pollen to the one taking it (Gastesbeschenk). He did not limit the extent of the influence to any special tissue or part of the plant, so we find him passing without an effort from xenia in maize, an actual case, to an effect in peas in which the seed coat and even the pod color is involved. He likewise applies the name xenia to a darkening observed in grapes, when pollen from a dark variety was transferred to a variety of lighter color. Presumably, in this case it is the pericarp that is to be understood. If the pericarp is meant the example cannot be properly classed as xenia, as will be shown later.

In peas, vetches and lilies mentioned in his writings as illustrations of xenia the variations are more than likely due to a previous cross fertilization and hybridity rather than to any immediate effect of the pollen, and Focke himself so additted by taking the precaution to state that he was not sure that these citations were after all, xenia.

It is worth while noting that previous hybridity had always been the stumbling block in the paths of those whose efforts were directed towards demonstrating the existence of xenia, and it was to disprove allegations of hybridity, I mean hybridity resulting from a cross fertilization taking place at some unknown time in the past, that a number of the early experiments were planned, especially those of VILMORIN and of HILDEBRANDT in 1867, and of KORNICKE (3) in 1872.

Kornicke's investigations are of exceptional interest inasmuch as he concluded that the influence of the pollen is immediately apparent in those races of maize in which the color is in the aleurone layer. Likewise that the effect of xenia does not pass out of the endosperm or appear in any other part of the seed. He went a step further, offering objection to HILDEBRANDT's work on the grounds that the color in the races used by HILDEBRANDT was located in the pericarp and therefore could not appear as the immediate effect of the pollen.

It is plain, therefore, that nearly ten years before the term xenia was proposed, the need of limiting it to a definite expression occuring in a definite tissue was felt. And even though FOCKE's interpretation admitted of a wide range of examples and rather indefinite ideas of the nature of this influence, maize became the medium used for the experimental demonstration of xenia, partly due to the fact that the results were easily secured, and partly because those obtained for maize were beyond dispute. This should be remembered in connection with the more modern investigations in endosperm formation and the discovery of triple or multiple fusion.

In 1899 both DE VRIES (4) and CORRENS (5) published papers on xenia. De Vries, who used a pure strain of sweet corn onto which he crossed pollen from a strain of starch corn showed that the kernels exhibiting xenia proved to be true hybrids when grown the second year. In other words, since he was sure that hybridization had not taken place in the races he was using, xenia served as an indicator to separate those seeds which when planted would produce hybrid plants from those which would produce the original pure strain. CORRENS concluded that the influence of the foreign pollen is limited to the endosperm, affecting only the color or the composition of the reserve food materials.

Xenia and Triple Fusion.

On August 24, 1898 NAWASCHIN (6) reported for the first time before the Russian Society of Naturalists the triple fusion which takes place between the two polar nuclei and the second sperm. This one finds occasionally referred to as "double fertilization," though this name is open to serious objection since double fertilization properly describes eggs fertilized by two sperms. In triple fusion the fusion has nothing to do with the fusion of the egg and the sperm, but bodies outside the egg fuse with another sperm. Shortly after NAWASCHIN'S paper was read, GUIGNARD (7) published a complete description of triple fusion with a number of figures announcing that the process is common throughout the angiosperms generally instead of being limited to the Liliaceæ, as was first supposed. The year before this significant morphological evidence was made known, CORRENS in the paper above referred to, drew the inference that triple fusion possibly was the means of explaining xenia, though no detailed researches on the development of the endosperm had been undertaken. The relation between triple fusion and endosperm formation also was suggested. It remained for GUIGNARD (8) in 1901 to clear up all doubt as to the occurrence of the same process in maize as takes place in the formation of endosperms of other angiosperms. In a number of different species MERREL, LAND, COULTER and others have demonstrated that triple fusion is general among the angiosperms, the typical case being where two polars, one micropylar and the other antipodal, of the female gametophyte, fuse to form the definitive nucleus. It is with this nucleus that the second male cell from the pollen tube unites.

As soon as it became certain that there is a triple fusion in the formation of the endosperm, xenia was no longer a mystery but is now regarded as an occurrence as normal as seed formation itself. The writer (9) pointed out somewhere else that it is a simple matter to demonstrate xenia experimentally in definite areas on an ear of corn as desired, and was able to produce an ear, a photograph of which appears in the paper referred to, on which about one-fourth of the grains appeared blue, while the grains in near by rows were pure white. This was done by careful manipulation of the silks and the application of pollen from a race of contrasting color in the aleurone layer. The value of this experiment is twofold, for it establishes the fact that the variation is due to an effect of the pollen, since only those grains within that area in which it was desired to produce the color appeared blue, and second, because the occurrence was in harmony with the expectation it was explainable as the normal result of the chromosome mechanism. What is this mechanism that causes xenia? In the processes preceding fertilization in the angiosperms the pollen tube discharges its contents of the two male cells into the embryo sac. One of these cells reaches the egg cell and by fusing with it completes fertilization. Rapid divisions take place in the fertilized egg and the embryo is formed. In order for the endosperm to be formed, the second male nucleus must enter into a fusion also and with the definitive nucleus which has arisen as the result of the fusion of the polar nuclei. Hence the name triple fusion aptly describes this union.

Xenia and Xeniophyte Tissue.

The resulting endosperm is therefore a unique tissue in the Plant Kingdom. Since it is a fusion product, as is the embryo, it must contain more than the haploid (x, or gametophytic), number of chromosomes. On the other hand, although formed similarly to the sporophyte, it contains more than the 2x or diploid number. Since the definitive nucleus is made up of two polar nuclei, each containing a full set of chromosomes and another set is brought in by the male cell, the endosperm must have at least 3x, or a triploid number of chromosomes. However, the number is not necessarily limited to three, for in some cases adjacent cells start fusing with the polars before the male cell joins in the fusion. Because of its unparalleled origin, the endosperm is different from the sporophyte and yet, unlike the so-called "endosperm" of gymnosperms, is not female gametophyte. So TRELEASE (10) has named this tissue, which he characterizes as "neglected," the xeniophyte, for it is here and here only that xenia will be expressed if it is to appear.

The formation of the xeniophyte is so closely associated with the formation of the sporophyte, that one would expect to find them closely related to one another in the plant's life processes. This is actually the condition. They are side by side in the seed and in sprouting the growing embryo parasitically consumes the reserve store of food materials of which the xeniophyte is composed. As far as the heredity is concerned, this use which the plant is able to make of the stored food materials of the endosperm disposes of the nx chromosome number of the xeniophyte tissue, and together with that any irregularities in the expression of the contained chromosomes.

Immediate Effect of the Pollen Limited to the Endosperm.

In view of the special mechanism operative in endosperm formation, xenia has come to hold a limited meaning, a restriction in meaning that was pointed out by one far-sighted botanist at least ten years before the word came into print. Certainly then, there should be no confusion in the significance of the term with the morphological evidence as clear as we now have it, nor is there any excuse for carrying the name of a perfectly definite and limited effect over into another field where the effects are from undetermined causes. But modern textbooks are by no means clear on the subject, and even Coulter (11) makes a statement that is so ambiguous that it might entirely prevent one who did not already know from finding out what xenia in corn is, instead of being able to demonstrate it to his own satisfaction. The statement reads: "For example, when a race of white or yellow corn is crossed with pollen from a race of red corn, many of the resulting kernels are red or mottled." By red corn those varieties with red in the pericarp only are generally understood, since corn with red pericarp is commonly enough grown as field corn, and white corn crossed with pollen from this would not have a red or mottled appearance. Doubtless this is one of those small, ludicrous mistakes from which no first editions are free; there are strains of corn with reddish endosperm, no doubt, but they are not common nor would they first come to mind when "red corn" is spoken of. If the author had said blue or purple, instead of red, or colorless and colored endosperm, there could have been no misinterpretation of his meaning.

In addition to ambiguity as in the above instance, the term xenia suffers from many misuses that likewise render its meaning obscure. What is referred to here is the abuse of the word by classing as xenia influences that follow fertilization, but are not brought about by the introduction of new hereditary factors into that tissue in which the variation appears. In none of the examples that are to be cited as having been wrongfully called xenia is there a triple fusion in which the second male nucleus from the foreign pollen adds something to the fusion which causes a difference in the expression.

The Nature of Some Effects Following Fertilization.

Some of the examples that have recently been brought to the writer's attention are: 1. The common folklore of farmers that watermelons pollinated by pumpkin pollen have a lower sugar content. This matter has also been made the subject of investigation recently. 2. A report by Daniel (12) of a walnut containing a hazel nut kernel. 3. A change in the sugar content of dates due to pollination. 4. A change in the color of the shell of fowl's eggs due to the influence of the male bird.

While some of these influences are not yet fully recognized, the author will not attempt here to confirm or deny the existence or non-existence of any of them. But since they are being pushed forward for discussion, those who are interested in them should insist that they be discussed in proper terms and not confuse them with another effect the nature of which is just beginning to be understood, and the term used to describe this effect just acquiring a distinct, comprehendable meaning.

In the case of the cucurbits, the date and a number of similar examples there is an effect occurring in the fleshy pericarp at a greater or less distance from the region of fertilization. Focke's observations on grapes belong under this head. Now that we know the facts about triple fusion it is obvious that this effect cannot be xenia. Although it follows fertilization it is not so closely connected with it that it is possible for determiners brought in by the pollen to be expressing themselves. The pollen cannot produce an effect in the pericarp for the determiners expressing themselves in the pericarp belong to the preceding sporophyte generation. Exactly what causes the change is not known, but one might postulate a specific chemical reaction following a specific pollination.

This is a very different thing from xenia. In xenia there is merely the expected expression of determiners capable of expressing themselves in the endosperm. There is nothing strange about it, except that they are appearing in a new place, that is in a race or variety in which they had not previously made an appearance. If any xenia occurred in dates or watermelons it would have to be inside the seeds, not in the fleshy pericarp.

In the paper by DANIEL the supposed hybrid, indicating its hybridity in xenia, is planted and sprouts. At the critical point, one reads "malhereusement le jardinier," etc., etc. But there is no need to know what misfortunes befell the luckless gardener. Xenia could not occur in this case because neither the walnut nor the hazelnut kernel contain any endosperm. This case has a superficial resemblance to xenia, but is simply the inheritance of dominant characters in a hybrid, if indeed a hybrid kernel was really formed. It is like a cross between yellow and green peas in which the color of the cotyledons (embryo tissue) shows through the pericarp.

An anonymous discussion of the effect of the male bird on the color of the shell of the eggs of fowls and of canaries is to be found in the May, 1915, number of the JOURNAL OF HEREDITY. This discussion is interesting and no objection would be made to it if the wording of the title were similar to that suggested above. But with xenia dependent upon triple fusion for its occurrence, calling any influence of the male bird, however remarkable, by the name of xenia is unthinkable.

Many plants, if no pollination takes place, develop a cleavage plane which cuts off not only the old flower, but frequently a portion of the stem also to a considerable distance away from the region of the fertilization. If pollination is successful, no abscission layer forms. The life processes continue in the stem which remains thick and green and capable of bearing the weight of the fruit. One is compelled to consider therefore, that the inheritance of the ability to form a cleavage plane is inhibited by the developing zygote. There is an increasing metabolism following fertilization. The ability to cut off one portion of the plant from the rest is an older adaptation of the individual plant than the ability to form fruits. It is resident in the vegetative parts of the plant; it is to be found in the lowest orders. In apples and pears and many common fruits if pollination is only partially instead of completely successful and well formed seeds are not distributed evenly around the fruit, there is a tendency towards flattening on the side where the pollination was faulty. The writer will gladly show the development of the cleavage plane as exhibited by the common morning glory, Ipomoea purpurea, to anyone interested. The examples were obtained by removing the styles from unopened flowers. The flowers opened normally and remained open as usual for several hours. In from five to seven days after the time that fertilization would normally have taken place, the floral organs and all of the floral stem to within a few millimeters of the main stem of the plant dropped off. The same plant was kept growing in the greenhouse for more than a year during which time no flowers whose development was not interfered with in the manner so described, were observed to drop off. In the Chinese hibiscus, Hibiscus rosa-sinensis, a fruit that was forming apparently normally suddenly dropped off. Upon examination it was found to have seeds developing in only one locule, due to imperfect pollination. The conclusion seems warranted that the influence from the developing zygotes was not strong enough to inhibit the formation of the cleavage plane which cut off the stem about 1 cm. below the flower. It is not to be inferred that the writer believes that the developing zygote is the only influence to inhibit the formation of an abscission layer or that the lack of proper pollination the only cause of its appearance. The question is bound up with the plant's general metabolic processes, especially that of food storage.

Hume (13) found that pollination or the lack of it brought about a change in the color and texture of the fleshy material of the fruit of Diospyros kaki, the Japanese persimmon. When the seeds were evenly distributed the flesh was uniformly dark colored, but when the seeds were not evenly distributed the fruit contained both light colored astringent flesh and dark colored edible flesh. "The dark flesh particularly when it softens and becomes somewhat juicy, has a sort of gritty consistency due to the presence of short well developed fibers, while the light flesh lacks these and is smooth to the palate." Clearly then, here is an influence due to an increasing metabolism following fertilization. The effect appears in the carpellate tissue outside the region of fertilization.

Just as fertilization is not the only influence leading up to cleavage plane formation, so the developing zygote is not the only cause of the coagulation of the emulsion colloid with which the tannin is associated, or in other words, of ripening of these fruits. Lloyd (14) has observed that the entire fruit can become non-astringent while still green and on the other hand that some seedless fruits lost their astringency. The accumulation of carbon dioxide in the tissues influences non-astringency by hastening coagulation. Killing the tissues also causes softening. But while these explanations may be partially independent of seed production they are not completely so since the rate of the process of becoming non-astringent is greatly hastened in the region of a large growing seed.

Another example that is more striking in certain ways, is set forth in an interesting paper by Close (15) on the immediate effect of cross pollination in apples. As a result of a certain cross he obtained a difference in the outline of the fruit and a brighter red color. "Even the fruit stems showed a variation, for out of 25 fruits taken at random from the general group, 19 had fleshy stems. Of the 23 crosses one had a fleshy stem, two slightly fleshy stems and the rest were slender." This experimental work has not, in the writer's knowledge been repeated, nor have checks been made by other observers whose results serve as a comparison with these just quoted, there is no reason to doubt this evidence though the data are meager. The point to be borne in mind is that these are influences removed some distance from the region of fertilization and not expressed as the result of any hereditary factors brought in by a male cell. That at once classes them apart from xenia.

How Are These Influences to be Described?

The writer proposes **ectogony,** (Gr., ectos, outside + **o-gony,** the fertilization product), as a convenient word for properly describing those influences which follow fertilization but are remote from it. Ectogony covers a whole field of influences that are the result of an increasing metabolism, or the effect of some chemical substance, or the response to some influence other than that brought in by hereditary factors. It would not be limited as xenia has necessarily been shown to be in the light of morphological researches, to an effect appearing only in triple fusion endosperm tissue.

There is a sharp contrast in thought between ectogony and telegony, a word derived from the same roots. Ectogony deals with real influences though scarcely intimate ones following fertilization. Telegony means the alleged influence of a father on offspring, subsequent to his own. No cases of telegony are known to exist, or to have ever existed, for in order for the thing to be possible, the father, or the growing embryo begotten by him would have to bring about a change in the unfertilized eggs, or in the uterus of the mother which would in turn affect the eggs, so that even after these eggs were fertilized from another father there would still remain some influence of the previous one.

In ectogony a change takes place outside the region of fertilization as a result of a new influence produced by the developing zygote. In xenia, on the other hand, a change that is more apparent than real is produced, since the new heredity introduced by the male nucleus consists of determiners that must express themselves in the same way that they would in the race to which they are native. There is nothing different from the normal, nothing unusual actually taking place in xenia, simply old determiners in a new place offer a surprise.

Xenia can frequently be successfully employed to separate cross pollinated from close fertilized kernels in maize, as the writer (16) recently indicated, and its practical advantages from the geneticist's standpoint are far reaching. The whole subject, however is practically unexamined by investigators to date and offers an inviting field in which much good work can be done.

Apart from the usefulness of xenia and apart from general interest in it as a fit subject for future investigation, the significance of the word has been brought into the widest botanical consideration by the introduction of the term xeniophyte. This reason is, per se, sufficient for retaining the meaning of xenia in its strict definiteness. If a distinction among influences following fertilization is to be made at all, the place to begin classifying the different effects is where the morphological evidence shows that a natural separation exists.

The opportunity is welcomed to make public acknowledgment of the gratitude felt toward Professor John H. Schaffner, of the Ohio State University, for helpful criticism and guidance during and before the time that the above paper was in preparation.

Summary.

Xenia is a phenomenon limited to the endosperm of angiosperms.

The xeniophyte, like the sporophyte, is a product of fusion. In the latter the egg nucleus and one male nucleus fuse; in the former there is fusion between the second male nucleus and the

definitive nucleus. The definitive nucleus is formed by the fusion of two nuclei from opposite poles of the female gametophyte. The fusion nuclei appear following three successive divisions of the megaspore nucleus, during which the egg is differentiated.

Ectogony is suggested as a necessary word to describe those influences which are due to the developing zygote. In xenia the variation appears as the direct result of the introduction of hereditary factors.

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SOME WINTER OBSERVATIONS OF MUSCID FLIES.*

Max Kisliuk, Jr.

If the hibernation of the house-fly (Musca domestica L.) and the other disease disseminators of the same family (Muscidæ) could be prevented, the early spring and summer generations would be controlled. Although these flies are the most common domestic pests the economic importance of a thorough study of their hibernation stages was but recently recognized. It seems that in the past too much had been assumed without actually experimenting to prove the assumption. With the knowledge of several diverging theories in mind, the author began a study of the hibernating stages of Musca domestica L. at College Park, Maryland, 1914–15, under the direction of Prof. E. N. Cory, Maryland State College, and continued, 1916–17, at Columbus, Ohio, under the direction of Prof. Jas. S. Hine, Ohio State University. (Dr. Gary deN. Hough's keys were utilized in determining the species herein discussed).

In order to find out experimentally, how long adults of the house fly would live confined in cages under otherwise natural winter conditions, tests extending throughout the winter were conducted in a large screen insectary and in an unheated stable at College Park, Maryland. The flies which were used in the above experiments were confined in rectangular wire cages (breeding cages—12 x 12 x 24 inches), which had a hole 6 inches in diameter in the upper half of one of the long sides. This opening was protected by a black-cloth sleeve and was used as a convenient method for admitting or replacing adults, food and manure. The adults were fed with fresh milk, which was daily supplied them in small dishes, packed with absorbent cotton. Fresh manure was also placed daily in a small flat dish in each cage as a medium in which eggs might be deposited. When one lot of adults died they were removed and a new lot installed. The new lots of flies were bred out in the greenhouse as will be described elsewhere in this paper.

These experiments show the greatest longevity of the adult to be 44 days (December 12, 1914–January 29, 1915), extreme temperatures 15° –63°, mean 45°, in the unheated stable

*Extract from a thesis written as part requiremental for a master's degree at Ohio State University.

and but 30 days (December 16, 1914–February 2, 1915) extreme temperature 13°–62°, mean 30°, in the insectary. Eggs were not deposited in the insectary until April 20, while in the stable they were noted on May 6th. These trials therefore show that the adults died under modified winter conditions after a short exposure.

These experimental results colaborate those obtained by Dr. F. C. Bishopp (1915), "Notes on Certain Points of Economic Importance in the Biology of the House-fly," who concludes that, "flies which are not kept cold enough to become inactive will either deposit if the temperature is sufficiently high or die comparatively soon." The climatical conditions in Texas are different from those in Maryland and Ohio. This point of varience from Dr. F. C. Bishopp's conditions was well expressed in his remarks that "oviposition was observed to occur on warm days in midwinter at Dallas, Texas, January 14, and at Valde, Texas, on February 5, 1914. Depositions may be expected at these latitudes on mild bright days in winter, especially if these are preceded by a few days of mild weather. During cool weather adults seem to choose places for deposition where the sun is bright and the wind is cut off."

At Columbus, Ohio, several student boarding houses and private houses were examined from roof to basement once a week throughout the winter of 1916–17. A search for flies was also made in the vicinity of the garbage cans of these stations. On December 17, 1916, a total of 7 males and 5 females of Musca domestica L. was collected in the kitchen. Then no adults were observed nor collected until a comparatively warm period about January 10, which brought 1 male and 2 females to the dining room of a private home and on January 28, two males were swept in slow flight from a gas pipe near the ceiling of a kitchen. At the latter station (a boarding club) no extra precautions were taken to screen food products. As a check, however, upon such careless conditions, a private home where every possible precaution was taken, such as screening and covering fly-attractive substances, was examined weekly. The latter station revealed two female Musca domestica on November 5, 1916, as the last collected up to the present writing, April 5th. Musca domestica was observed in flight in a restaurant, March 10, 1916. Therefore from January 28th to March 10th no adult houseflies were observed in dwelling houses.

Sufficient artificial heat and the presence of breeding media, however, will result in different observations. Thus in Columbus, Ohio, Musca domestica was found in all stages, egg, larva, pupa and adult, all winter in the favored environment prevailing in an animal house where the temperature was regulated to 70°. Similar conditions were found in the greenhouse-insectary, where flies were bred from fish, meat and manures. At the Columbus Garbage Disposal Plant these flies were common during the winter, breeding in the thick moist drippings from the vats. In the winter 1914–15, from December 7th to May 21st, the author succeeded in producing 6 generations of houseflies from horse manure in a greenhouse at College Park, Maryland.

Manure piles were also investigated for the immature stages. Significant observations were obtained in Maryland. Large masses of puparia were taken from the north-east corner of a maggot trap containing horse manure on the 2nd and 10th of December, 1914, and on the 13th of January, 1915, then again from the south side of the same pile on the 13th of May, 1915. Some advantageous effect produced by the trap prevented the rearing of adults from these puparia. Probably draining the pile, thus loosening it, retards heating by fermentation, allows abundance of ventilation and the corresponding decrease in temperature of the pile. Furthermore, an examination of the puparia still in the pile in the spring revealed no emptied pupæ shells from normal emergence. The revealing of so many puparia on the manure pile on the trap from very early winter and then throughout the winter apparently indicates that under natural conditions the housefly hibernates as pupæ. At Columbus, however, several scattered batches of eggs were found but these did not hatch when placed in the insectary. Maggots of the housefly were not taken in these situations this winter. Puparia, however, were collected January 6th in guinea-pig manure pile containing rabbit and pig carcasses on west side of Animal House. They were brought into the laboratory where a male Musca domestica L. emerged the next day. A very large mass of puparia was found February 26, 1917, about 2 inches above the surface of the ground and about 2 feet within the southwest edge of a pile of sheep manure. This manure was undisturbed all winter, except for the addition of cleanings from the sheep sheds. This mass of puparia was placed in a breeding box in the insectary where one male Musca domestica L. emerged March 10th, 1917 (13 days after isolation), another male March 11, 1917 (14 days) and two females on March 12th (15 days). These evidently spent most of the winter in this resting stage. The remaining puparia of this mass revealed a large percentage empty and showing the evidence of emerged parasites. Of 615 housefly puparia (identified by the structures of the posterior stigmal plates as seen under the binocular) 196 were so injured that I could not tell what had emerged from them. Of the more perfect 419 puparia, 385 or 91.8% had small holes characteristic of parasitized pupæ and 34 or 8.1% had the normal T breaks at the anterior end.

Briefly, then the above hibernating experiments and observations with Musca domestica L. may be summarized for Maryland and Ohio as follows:

1. All stages may be obtained in rare conditions of artificial heat and breeding media.

2. Under natural conditions neither eggs nor maggots were found alive in the normally perferred situations, although the maggots will probably be found in early winter.

3. The adults did not live more than 44 days (experimentally) nor were they collected during the winter proper in houses where it was formerly supposed they were hiding.

4. The few samples of puparia taken from their preferred environment in midwinter (February 26th, 1917) at Columbus and then their successful emergence March 10th to 12th under artificially heated conditions, in spite of the large number affected by fall parasites, apparently indicates that under natural conditions the housefly (Musca domestica L.) hibernates as pupæ.

The winter of 1916-17 afforded an unusually good opportunity to study hibernating conditions because the temperature seemed to lower gradually at first and the cold part of the season was not interrupted very frequently by unusual warm periods. However, such interruption did occur about the 6th of January and again on the 26th of February.

Lucilia sericata Meig.

The common greenbottle was collected outside on the 7th of November, 1916, and was not taken again until the 24th of March, 1917.

In the presence of artificial heat and breeding media Lucilia sericata in addition to Musca domestica was collected in all stages in the insectary all winter. On the 25th of February, 1916, two males and one female were placed in a breeding cage (of the type previously described) over some banana and fresh beef. This female deposited 4 masses of eggs before she died—one on the 3rd of March, 1916, containing 163 eggs (by actual count) another on the 6th of March, containing 232 eggs (by actual count) another on the 9th of March, containing 119 eggs (by actual count) and another on the 14th of March, containing 200 eggs by estimate. Thus in early spring a female of unknown age produced 714 eggs within a period of 7 days. A female emerging March 22nd from this first mass of eggs was placed in a cage with 3 of her brothers under conditions similar to that of their parent. On the 7th day after her emergence this female produced her first batch of eggs.

On the 15th of October, 1916, a fish head literally covered with muscid eggs was taken from a garbage can at one of the boarding-house stations and placed in a battery jar over an inch layer of moist sand. In the insectary most of the eggs hatched within 24 hours and shortly afterward, on the 17th of October, the fish head became insufficient, therefore necessitating more food. The maggots became so numerous within the jar, which was covered with a glass plate, that they formed a horizontal layer, standing on their heads, so that on looking down upon the mass one could see a wave of wriggling, crowding, pushing posterior ends. Still more fish was provided for them and when this could not be obtained soon enough, they began feeding upon one another. Many empty skins were found punctured with holes made by the greedy survivors who then proceeded to pump the body fluids from their companions.

Just as soon as these maggots pupated they were placed over moist sand in vials (1 inch in diameter by 3 inches tall) and covered with a tight cotton plug. These vials were placed in a rack about 10 inches from a south window (shaded from southwest by the front of the building) of the laboratory where the room temperature averaged 70° all winter. Most of the maggots pupated 15 days after hatching. Others appearing to be in a pre-pupal stage were placed in vials November 1st. Of this latter lot, some pupated in 64 days, others 81 days and still some in 101 days after hatching. The pupal period of these persisting maggots was 27; 4–?, 15 and 16 days respectively, thereby completing the developmental or immature stage as follows:

One male on 11th November, 1916—27 days; one female 16th of November—32 days; one male on 15th January, 1917—92 days; one female 9th of February—117 days; one male on 10th of February—118 days.

The variation of from 17 to 101 days in the maggot stage, and this under conditions which ordinarily hastens their development is particularly noteworthy.

Maggots of this species were taken November 10, 1916, from the sheep manure pile, previously described. These pupated in vials 3 days later and were placed in the laboratory where they remained until February 28th, 1917, where 1 male appeared after resting in puparia 107 days.

Maggots were again taken from this same manure pile on January 6th, 1917. These pupated in vials in the laboratory 11, 17 and 19 days later and brought forth adults in 11, 15 and 16 days respectively—these emerging from January 28th to February 10th.

Some of the sheep manure taken January 6th was placed in a breeding box in the cool chamber of the insectary. This chamber became very hot, however, on sunny days. Adults appeared in this box from 49 to 64 days after, thus emerging from the 24th of February to the 10th of March.

Lucilia sericata Meig. was also bred from maggots found on a dead sparrow in the autumn, from decaying cantaloupe and from guinea-pig manure.

The above data points to the larval and pupal stages as the hibernating condition for Lucilia sericata Meig.

Lucilia caesar L.

This species does not seem to be as common in the vicinity of Columbus as does the sericata. Maggots, however, were taken on the 27th of October, from the guinea-pig manure pile, containing carcasses. One pupated in a vial in the laboratory on the 10th of March (135 days after its removal from its habitat). The male emerging 10 days afterward or on March 20, 1917. This remarkable period of more than one-third of a year in the immature stages of this fly is comparable with that of the L. sericata just described.

Maggots of L. caesar were again taken from guinea-pig manure on January 6, 1917, producing adults from 20 to 32 days later. From this it is suggested that L. caesar may spend the winter in the larval stage.

Lucilia sylvarum Meig.

This species seems to occur still less frequently than the others. A maggot of this form, however, was taken from the guinea-pig manure pile containing carcasses on the 27th of October and was placed in a vial in the laboratory where it pupated 88 days later. The male emerged 33 days after this, thereby requiring a developmental period of more than 121 days.

Phormia regina Meig.

The king of blowflies was taken on the 12th of November, 1916, near a garbage can at one of the stations and was not collected again until the 24th of March, 1917, when it was trapped with meat bait.

Among the masses of eggs taken October 15th, 1915, on the fish head described with Lucilia sericata there were also eggs of Phormia regina. Pre-pupal maggots were transferred from the battery jar in which they were fed, to the breeding vials in the laboratory where they pupated in 15 to 45 days after hatching. The pupal period was brief, extending from 2 to 7 days, adults issuing from November 7th, 1916 (23 days from egg) to December 8, 1916 (54 days from egg). Some of these fresh adults were placed over banana and fish in a breeding cage in the insectary. No eggs were produced. Four males and three females emerged and were immediately transferred to the cages on the 5th of December. In four days 1 male and 1 female were found dead, in five days another pair and still another pair in six days. The remaining male died in eleven days, or December 16, 1916.

A similar longevity test was made with 3 males and 6 females emerging on the 7th of December. One female died in 2 days, another in 3 days, a pair in 4 days, 1 male and 3 females in 5 days and the remaining male on the 10th day.

A peculiar phenomena in the manner of emergence was observed at this time. Similar conditions, however, were observed when working with puparia of Musca domestica, Lucilia sericata and Sarcophaga sarraceniæ. Apparently an insect became reversed in some way, so that when the anterior end of the puparum was pushed off the apex of the abdomen was revealed instead of the head. These flies invariably died in this condition. Although only a small number behaved in this way, it may have some significance in nature.

As for the hibernation of this species the dates of collection give partial evidence in favor of the immature stages.

Calliphora erythrocephala Meig.

The large bluebottle was taken in the insectary until the 8th of December, 1916, collected outside on the south and west walls of the animal house during a brief warm period on the 6th of January and again in a meat trap on the 31st of March. Among those taken on the 6th of January there was one whose wings were not quite entirely expanded and its ptilinum still extended. On the 8th of December, 1916, eggs of this species were taken in the insectary from the cloth sleeve of a breeding box containing fish. These hatched the next day after their transfer to the fish, December 9th. Adults emerged in the insectary from 26 to 28 days (Jan. 5, 1917) later.

A puparium taken on the 6th of January, 1917, from the guinea pig manure pile containing carcasses was transferred to a breeding vial in the laboratory where a female emerged in 38 days (Feb. 13, 1917).

A maggot taken on the 6th of January from wet earth 2 inches deep and 1½ feet southwest of the sheep manure pile produced an adult female in 24 days (February 24, 1917).

The adult distribution and the occurrence of the living maggots and puparia indicate the immature stages as the hibernating forms.

Calliphora vomitoria. L.

This bluebottle was not found as adult in early winter, but was collected in a meat trap on the 31st of March, 1917. On January 31st, 1917, in the earth 1½ feet southwest of sheep manure pile a maggot of this species was taken, then placed in a breeding vial in the laboratory where an adult female emerged on the 24th of February.

As for hibernation then this species resembles the Calliphora previously noted.

Calliphora viridescens Desv.

This species was not found in the late autumn, but freshly emerged specimens were taken in a meat trap on the 26th of March.

Cynomyia cadaverina Desv.

This was among the first flies to appear this spring. It was taken in the insectary on the 25th of February and outside on the 20th of March, over decaying rabbit. The latest autumn occurrence for this species in Columbus was on the 13th of November, 1916.

Maggots taken on the 31st of January, 1917, from the earth $1\frac{1}{2}$ feet from sheep manure pile were transferred to breeding vials in the laboratory, where they pupated 4 days later (February 4th) and an adult female issued from these on the 24th of February.

The immature stage again seems to be the hibernating condition.

Among the muscids collected early this spring and indicating fresh emergence, as indicated by their clean, perfect condition and comparatively soft chitin are *Muscina stabulans* Fall (March 20th), *Pseudopyrellia cornicina* Fabr. (March 24) and *Pollenia rudis* Fabr.

Pollenia rudis Fabr.

The cluster fly was found occurring as adults every now and then throughout the winter. About 55 were taken December 4th, 1916, in the lock round-house at the Columbus Sewage Disposal Plant. These flies were transferred alive to a breeding cage in the cool chamber of the insectary. During sunny days this chamber recorded from over 100 at noon to about 20 at night. In the extreme temperatures thus provided, they were quite active during sunlight, while toward evening they gradually closed in towards a protected corner of the cage, where they clustered until the sunshine warmed the atmosphere again. They were given banana as food and a layer of wet clay for possible oviposition. As soon as the females died their ovaries were examined for the condition of development. These ovaries were immature, almost negligible until the last female died on the 7th of March. Here the ova were about the size of a normal egg of Musca domestica. All the ova in this fly appeared to be about the same size. The longevity ranged to more than 94 days.

Cluster flies were also collected outside on the 8th and 17th of December, in the old biology building on the 10th of January, in a bath room January 19th, and again at the Columbus Sewage Disposal Plant, March 3, 1917. They were collected quite abundantly outside during a warm period on March 20th. These early specimens, however, appeared to be freshly emerged for their thoraces glistened with the full supply of golden hairs. In older specimens these become broken so that only a small bunch of them remain on the pleura.

Some of these cluster flies caught in traps March 21st and others swept from the west wall of the Domestic Science Building, were placed in a breeding cage over banana and a layer of wet clay, a method previously used by Hutchison. Single eggs were found scattered on the clay on March 24th, but these did not hatch. They were placed in petri dishes on a moistened strip of blotting paper where they were enclosed with a living green earthworm (*Allolobophora chlorotica*), which has been reported as its host. The angleworm was found in the truck garden near the surface in spring and summer, but often 2 to 3 feet under the surface in winter. These worms were brought in from the garden occasionally in the winter and examined under the binocular, but no parasites were observed.

On the 31st of October, 1916, puparia of Pollenia rudis were taken in the truck garden at a depth of 2 to 6 inches. These were placed in breeding vials in the laboratory where one female emerged on the 1st and a male on the 11th of November.

There is plenty of evidence that Pollenia rudis hibernates as adult, although the apparent appearance of fresh spring specimens suggests that it hibernates in the immature stages also.

CONCLUSION.

It has been recommended repeatedly that the adults of flies be killed in early spring in order to reduce the numbers of later generations, but from the evidence brought forth by these winter observations on various Muscids, the maggots and puparia should also receive attention. If manure piles, rubbish heaps and the like, where larvæ and pupæ may winter successfully, are given proper attention during late fall and winter, the immature stages of these flies would be more exposed to fatal temperatures and their numbers thereby reduced.

NOTES ON AMERICAN TINGIDÆ WITH DESCRIPTIONS OF NEW SPECIES.*

By Herbert Osborn and Carl J. Drake.

Since the publication of recent papers on Tingidæ we have examined a number of collections and specimens sent in for determination by Professors Cooley, Lovett, Ewing, Swenk, Doane, Ferris, and Melander. This material with our private collections enable us to present the following notes.

Atheas insignis Heidemann.

Two specimens, one taken at Vienna, Virginia, August 8, 1913, by Mr. Barber and the other at Bladensburg, Maryland, July 21, 1890, by Heidemann. The Blandensburg specimen bears the label, "*Leptostyla exquisita* Uhler MS," as identified by Mr. Heidemann.

Atheas mimeticus Heidemann.

Four specimens; one specimen taken at Fort Collins, Colorado, August 8, 1898, and the other three at Albuquerque, New Mexico, August 30, 1888, by Wickham. The Colorado specimen is a little darker than our New Mexican forms and the color indicated in the original description and drawing, but agrees in other characters.

Atheas annulatus spec. nov.

This species is closely allied to *A. fuscipes* Champion, from Mexico and Central America, but readily separated from it by the annulate first segment of the antennæ, the much longer discoidal area, the brown transverse nervures along the inner row of cells in the costal area, and the testaceous legs.

Pronotum feebly convex, closely punctate, distinctly tricarinate, converging anteriorly; membraneous margins narrow, slightly concave, with a single row of small, round or oval areolae and three extra cells along the inner margin at the widest part just in front of the middle. Head rugulose, a little broader than long, the antenniferous tubercles stout, pointed and slightly divergent. Antennæ slender, slightly longer than from the apex of head to tip of triangular process of the pronotum; basal segment constricted beyond the middle, and forming a fairly distinct annulus, a little more swollen, and nearly one and a half times as long as the second; third segment longest, slenderest; fourth segment thickened, twice as long as the second and a little more than one-half the length of the third. Rostrum reaching between the intermediate coxæ. Mesosternal laminæ diverging posteriorly. Elytra reaching considerably beyond the abdomen, rounded at the tip, widest before

*Contribution from the Department of Zoology and Entomology, No. 50.

the middle; costal area biseriate, the outer row of areolæ smaller than the inner one; subcostal area biseriate; discoidal area reaching beyond the middle of the elytra (farther than in *fuscipes*), with four rows of areolæ at its widest part; sutural area broad, the areolæ along the inner margin and distal end very large. Wings longer than the abdomen. Length, 2.45 mm.; width, .9 mm.

Color: Head and body beneath black. Legs testaceous, the tips of tarsi infuscated. Antennæ black, except distal two-thirds of the third segment and narrow basal portion of the fourth testaceous. Margin of bucculæ and rostral laminæ whitish. Pronotum black, a few spots on the carinæ, apex of posterior process, and lateral margins whitish. Elytra with the outer margin and areolæ whitish, the areolæ nearly opaque; transverse nervures along inner row of costal area, costate nervures that bound areas, and the inner and distal nervures of sutural area brownish.

Described from one macropterous male, labelled "Marion County, Arkansas, June 27, 1897."

Atheas nigricornis Champion.

We have one example of this species that was taken in the Huachuca Mountains, Arizona, July 26, 1905, by Mr. H. G. Barber. This seems to be the first record for the species in the United States.

Atheas sordidus spec. nov.

Head a little broader than long, the antenniferous tubercles stout and pointed, but more slender and longer than in *annulatus*. Antennæ reaching a little beyond the apex of posterior process of the pronotum; first segment a little thicker and one and a half times as long as the second; third segment slenderest, less than twice the length of the fourth; fourth segment thickened towards the apex, a little longer than the first. Pronotum closely punctate, tricarinate, the carinæ more strongly raised than in *A. annulatus;* lateral margins narrow, converging forwards, with the outer margin nearly straight, with two rows of cells at the anterior end and only a single series back of the middle, the areolæ small and round or oval. Rostrum reaching between the first pair of coxæ. Elytra reaching a little beyond the apex of the abdomen, the outer margin rounded, with the nervures that bound the areas distinctly raised; costal area narrow, with one complete series of areolæ and an extra row near the base and apex; subcostal area with two rows of areolæ; discoidal area reaching considerably beyond the middle of the elytra, with five rows of areolæ at the widest part, the inner boundary distinctly wavy. Wings not visible. Length, 2.15 mm.; width, .85 mm.

Color: Head and body beneath blackish. Antennæ black, except the distal third or half of third segment, which is yellowish. Legs testaceous, the tarsi infuscated. Pronotum black, the carinæ, anterior margin, apex of posterior process, and lateral margins whitish. Elytra sordid yellowish, the lateral margins whitish, and the areolæ whitish, opaque. Margins of bucculæ and rostral laminæ whitish.

Three brachypterous specimens from Iowa; two specimens collected at Ames by Prof. Ball and the other at Little Rock, July 2, 1897, by the senior author. This Tingid approaches *A. nigricornis* Champion, which has the antennæ entirely black, but it also differs from that species in the costal area of the elytra.

Corythucha ciliata Say.

This species is well known as the sycamore or buttonwood Tingid and is common throughout the eastern and central portions of the United States. West of the Mississippi River we have specimens from Iowa, Oklahoma, Texas and California. When heavy infestations of the insects occur the leaves of the sycamore tree are often very much whitened and wilted. It is not uncommon to find buttonwood trees considerably damaged by these insects in Ohio. During the winter the adults may be collected on the trees beneath the loose bark. The mature form is whitish and it usually has a brown spot on the posterior portion of the tumid elevation of the elytra. Teneral specimens are more or less opaque and of a milky white color. The adult is parasitised by a red mite.

Corythucha arcuata Say.

The oak lace-bug is also a well known and widely distributed species. We have numerous records for the central and eastern states and west to Iowa. Prof. Sanders and Mr. DeLong observed during the summer of 1916 that the leaves of *Quercus macrocarpa*, on the shore of Lake Wagapasset, in Wisconsin, were discolored and almost entirely destroyed. This damage was also noted by them in numerous other places in the state, and the insect is of considerable economic importance in Wisconsin. The oak Tingid is quite variable in color, especially the color bands on the elytra. In some specimens the hood, lateral pronotal margins, and distal portions of the elytra are almost entirely whitish and the areolae hyaline. In some cases the brown band near the base of the elytra is also more or less evanescent. The life cycle of this species has been carefully studied by Dr. Morrill (Psyche, Vol. X, page 127-132).

Corythucha juglandis Fitch.

This is a very common species on walnut, butternut, and linden. The color of this species is also quite variable. Our collections include specimens from Iowa, Wisconsin, Ohio, New York, Maine, Georgia and Tennessee.

Corythucha salicis spec. nov.

Hood moderately elevated, abruptly constricted about the middle, tapering in front and somewhat globose behind, widely reticulated, the reticulations becoming smaller at the sides in front. Pronotum with the membraneous margins broad, reniform, bullate about the middle, and armed with a few spines on the anterior margins; median carina, low, uniseriate (in some specimens with one or two cells divided near the middle); lateral carinæ raised anteriorly, with a few distinct cells. Antennæ clothed with a few long hairs, the first segment slightly more swollen and twice the length of the second. Rostrum reaching between the intermediate coxæ. Elytra broad, the outer margin slightly convex; costal area broad, with three rows of areolæ, the reticulation very large between the transverse fasciæ. Claspers in the male strongly curved. Length, 3.5 mm.; width, 1.9 mm.

Color: General color whitish, marked with brown. Antennæ testaceous. Legs yellowish-brown, the tip of tibiæ and tarsi infuscated. Pronotum embrowned; lateral margins and hood with the nervures whitish and marked with brown, the areolæ hyaline and narrowly margined with whitish opaque; posterior process and carinæ whitish. Elytra whitish, with a transverse band near the base, a more or less oblique band near the apex, a few spots near the inner margin and posterior portion of tumid elevation embrowned. Body beneath black, the genital segment more or less embrowned.

Middlesex Falls, Massachusetts, Wisconsin (DeLong) and Bozeman, Montana, June 4, 1912 (Cooley). This species infests willow and currant. Although very distinct it is probably most closely allied to *C. arcuata* Say. We have seen this species labeled "*Corythucha fuscigera* Stal," in eastern collections, but it is very distinct from our Mexican specimens of this species.

Corythucha marmorata Uhler.

The color of this species is somewhat variable and in some specimens the marmorate markings on the elytra are more or less evanescent. We have specimens from Nebraska, Indiana, Michigan, Ohio, Pennsylvania, Maine, Massachusetts, New York, Georgia, Tennessee, Louisiana, Iowa and Colorado. This species has been reported as causing damage in greenhouses.

Corythucha morrilli spec. nov.

This species was given the manuscript name of *C. morrilli*, by Mr. Heidemann in honor of the excellent work that Dr. Morrill has done in this genus.

Hood highly elevated, rather narrow, not very widely reticulate, moderately constricted back of the middle; anterior portion long, the sides depressed, with two rows of areolæ on the dorsal surface; posterior portion with the sides narrowed dorsally, the dorsal surface only slightly broader than the dorsal surface of the anterior portion. Antennæ clothed with a few long hairs, the first segment twice the length of the second. Pronotum punctate; median carina highly elevated, with two rows of cells at the highest portion; lateral carinæ rather long, raised anteriorly, flaring outwardly, with six or seven areolæ; lateral margins not very broad, reniform, the outer margins armed with rather short, closely set spines, slightly bullate near the middle, the posterior margin slightly turned up. Rostral sulcus broad, the sides moderately raised; rostrum reaching to the intermediate coxæ. Elytra narrow, long, reaching considerably beyond the abdomen, the outer margin slightly concave and armed with rather short spines, except distal portion; costal area narrow, biseriate. Length, 2.85 mm.; width, 1.82 mm.

Color: General color whitish, usually marked with brown. Antennæ and legs light testaceous, the tips of tarsi and apical segment of antennæ darker. Pronotum embrowned; lateral margins and median carina each with a fuscous spot near the middle; hood distinctly marked with fuscous. Elytra whitish, usually with four transverse fascia, a spot on the tumid elevation, and a few spots on sutural area fuscous. Body beneath black, the genital segment partially embrowned. Margins of bucculæ, rostrum, rostral laminæ and portions of thoracic pleura embrowned.

This species has been determined in many collections as *C. decens* Stal, but it is very distinct from Champion's figure of the species and Stal's original description. In some specimens the fuscous or brown markings are almost entirely wanting. It is a very common species in the southwestern portion of the United States. We have numerous specimens from Colorado and Arizona.

Corythucha coryli spec. nov.

Hood large, highly elevated, strongly deflected in front, abruptly constricted near the middle, globose behind and narrowed in front, widely reticulated, the reticulations becoming closer at the sides in front. Antennæ clothed with a few long hairs, the first segment a little more than twice the length of the second. Pronotum rather evenly punctate, the lateral margins slightly bullate near the middle, reniform, evenly reticulate, median carina strongly raised, the outer carinæ slightly raised anteriorly. Rostral laminæ rather large, reticulate; rostrum reaching near the end of the rostral sulcus. Elytra reaching considerably beyond the abdomen, the outer margins sinuate, strongly concave, broadly rounded at the tip; costal area widely reticulate, with three rows of areolæ (a few additional cells near the base). Wings extending a little beyond the abdomen. Outer margins of elytra and lateral margins of pronotum armed with rather long, closely-set, strong, spines. Length, 2.8 mm.; width, 1.52 mm.

Color: Body beneath black, the genital segment partially embrowned. Claspers in the male brown. Hood infuscated, except the sides in front whitish. Pronotum embrowned; explanate margins with areolæ hyaline, the nervures whitish. Elytra whitish, with a transverse band near the base, another near the apex, and more or less of a rather broad margin along inner border infuscate. Male claspers brown. Antennæ and legs light testaceous. Spines whitish, with the tips infuscate.

A common Tingid that infests hazlenut, *Corylus americana* Walt. We have specimens that were taken by Mr. W. L. McAtee "near Plummers Island, Maryland, August 20, 1914."

Corythucha floridana Heidemann.

Our specimens are from Kissimmee, Florida, where they were reported by Dr. Berger as doing a considerable amount of damage to the oak trees. Heidemann reports the species as being found on Cephalanthus.

Corythucha gossypi Fabricius.

Our Florida specimens were taken on the leaves of *Icthyonethia piscipula*. We also have a few specimens from Grenada, British West Indies.

Corythucha pergandei Heidemann.

This is a very common species that infests Alder. We have specimens from Wisconsin, Illinois, Ohio, New Jersey, Washington, D. C., Maryland and Tennessee.

Corythucha crataegi Morrill (Osborn and Drake).

The hawthorn Tingid is common throughout the greater portion of the United States. We have specimens from South Dakota, Nebraska, Iowa, Wisconsin, Ohio, Pennsylvania, Massachusetts, Maryland, Virginia, South Carolina, Georgia, Texas and Colorado. Some workers have questioned the priority of the name, claiming that the species is identical with *C. cydonia* Fitch. According to the International Code the original description of *cydonia* is invalid, as it was not published in a scientific journal. We would be glad to recognize *cydonia* if the identity of the two forms can be fully established.

Corythucha pallida Osborn and Drake.

This species was described from a series of specimens that were taken on linden, *Tilia americana*, by Kellicott and Hine. During the past summer we have received numerous specimens that were taken on mulberry, *Morus rubra*, in Ohio, Maryland, Tennessee, Virginia and Arizona. This species may be found in collections under the names, "*Corythucha adjusta* Uhler MS" and "*Corythucha mori* Heid. MS."

Corythucha obliqua Osborn and Drake.

The authors described this species from a single specimen that was taken in California by Mr. Dury. Our collections now include specimens from Oregon and Idaho, besides the type locality.

Corythucha immaculata Osborn and Drake.

The food plant of this species has not been recorded. We have specimens from Oregon, California and Colorado.

Corythucha distincta Osborn and Drake (Fig. 1, variety).

This is a very common lace-bug throughout the western part of the United States. Our collections include specimens from Washington, Montana, Wyoming, Utah and Colorado. Mr. McAtee states that he has specimens from California. In western collections we have seen this species labeled "*Corythucha contaminata* Uhler MS." Our long series of specimens indicate the type to be the typical form of the species. The Utah specimens were taken on *Carduus lanceolatus* by Larson.

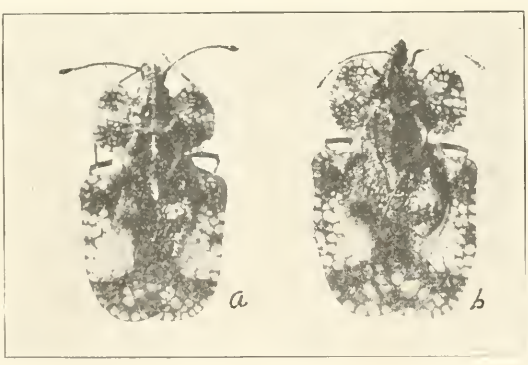

Fig. 1. Corythucha distincta spinata, n. var.; *a*, ♂; *b*, ♀. (Photo by Carl J. Drake).

Corythucha distincta spinata var. nov. (Fig. 1, a and b).

This new variety is armed on the outer margins of the elytra, except distal third, and lateral margins of the pronotum with short spines. The color is a little darker than the typical form. All specimens of this variety were collected at Florence, Montana, June 1, 1912, by Mr. Parker. One specimen bears the food plant label "thistle."

Corythucha hoodiana spec. nov.

Hood moderately elevated, very broad, very abruptly constricted at the middle, widely reticulated, the areolæ becoming smaller at the sides in front; anterior portion narrowed anteriorly, with the sides depressed; posterior portion rounded, but not globose. Antennæ slender, clothed with a few long hairs, the basal segment nearly three times the length of the second. Pronotum not very closely punctate, with the lateral margins broad, reniform, bullate just back of the middle, with the anterior and posterior margins slightly turned up, the spines on the outer margin almost entirely obsolete; median carina highly elevated, the areolæ long-rectangular, except a few divided cells that form a double row of nearly square cells; lateral carinæ raised anteriorly, with three or four areolæ. Mesosternal laminæ diverging posteriorly, the metasternal ones cordate; rostrum reaching the meso- metasternal suture. Elytra broad, reaching considerably beyond the abdomen, with large, nearly round, tumid elevations, with the outer margins sinuate, slightly emarginate, and the lateral spines almost entirely obsolete; costal area broad, unevenly reticulate, with three rather irregular rows of areolæ and a few extra cells near the base and hyaline portion; sutural area broad, unevenly reticulate. Abdomen very broad. Length, 2.5 mm.; width, 2.6 mm.

Color: Pronotum, a spot on each lateral margin, a rather broad band near the base of the elytra, another near the apex (except two or three cells near inner margin hyaline), a spot on the posterior portion of tumid elevation and a few small spots near inner margin brown. Areolæ mostly hyaline, the nervures whitish. Antennæ and legs testaceous. Body beneath black.

Described from a ♀ specimen, taken on Mt. Hood, Oregon.

Corythucha eriodictyonae spec. nov.

Hood low, narrow, armed with a few long spines on the sides, with the median nervure sinuate, rather abruptly constricted back of the middle, the anterior portion long and narrow and the posterior short. Antennæ clothed with a few long hairs; basal segment constricted beyond the middle, more swollen and a little more than twice the length of the second; fourth segment swollen towards the tip. Pronotum punctate, tricarinate; median carina low, undulate, uniseriate, very low near the middle and where it conjoins with the hood; lateral carinæ widely separated from the hood, raised anteriorly, with 4–5 distinct areolæ; membraneous margins widely reticulate, long, rather broad, armed with very long spines on the outer margins. Rostral sulcus broad, the rostrum extending between the posterior coxæ. Elytra long, broad, the tumid elevations small, armed with very long spines on the outer margins; costal area broad, mostly triseriate, the areolæ large and not of a uniform size; subcostal areolæ very small. Wings visible. Length, 3.2 mm.; width, 1.8 mm.

Color: Nervures of hood, pronotal margins, and elytra yellowish, slightly marked with brown and fuscous; areolæ hyaline. Pronotum brownish, a few spots fuscous. Antennæ testaceous, the distal portion of the fourth segment fuscous. Legs testaceous, the tips of tarsi darker. All spines testaceous, with tips black. Body beneath black.

Described from a good series of specimens, taken on "*Eriodictyon californicum*," both adults and nymphs at "San Francisquito Cr., San Mateo Co., Cal.," by G. F. Ferris. This insect has long spines like *hispida* Uhler, but it can readily be separated from it by the smaller hood, smaller size, and the slightly shorter spines.

Corythucha fuscigera Stal.

Our specimens of this species are from Mexico. It is probably found in the southern part of the United States, but the specimens that we have examined labeled *fuscigera* have proved to be of five or six different species. The figure in the Biologia Centrali-Americana is an excellent drawing of the species.

Corythucha pruni Osborn and Drake.

This species which was described from a series of specimens from Washington, D. C., has not been noted in other collections. The hood in this species is much smaller than in either of the other two species that infests wild cherry.

Corythucha padi Drake.

This Tingid infests choke cherry, *Prunus demissa*, in the western states. We have specimens from Montana, Oregon, Washington and Chilliwack, British Columbia. The three cherry Tingids, *C. pruni*, *C. padi*, and *C. associata*, are very distinct from each other, the size and shape of the hood being the outstanding difference. In *pruni* the hood is small and not highly elevated; in *associata* the hood is highly elevated, very large, very abruptly constricted near the middle, and globose behind; in *padi* the hood is between the other two in size and nearly semiglobose behind. This is a good illustration of the number of Tingids that may feed on allied food plants, and, although it is very desirable to know the plant or plants that a species infests, it is not safe to assume that one has the species known to occur on a given plant simply because it has been found feeding or breeding on these plants. *Associata* is more closely allied to *aesculi* than to either of the two cherry Tingids.

Corythucha aesculi Osborn and Drake.

A very common species that infests buckeye, *Aesculus glabra*, throughout Ohio. We also have specimens from Illinois and Kentucky. The winter is spent in the adult state in among the leaves and grass on the ground beneath the tree.

Corythucha associata Osborn and Drake.

A common species that infests wild cherry, *Prunus serotina*, east of the Mississippi River. Our collections include specimens from Tennessee, Georgia, Long Island and Washington, D. C. During the summer of 1916 Mr. L. A. Stearns found these insects in immense numbers on wild cherry near Clarksville, Tennessee.

Corythucha bulbosa Osborn and Drake.

Although we have no positive data, this species seems to be known in some collections as *Corythucha carbonata*, a manuscript name given to the species by Uhler and used by Heidemann. It feeds on the American bladder nut, *Staphylea trifolia*, in immense numbers. This is the largest *Corythucha* known to us and very distinct from any other described species.

Corythaica constricta spec. nov.

Hood elongate, a little more arched and narrowed anteriorly than in *C. carinata* Uhler. Pronotum closely punctate, tricarinate, the carinæ arranged as follows: the lateral carinæ raised anteriorly, uniseriate, and extending from the base of posterior process to the outer posterior margin of the hood, the median carina more strongly raised anteriorly, with one complete row of areolæ and three or four extra cells at the highest part near the anterior end forming a double series, reaching from the apex of triangular process and uniting with the median raised nervure of the hood. Pronotal margins biseriate, strongly reflexed, the outer margin following the contour of pronotum. Bucculæ large, with three to four rows of cells. Rostral groove closed at the apex, the side reticulate; rostrum reaching between the intermediate coxæ. Antennæ long, slender; first segment a little longer and more swollen than the second; third segment slender, nude, nearly three times the length of the fourth; fourth segment swollen towards the apex, clothed with a few long bristly hairs. Elytra reaching considerably beyond the abdomen, broader and more strongly constricted just back of the middle than in *C. carinata*, the tumid elevation moderately large; costal area uniseriate, with most of the areolæ very large; subcostal area mostly triseriate; discoidal area not quite reaching the middle of the elytra, with four rows of cells at the widest part; sutural area broad, widely reticulate, with five or six cells at the widest part. Length, 2.62 mm.; width, 1 mm.

Color: General color grayish, with fuscous markings. Body beneath brownish, the thorax darker brown. Legs brownish, the tips of tarsi infuscated. Antennæ brownish. Pronotum brownish. Elytra grayish-brown, with a transverse costal band in front of constriction, another near apex, and a few apical spots fuscous.

Described from a specimen from Colorado, but without a definite locality and date, probably Fort Collins, 1898.

Genus **Alveotingis** Osborn and Drake.

In this genus the subcostal, discoidal, and sutural areas are either partially defined, poorly defined, or entirely undifferentiated. The third antennal segment is more or less densely clothed with decumbent hairs and thickened towards the apex. In the macropterous specimens the elytra are broadly rounded at the apex, widely overlapping, and reaching considerably beyond the abdomen; in the brachypterous forms the inner margins of the elytra are nearly straight, slightly overlapping to the apex, and reaching a little beyond the tip of the abdomen. The bucculæ are contiguous anteriorly.

The photographs of the species of *Alveotingis* were made from the type specimens and are all of the same magnification. The known species of the genus may be separated by the following key:

1. Antennæ short and stout, not reaching the apex of the posterior process of the pronotum. . . . **A. brevicornis** n. sp.
   Antennæ longer, reaching slightly beyond the apex of the posterior process of the pronotum. . . . . 2.
2. Third antennal segment very long; strongly swollen; median and lateral pronotal carinæ about equally elevated, reticulate; subcostal, discoidal, and sutural areas only partially or poorly defined. . **A. grossocerata** Osb. & Drk.
   Third antennal segment more slender and shorter; pronotum with the lateral carinæ not as highly elevated as the median one, the areolate indistinct in the lateral carinæ; subcostal, discoidal, and sutural areas without the slightest trace of a boundary. . . . . **A. minor** n. sp.

Alveotingis minor spec. nov.

Head a little broader than long, with the median and two posterior spines depressed and the two anterior ones strongly curved and converging. Antennæ rather long, moderately slender; basal segment one and a half times the length of the second; second segment short, swollen towards the tip; third segment slightly curved, slightly enlarged towards the apex, moderately clothed with rather long decumbent hairs; apical segment subconical, beset with long straight hairs and dense pile, at its widest part about three-fourths as broad as the apex of the third. Pronotum widely pitted, tricarinate, the carinæ not as strongly raised as in *brevicornis* or *grossocerata*, the lateral carinæ without distinct areolæ; lateral margins reflected back against the sides of the pronotum, with a single series of areolæ. Sides of thorax widely pitted. Elytra strongly convex, reaching a little beyond the abdomen; costal area with a single row of areolæ; discoidal, sutural, and subcostal areas without a trace of a boundary. Length, 2.51 mm.; width, 1.16 mm.

Color: General color dark grayish-brown, the areolæ whitish. Rostral laminæ whitish. This species like the other two known species in the genus has a very shining appearance, due to the polished nervures.

Described from a macropterous male, taken at Ames, Iowa, June 14, 1897, by the senior author. It is closely related to *A. grossocerata*, but readily differentiated from it by the characters given in the key.

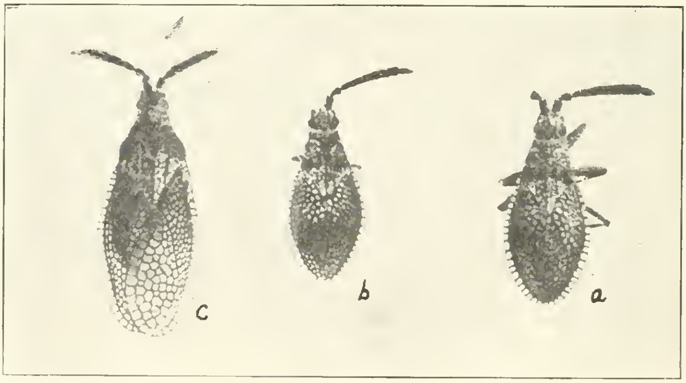

Fig. 2. *a*, Alveotingis grossocerata Osb. & Drk.; *b*, A. minor n. sp.; *c*, A. brevicornis n. sp. (Photo by Carl J. Drake).

Alveotingis grossocerata Osborn and Drake.

This species, described in Ohio Biol. Survey Bulletin, No. 8, p. 245, has been seen so far only from Maine and New Hampshire. The figure shows the third antennal segment slightly too thick in the middle portion and the basal process is large and formed as in related genera. This difference may be noted by a comparison of the figure with the photograph of the type presented herewith.

Alveotingis brevicornis spec. nov.

Antennæ short, stout, not quite reaching the apex of the posterior process of the pronotum (in the other two species the antennæ extends a little beyond the apex); first segment nearly one and one-half times the length of the second; third segment strongly swollen towards the apex, densely clothed with rather long decumbent hairs, about twice the length of the first and second conjoined; fourth segment clothed with mostly straight hairs, subconical, a little shorter than the first, about two-thirds as thick as the apex of the third. The right antenna is abnormal; second segment clothed with hairs like the third, the second and third segments taken together not longer than the third segment of the left antenna. Elytra strongly convex; costal area uniseriate, the areolæ large; sutural, discoidal, and subcostal areas poorly defined. Pronotum tricarinate, the carinæ about as highly elevated as in *grossocerata*, the areolæ small. Other characters about the same as in *minor* and *grossocerata*. Length, 3.45 mm.; width, 1.4 mm.

Color: General color dark grayish-brown, shining, the areolæ whitish. Rostral laminæ whitish.

Described from a macropterous female, taken by the senior author at Little Rock, Iowa, July 2, 1897. As the figure indicates, the antennae are very distinct from those of the two known congeners

THE BRASSICACEÆ OF OHIO.

Emma E. Laughlin.

Brassicaceæ. Mustard Family.

Herbs, with watery sap of a pungent taste, not poisonous; with alternate, exstipulate leaves, usually large at the base of the stem and intergrading in form to the top of the stem. Flowers hypogynous, bisporangiate, usually isobilateral, appearing actinomorphic, regular, usually with glands, in racemes, short at first and elongating, or in corymbs; calyx of 4 sepals, deciduous, rarely persistent; corolla choripetalous, tetramerous, cruciform; stamens 6, tetradynamous, rarely 4 or 2; ovulary compound, bilocular, the parietal placentæ connected by a thin septum from which the valves separate when ripe; ovules 2 to several, campylotropous; fruit a silique if longer than broad, or a silicle if short, generally with 2 cavities, sometimes unilocular, dehiscent or in a few genera indehiscent; endosperm scanty; cotyledons accumbent, incumbent or conduplicate.

SYNOPSIS.

I. Pod usually not more than twice as long as wide (a silicle); cotyledons accumbent or incumbent.
  - A. Pods more or less flattened parallel to the broad partition, dehiscent; cotyledons accumbent; leaves not lobed.
    - 1. Pubescence stellate or of forked hairs.
      - Alysseæ.
        - Berteroa, Koniga, Alyssum, Draba.
    - 2. Pubescence of simple hairs or wanting; pods very broad and flat; leaves opposite.
      - Lunarieæ.
        - Lunaria.
  - B. Pods flattened at right angles to the partition or not flattened.
    - 1. Pubescence of forked hairs; cotyledons incumbent.
      - Camelineæ.
        - Camelina, Bursa, Neslia.
    - 2. Pubescence of simple hairs or wanting.
      - *a*. Pod scarcely or not at all flattened; cotyledous accumbent.
        - Cochlearieæ.
          - Armoracia, Neobeckia, Sisymbrium, Radicula.
      - *b*. Pods strongly flattened at right angles to the narrow partition.
        - (a) Pod dehiscent; cotyledons accumbent or incumbent.
          - Lepidieæ.
            - Lepidium, Carara, Thlaspi.
        - (b) Pod indehiscent; cotyledons incumbent.
          - Isatideæ.
            - Myagrum.

II. Pod usually elongated-linear, more than twice as long as wide (a silique).
  A. Pod not transversely 2-jointed.
    1. Cotyledons accumbent or incumbent; pod not beaked, but often tipped with the style; seeds usually in one row in each cavity.
      a. Cotyledons incumbent.
        NORTEÆ.
          Alliaria, Sophia, Cheirinia, Erysimum, Norta, Conringia, Hesperis, Arabidopsis.
      b. Cotyledons accumbent.
        ARABIDEÆ.
          Barbarea, Iodanthus, Arabis, Cardamine, Dentaria.
    2. Cotyledons conduplicate; pod beaked.
      BRASSICEÆ.
        Sinapsis, Brassica, Diplotaxis. Raphanus.
  B. Pod transversely 2-jointed, fleshy, indehiscent; cotyledons accumbent.
      CAKILEÆ.
        Cakile.

KEY TO THE GENERA OF THE BRASSICACEÆ OF OHIO BASED ON THE FLOWER AND OTHER CHARACTERISTICS PRESENT AT ANTHESIS.

1. Flowers white. 2.
1. Flowers yellow. 19.
1. Flowers purple. 32.
2. Leaves simple, not lobed. 3.
2. Leaves deeply lobed or pinnatifid. 12.
3. Stems scapose; basal leaves in a rosette. *Draba*.
3. Stems leafy. 4.
4. Leaves entire. 5.
4. Leaves dentate, crenate or wavy. 6.
5. Petals bifid; plant hoary-pubescent. *Berteroa*.
5. Petals entire; plant appressed-pubescent; flowers fragrant. *Koniga*.
6. Basal and stem-leaves the same. 7.
6. Basal and stem-leaves different. 8.
7. Leaves broadly cordate, dentate; petals clawed. *Alliaria*.
7. Leaves orbicular, wavy; stems decumbent, stoloniferous. *Cardamine*.
8. Stem-leaves sessile; petals twice the length of the sepals. 9.
8. Stem-leaves clasping. 10.
9. Basal leaves oblanceolate, rosulate; stem-leaves lanceolate; pubescent with forked hairs. *Arabidopsis*.
9. Basal leaves obovate; stem-leaves lanceolate, narrowed at each end; pods scythe-shaped. *Arabis*.
10. Basal leaves oblanceolate, early deciduous; stem-leaves lanceolate; pods broadly winged. *Thlaspi*.
10. Basal leaves obovate or spatulate, dentate; flowers less than one-third inch broad. 11.
11. Racemes dense; silicles orbicular. *Lepidium*.
11. Racemes loose; siliques flat, linear. *Arabis*.
12. Basal and stem-leaves the same. 13.
12. Basal and stem-leaves different. 15.
13. Leaves deeply lobed or pinnatifid. 14.
13. Leaves palmately 3-lobed; stems leafless below; flowers corymbose. *Dentaria*.
14. Stems glabrous, aquatic, rooting at the nodes; end lobe of the leaf large. *Sisymbrium*.
14. Stems spreading; plants fetid; pods didymous. *Carara*.
15. Lower leaves pinnatifid; upper leaves dentate or entire. 16.
15. Lower leaves pinnatifid; upper leaves smaller and narrower. 18.
16. Lower leaves immersed, dissected; upper leaves lanceolate. *Neobeckia*.
16. Basal leaves large, rough but glabrous; root thick, pungent; pods seldom formed. *Armoracia*.
16. Basal leaves in a rosette or rosulate. 17.

17. Stem-leaves sagittate; pods triangular. *Bursa.*
17. Stem-leaves lanceolate, oblong or linear; pods orbicular. *Lepidium.*
18. Leaf-segments numerous, end one larger. *Cardamine.*
18. Leaf-segments very narrow; stems diffuse. *Arabis.*
19. Leaves simple, not lobed, entire, rarely dentate or repand. 20.
19. Leaves lobed or pinnatifid. 24.
20. Leaves spatulate or linear; sepals persistent; petals pale yellow. *Alyssum.*
20. Leaves lanceolate. 21.
20. Leaves ovate or oblong, cordate at the base. 23.
21. Leaves clasping by a sagittate base; silicles obovoid or globose. 22.
21. Leaves not clasping by a sagittate base; pubescent with 2-branched appressed hairs. *Cheirinia.*
22. Stems nearly simple, glabrous or slightly pubescent; pods pear-shaped, dehiscent. *Camelina.*
22. Stems branching, hispid; pods reticulated, indehiscent. *Neslia.*
23. Glabrous and glaucous; leaves oblong to lanceolate; longer stamens connate in pairs. *Myagrum.*
23. Glabrous, pale green; leaves obtuse; flowers pale yellow. *Conringia.*
24. Flowers small, less than one-third inch broad. 25.
24. Flowers large, more than one-third inch broad. 29.
25. Leaves deeply pinnatifid. 26.
25. Leaves bi-pinnatifid; sepals caducous. *Sophia.*
26. Plants of wet places; sepals and pedicels spreading. *Radicula.*
26. Plants of dry places. 27.
27. Leaves runcinate. 28.
27. Leaves lyrate; stems angled, glabrous. *Barbarea.*
28. Basal and stem-leaves similar; pods appressed. *Erysimum.*
28. Basal leaves runcinate; stem-leaves deeply pinnatifid; pods spreading. *Norta.*
29. Leaves lyrate or lobed. 30.
29. Leaves various. 31.
30. Plants hispid; pods constricted, dehiscent. *Sinapis.*
30. Plants rough, pods spongy, indehiscent. *Raphanus.*
31. Basal leaves lobed or pinnatifid; stem-leaves reduced to lanceolate. *Brassica.*
31. Basal and stem-leaves deeply pinnatifid into narrow lobes. *Diplotaxis.*
32. Basal and stem-leaves similar. 33.
32. Basal and stem-leaves different. 35.
33. Leaves dentate, cordate, earliest opposite; petals clawed. *Lunaria.*
33. Leaves lanceolate, oblanceolate or obovate. 34.
34. Plants tall; flowers large, fragrant. *Hesperis.*
34. Fleshy plants of the seashore; pods short, 2-jointed. *Cakile.*
35. Leaves simple, not lobed. 36.
35. Leaves deeply lobed. 37.
36. Basal leaves rosulate; stem-leaves sagittate. *Arabis.*
36. Basal leaves orbicular, long-petioled; stem-leaves ovate, coarsely dentate, sessile; flowers corymbose. *Cardamine.*
37. Leaves pinnately lobed. 38.
37. Leaves palmately 3-lobed. *Dentaria.*
38. Lower leaves pinnatifid, clasping; upper leaves lanceolate; lateral sepals slightly gibbous at the base; petals long-clawed. *Iodanthus.*
38. Lower leaves lyrate; upper leaves small, rough; petals veiny. *Raphanus.*

Key to the Brassicaceæ of Ohio Based Upon the Fruit and Other Characteristics Present With the Fruit.

1. Fruit a silicle, not more than twice as long as broad. 2.
1. Fruit a silique, more than twice as long as broad. 14.
2. Pods flattened. 3.
2. Pods not flattened. 11.
3. Pods flattened parallel to the partition. 4.
3. Pods flattened at right angles to the partition. 8.
4. Stems scapose; basal leaves in a rosette; petals white. *Draba.*
4. Stems leafy. 5.

5. Leaves entire. 6.
5. Leaves dentate, cordate; flowers purple. *Lunaria.*
6. Sepals persistent; petals yellow. *Alyssum.*
6. Sepals deciduous; petals white. 7.
7. Pods elliptic, canescent; petals bifid. *Berteroa.*
7. Pods orbicular, glabrous; petals entire. *Koniga.*
8. Pods dehiscent; flowers white. 9.
8. Pods indehiscent; flowers yellow; leaves large. *Myagrum.*
9. Pods triangular; basal leaves tufted. *Bursa.*
9. Pods didymous, rugose; leaves pinnatifid. *Carara.*
9. Pods orbicular. 10.
10. Pods broadly winged, several seeded; leaves dentate. *Thlaspi.*
10. Pods scale-shaped, smooth; leaves pinnatifid to entire. *Lepidium.*
11. Pods dehiscent; plant usually glabrous. 12.
11. Pods indehiscent, reticulated; plant hispid; leaves lanceolate, sagittate. *Neslia*
12. Pods pear-shaped; flowers yellow; leaves lanceolate. *Camelina.*
12. Pods globose or ovoid; flowers white. 13.
13. Leaves various; root pungent; pods seldom formed. *Armoracia.*
13. Leaves immersed, dissected, and emersed. *Neobeckia.*
14. Pods dehiscent. 15.
14. Pods indehiscent, beaked. 32.
15. Pods tipped with the style or style none. 16.
15. Pods beaked; flowers yellow. 30.
16. Seeds in two rows in each cavity. 17.
16. Seeds in one row in each cavity. 20.
17. Glabrous, aquatic; leaflets 3-11; flowers white. *Sisymbrium.*
17. Pubescent or glabrous. 18.
18. Leaves simple, not lobed; basal leaves tufted; flowers purplish. *Arabis.*
18. Leaves pinnatifid or bi-pinnatifid; flowers yellow. 19.
19. Plants of wet places; valves nerveless. *Radicula.*
19. Plants of dry places; valves 1–3-nerved. *Sophia.*
20. Leaves simple, not lobed. 21.
20. Leaves lobed or pinnatifid. 26.
21. Leaves entire, obtuse, cordate; plants glabrous, pale green; flowers pale yellow. *Conringia.*
21. Leaves not entire. 22.
22. Leaves ovate or cordate; plants glabrous or nearly so; pods long, slightly constricted between the seeds. 23.
22. Leaves lanceolate or oblanceolate; plants pubescent. 24.
23. Leaves broad, dentate, cordate; flowers white. *Alliaria.*
23. Leaves sometimes lyrate; flowers purple. *Iodanthus.*
24. Stems nearly leafless, slender; flowers white. *Arabidopsis.*
24. Stems leafy. 25.
25. Stems branching, rough-pubescent or hoary; flowers yellow. *Cheirinia.*
25. Stems simple or nearly so; flowers large, purple, fragrant. *Hesperis.*
26. Leaves palmately 3-lobed; stems leafless below; rootstocks pungent. *Dentaria.*
26. Leaves pinnately lobed. 27.
26. Basal and stem-leaves different. 29.
27. Leaves runcinate-pinnatifid. 28.
27. Leaves lyrate; pods and stems 4-angled, glabrous. *Barbarea.*
28. Pods appressed, ½ in. long. *Erysimum.*
28. Pods spreading, 2–4 in. long. *Norta.*
29. Pods elastically dehiscent. *Cardamine.*
29. Pods not elastically dehiscent. *Arabis.*
30. Pods constricted; beaks long and flat. *Sinapis.*
30. Pods not constricted. 31.
31. Pods round; beak conic; seeds in one row, globose; basal leaves pinnatifid. *Brassica.*
31. Pods flattened; beak short; seeds in two rows, ovoid; all leaves deeply pinnatifid. *Diplotaxis.*
32. Pods constricted, spongy; leaves lyrate; flowers yellow or purple. *Raphanus.*
32. Pods 2-jointed; flowers purple; fleshy seaside plants. *Cakile.*

1. **Berteròa** DC. Berteroa.

Annual or perennial, stellate-pubescent, erect herbs, with narrow entire leaves, and white flowers in terminal racemes. Petals bifid. Silicles elliptic, canescent, plump. Seeds several in each cavity, winged.

1. **Berteròa incàna** (L.) DC. Hoary Berteroa. Pale green, 1-2 ft. high, branched above; leaves lanceolate, obtuse, $\frac{1}{2}$-$1\frac{1}{2}$ in. long; racemes elongating, flowers small, numerous.

Recently introduced from Europe and becoming naturalized in waste places. No specimens.

2. **Kòniga** Adans. Sweet Alyssum.

Annual or perennial, weak ascending herbs, slightly pubescent, with entire leaves and white flowers in terminal racemes. Hairs of stem and leaves forked. Silicles oval or orbicular, compressed. Seeds one in each cavity.

1. **Kòniga marítima** (L.) R. Br. Sweet Alyssum. Slightly hoary, branching, 4-12 in. high; basal leaves oblanceolate; stem-leaves linear, $\frac{1}{2}$-2 in. long, sessile; flowers small, sweet scented; pods glabrous, nearly orbicular, pointed, ascending. Escaped from gardens.

Erie County.

3. **Alýssum** (Tourn.) L. Alyssum.

Annual, erect, stellate-pubescent, tufted herbs, with narrow leaves and yellow flowers in racemes. Silicles small, orbicular, compressed. Seeds one or two in each cavity, wingless.

1. **Alyssum alyssoìdes** L. Yellow Alyssum. Dwarf hoary herbs, branching from the base, 3-10 in. high; leaves linear-spatulate, entire, $\frac{1}{3}$–$1\frac{1}{3}$ inches long; flowers pale yellow, small, petals entire, sepals persistent; pods margined.

In fields and meadows, naturalized from Europe.

Sandusky County.

4. **Dràba** (Dill.) L. Whitlow-grass.

Annual or biennial low tufted herbs, with stellate-pubescence, simple leaves mostly basal, and flowers in slender racemes. Silicles oval or oblong, flat. Seeds many, in two rows in each cavity, wingless.

1. Petals bifid, stems scapose. *D. verna.*
1. Petals entire, stems leafy below. *D. caroliniana.*

1. **Draba vérna** L. Vernal Whitlow-grass. Scapes numerous, 1-5 in. high; leaves basal, rosulate, ½-1 in. long, oblanceolate pubescent, nearly entire; racemes elongating, flowers small, cleistogamous; pods ¼-⅓ in. long, shorter than the pedicels.

In fields and on roadsides, naturalized from Europe. Portage County and southern half of state.

2. **Draba caroliniàna** Walt. Carolina Whitlow-grass. Scapes short, leafy below, 1-5 in. high; leaves obovate, entire, sessile, pubescent, ⅓-1 in. long; petals sometimes wanting; pods broadly linear, crowded.

Indigenous winter-annual in sandy fields, flowering early. Adams, Clark, Erie and Ottawa Counties.

5. **Camélina** Crantz. False-flax.

Erect annual herbs with entire or toothed leaves and small yellow flowers in long racemes. Silicles obovoid, style slender. Seeds many, oblong, in two rows in each cavity, wingless.

1. Glabrous, pods large. *C. sativa.*
1. Pubescent, pods small. *C. microcarpa.*

1. **Camelina satìva** (L.) Crantz. Common False-flax. Stem simple or nearly so, 1-2 ft. high; lowest leaves lanceolate, 2-3 in. long, toothed, petioled; upper leaves smaller, entire, sagittate, sessile; flowers numerous, pods obovoid, spreading, pedicels slender.

A weed in fields, naturalized from Europe. Auglaize, Franklin, Miami, Montgomery, Sandusky.

2. **Camelina microcàrpa** Andrz. Small-fruited False-flax. Stem as in **C. sativa,** but pubescent and more slender; leaves lanceolate, sessile and clasping, or narrowed at the base; pods smaller.

A weed in cultivated fields, naturalized from Europe. Clark County.

6. **Búrsa** (Siegesb.) Weber. Shepherd's-purse.

Annual or winter-annual erect herbs, pubescent with forked hairs, with rosulate basal leaves and small white flowers in racemes. Silicles triangular, emarginate, flattened at right angles with the partition. Seeds 10 or 12 in each cavity, wingless.

1. **Bursa bursa-pastòris** (L.) Britt. Shepherd's-purse. Stems from a long taproot, branching, 6-20 in. high; basal leaves

many, 2-5 in. long, more or less lobed; stem-leaves few, sessile, sagittate, dentate or entire. Flowers begin to bloom when the stem is very short, and the stem lengthens as the flowers open. Blooms throughout the growing season.

Naturalized from Europe. General and abundant.

7. **Néslia** Desv. Ball-mustard.

Annual or biennial erect branching herbs, with entire leaves and small yellow flowers in racemes. Silicles small, round, indehiscent, 1-celled, 1-seeded. Style slender. A monotypic genus.

1. **Neslia paniculàta** (L.) Desv. Ball-mustard. Stem slender, branched at the inflorescence, rough-hispid with branched hairs, 1-2 ft. high; leaves lanceolate, acute, sagittate-clasping, 1-2 in. long; racemes elongated; pods globose, reticulated, spreading.

In waste places and grain fields, naturalized from Europe. Escaped in Lake County.

8. **Armoràcia** Gaertn. Horseradish.

Tall perennial glabrous herbs from large and long pungent roots, with large leaves and white flowers in paniculate racemes. Silicles nearly globular, style short. Seeds few, in 2 rows in each cavity, wingless.

1. **Armoracia armoràcia** (L.) Britt. Horseradish. Stems erect, 2-3 ft. high, leafy; basal leaves rough but glabrous, wavy, crenate or even pinnatified, 6-12 in. long, petioled; stem-leaves smaller, lanceolate, crenate or dentate, sessile; racemes terminal and axillary, flowers large; pods seldom matured.

Escaped from gardens into moist ground and spreading by the roots which furnish the well-known sauce. Naturalized from Europe. General.

9. **Neobéckia** Greene. Lake Water-cress.

Branching perennial aquatic herbs, with finely dissected immersed leaves and oblong emersed leaves. Flowers large, white racemose, petals longer than the calyx. Silicles ovoid. Seed few, in 2 rows in each cavity.

A monotypic genus of eastern North America.

1. **Neobeckia aquática** (Eat.) Britt. Lake Water-cress. Stems 1-2 ft. long; immersed leaves 2-6 in. long, pinnately

dissected into many very narrow segments; emersed leaves 1-3 in. long, oblong, entire or serrate, easily broken off; pods 1-6 in. long, with style half as long; pedicels spreading. Detached leaves said to produce new plants.

Indigenous but local in lakes and slow streams. Coshocton, Licking, Lucas, Madison, Perry.

10. **Sisýmbrium** (Tourn.) L. Water-cress.

Perennial glabrous aquatic herbs, with pinnate leaves and small white flowers in short erect terminal racemes. Siliques broadly linear on slender pedicels, style stout. Seeds numerous, in 2 rows in each cavity, wingless. A monotypic genus of the Old World.

1. **Sisymbrium nastúrtium-aquáticum** L. True Water-cress. Stems creeping and rooting at the nodes, fleshy; leaflets 3-11, roundish, entire or notched, the terminal one largest; petals twice as long as the sepals; pods $\frac{1}{2}$-$1\frac{1}{3}$ in. long, ascending on spreading pedicels.

Originally cultivated, but now naturalized in shallow brooks and spring drains. Rather general.

11. **Radícula** Hill. Yellow-cress.

Branching herbs with lyrate or deeply pinnatifid leaves and small yellow flowers in lateral and terminal racemes. Siliques short, terete dehiscent. Seeds numerous, turgid, marginless, in 2 irregular rows in each cavity.

1. Stems creeping, leaves pinnatifid. *R. sylvestris.*
1. Stems erect, leaves lyrate. 2.
2. Glabrous, pods linear to ellipsoid. *R. palustris.*
2. Hirsute, pods globose. *R. hispida.*

1. **Radicula híspida** (Desv.) Britt. Hispid Yellow-cress. Resembles **R. palustris,** but is stouter, taller, 4 ft. high, with lower leaves 10 in. long; hirsute with spreading hairs, especially at the base of the plant; pods globose or a little longer than thick.

Annual or biennial in wet places, more common eastward. Introduced from Europe. Cuyahoga, Erie, Huron, Logan, Monroe, Ottawa, Shelby, Summit.

2. **Radicula palústris** (L.) Moench. Marsh Yellow-cress. Stems erect, bushy, glabrous, 1-$3\frac{1}{2}$ ft. high, from fibrous roots; leaves 3-7 in. long, lyrate-pinnatified or the upper ones smaller, laciniate, the lobes oblong and toothed; pods short, linear-oblong.

Annual or biennial in wet places. Indigenous or introduced from Europe. General.

3. **Radicula sylvéstris** (L.) Druce. Creeping Yellow-cress. Stems creeping, branches ascending; leaves 3-5 in. long, petioled, pinnately parted, divisions toothed or lobed, obovate or lanceolate; pods linear, style short.

A perennial in wet places, naturalized from Europe. Cuyahoga, Erie, Lucas.

12. **Lepídium** (Tourn.) L. Peppergrass.

Erect glabrous and pubescent herbs, with entire or pinnatified leaves and white flowers in racemes. Petals small or wanting. Stamens 6 or 2. Silicles orbicular, dehiscent, flattened contrary to the partition. Seeds 2, pendulous, 1 in each cavity.

1. Stem-leaves clasping by an auricled base; stamens 6. 2.
1. Stem-leaves not clasping by an auricled base; stamens 2. 3.
2. Stem-leaves sagittate-clasping; pods ovate, winged; style minute. *L. campestre.*
2. Stem-leaves broadly auricled; pods broad-ovate, wingless; style conspicuous. *L. draba.*
2. Stem-leaves oval, deeply clasping, pods orbicular. *L. perfoliatum.*
3. Petals present, pods orbicular. *L. virginicum.*
3. Petals wanting or rare. 4.
4. Plant fetid, petals none. *L. ruderale.*
4. Plant scentless, petals none or very small. *L. densiflorum.*

1. **Lepidium ruderàle** L. Roadside Peppergrass. Stem erect and branching, glabrous, 6-15 in. high; lower leaves 1-4 in. long, bipinnatifid, upper leaves small, entire; pods flat, oval, marginless, on slender ascending pedicels.

An annual in waste places near cities, naturalized from Europe. No specimens.

2. **Lepidium virgínicum** L. Virginia Peppergrass. Stems erect, glabrous, much branched; leaves of all forms from the large pinnatifid lower leaves to the linear entire form near the inflorescence; lower leaves early deciduous; flowers small in elongating racemes; pods flat, obscurely margined at the top.

An indigenous annual weed. General and abundant.

3. **Lepidium densiflòrum** Schrad. Wild Peppergrass. Resembles **L. ruderale** and **L. virginicum.** Leaves toothed or pinnatifid; petals usually wanting; pods orbicular, slightly winged at the top.

An annual, more common in the West, lately introduced eastward. Auglaize, Champaign, Cuyahoga, Fayette, Franklin, Lake, Lorain, Wayne.

4. **Lepidium dràba** L. Hoary Peppergrass. Stems erect, hoary, branching, 10-18 in. high; leaves oblong, irregularly dentate, $1\frac{1}{2}$-2 in. long, the lower petioled, the upper auricle-clasping; flowers corymbose; pods ovate or cordate, style as long as the pod.

Perennial in waste grounds. Fugitive from Europe. Lucas County.

5. **Lepidium campéstre** (L.) R. Br. Field Peppergrass. Stem erect, hoary-pubescent, with scale-like hairs, branching above, 10-18 in. high; basal leaves 2-3 in. long, spatulate, tapering to a petiole, entire or lobed, somewhat rosulate at first; stem leaves crowded, lanceolate, obtuse; pods winged at the apex, rough.

An annual or biennial weed in fields and on roadsides, naturalized from Europe. Rather general.

6. **Lepidium perfoliàtum** L. Perfoliate Peppergrass. Stem branching, erect, 1 ft. high; basal and lower leaves finely pinnatifid, upper leaves oval, entire, deeply clasping around the stem; pods round, on slender, spreading pedicels.

Fugitive from Europe. Portage County.

13. **Caràra** Medic. Wart-cress.

Annual or biennial, diffuse, spreading, fetid herbs, with pinnatifid leaves and small whitish flowers in axillary and terminal racemes. Stamens sometimes only 2. Silicles small, didymous, tuberculate or rugose, indehiscent. Seeds 1 in each cavity.

1. **Carara dídyma** (L.) Britt. Lesser Wart-cress. Stems tufted, slightly pubescent, branching, 2-15 in. long, prostrate; leaves deeply pinnatifid, lower petioled, upper sessile; pods didymous, notched at apex, rugose, separating into 2 ovoid nutlets.

A weed in waste places, introduced from Europe. Lake County.

14. **Thláspi** (Tourn.) L. Penny-cress.

Low winter annuals with rosulate basal leaves, auriculate-clasping stem-leaves, and small white or purplish flowers in panicled racemes. Silicles orbicular, obcordate, winged, flattened contrary to the partition. Seeds 2-8 in each cavity, wingless.

1. Lower stem-leaves not clasping; pods large. *T. arvense.*
1. All the stem-leaves clasping; pods small. *T. perfoliatum.*

1. **Thlaspi arvénse** L. Field Penny-cress. Stems erect, glabrous, 6-18 in. high, branching above; basal leaves petioled, oblanceolate, entire, falling away early; stem-leaves slightly dentate, 1-3 in. long, the lower sessile, the upper clasping by a sagittate base; flowers very small, white; pods nearly orbicular when ripe, $\frac{1}{3}$-$\frac{1}{2}$ in. broad, winged all around, notched at the top.

In waste places, naturalized from Europe. Cuyahoga, Henry, Highland, Belmont (Laughlin Herbarium).

2. **Thlaspi perfoliàtum** L. Perfoliate Penny-cress. Stems slender, erect, glabrous, 3-7 in. high, usually branching at the base; basal leaves petioled, ovate or orbicular; stem-leaves ovate, sessile, clasping by an auricled base, $\frac{1}{2}$-1 in. long, upper leaves nearly perfoliate; flowers small, white; pods $\frac{1}{4}$ in. broad or less, winged, notched at the top.

In gravel soil, adventive from Europe. Clermont County.

15. **Myàgrum** L. Myagrum.

Annual erect branching herbs, with entire or undulate lanceolate leaves and small yellow flowers in elongating racemes. Longer stamens somewhat connate in pairs. Silicles obcuneate to spatulate, indehiscent, 1-seeded. A monotypic genus.

1. **Myagrum perfoliàtum** L. Myagrum. Stem glabrous and glaucous; lower leaves narrowed into petioles; upper leaves oblong, obtuse, 2-5 in. long, with rounded basal lobes; pods as long as the ascending pedicels.

In waste places, fugitive from Europe. Lake County.

16. **Alliària** Adans. Garlic Mustard.

Biennial, erect branching herbs, glabrous or slightly pubescent, with broad, coarsely dentate cordate or rounded leaves and white flowers in racemes. Sepals caducous, petals long-clawed, stamens 6. Siliques long, linear, dehiscent from the base. Seeds in 1 row in each cavity, wingless.

1. **Alliaria alliària** (L.) Britt. Garlic Mustard. Stems tall, 1-3 ft. high, nearly glabrous; leaves broadly ovate or cordate, petiolate, 2-7 in. broad; basal leaves round, crenate, long petioled; flowers small, white; pods 1-2 in. long, on short stout pedicels.

Naturalized from Europe in waste places near dwellings. No specimens. (Erie County—Moseley Herbarium).

17. **Sòphia** Adans. Tansy-mustard.

Annual canescent or pubescent herbs with finely pinnatified leaves and small yellow flowers in elongating racemes. Siliques narrow, pedicelled. Seeds very small, in 1 or 2 rows in each cavity, wingless.

1. Canescent, pods horizontal. *S. pinnata.*
1. Green, pods ascending. *S. incisa.*

1. **Sophia pinnàta** (Walt.) Howell. Pinnate Tansy-mustard. Stems slender, erect, branching, canescent, 8-24 in. tall; leaves finely 2-pinnatifid, 2-4 in. long; flowers very small, yellowish; pods erect, shorter than the horizontal pedicels; seeds in 2 rows in each cavity.

Indigenous in dry situations. Hamilton, Jackson, Miami, Montgomery, Ottawa.

2. **Sophia incìsa** (Engelm.) Greene. Western Tansy-mustard. Resembling **S. pinnata,** but not canescent. Leaves pinnatifid; pods ascending, about the length of the pedicels; seeds in 1 row in each cavity.

An indigenous western polymorphous species. Erie, Miami, Portage.

18. **Cheirínia** Link. Cheirinia.

Annual and biennial erect branching herbs, pubescent with 2-parted hairs, with lanceolate entire or toothed leaves, and yellow flowers in racemes. Siliques linear, 4-sided. Seeds in 1 row in each cavity, wingless.

1. Slender, pubescent; flowers small, pods short and spreading. *C. cheiranthoides.*
1. Stout, pubescent, pods long and spreading. 2.
2. Leaves repand or lobed, flowers medium. *C. repanda.*
2. Leaves lanceolate, dentate, flowers large. *C. aspera.*

1. **Cheirinia cheiranthoìdes** (L.) Link. Wormseed Mustard. Stems erect, roughish, branching, $\frac{2}{3}$-2 ft. high; leaves lanceolate, usually entire, 1-4 in. long; flowers yellow; pods slender, erect, on diverging pedicels.

A biennial, on banks of streams or in waste places, introduced from Europe. Hamilton, Lake, Lucas, Portage.

2. **Cheirinia repánda** (L.) Link. Repand Cheirinia. Stem pubescent, 1 ft. high, much branched; leaves repand-denticulate, lanceolate, lower ones sometimes lobed, 1-3$\frac{1}{2}$ in. long; flowers larger than in **C. cheiranthoides;** pods long, spreading, on stout pedicels.

Annual in waste ground, adventive from Europe. Erie, Logan.

3. **Cheirinia áspera** (DC.) Britt. Western Cheirinia. Stem nearly simple, hoary-pubescent, 1-3 ft. high; leaves narrowly lanceolate, usually dentate, 1-2 in. long; flowers large, orange-yellow, in a close raceme; petals orbicular, on slender claws; pods 1-4 in. long, rough, spreading on slender pedicels, 4-sided.

An indigenous biennial, in open places. Franklin County.

19. **Erýsimum** (Tourn.) L. Hedge-mustard.

Tall erect annual herbs, with pinnatifid leaves and small yellow flowers in racemes. Siliques linear, round. Seeds many, in 1 row in each cavity, marginless.

1 **Erysimum officinàle** L. Hedge-mustard. Stem branching, somewhat pubescent, 1-3 ft. high; leaves runcinate, the lower petioled, the upper sessile, lobes 7-13, the end lobe largest; flowers pale yellow; pods linear, $\frac{1}{2}$ in. long, closely appressed to the stem. Lower leaves sometimes rosulate.

A common weed in waste places, naturalized from Europe. General and abundant.

20. **Nórta** Adans. Hedge-mustard.

Erect annual herbs, with pinnatifid leaves, and medium-sized yellow flowers in loose racemes. Siliques very long, linear, terete, spreading or ascending. Seeds wingless, in 1 or 2 rows in each cavity.

1. Pods spreading; leaves runcinate-pinnatifid. *N. altissima.*
1. Pods ascending; leaves runcinate, with a large terminal segment. *N. irio.*

1. **Norta altíssima** (L.) Britt. Tall Hedge-mustard. Stem glabrous, much branched, 2-4 ft. high; lower leaves narrowly runcinate, upper leaves pinnatifid into narrow segments; flowers pale yellow; pods 2-4 in. long, rigid, spreading.

A bad weed introduced from the Northwest, but native of Europe. Belmont, Cuyahoga, Erie, Greene, Jackson, Lake, Ottawa, Portage, Wayne.

2. **Norta írio** (L.) Britt. Longleaf Hedge-mustard. Similar to **N. altissima.** Leaves runcinate-pinnatifid, the terminal segment large.

In waste places, adventive from Europe. Portage County.

21. **Conríngia** (Heist.) Adans. Hare's-ear Mustard.

Annual erect glabrous herbs, with elliptic, entire sessile or cordate-clasping leaves, and yellowish white flowers in terminal racemes. Sepals and petals narrow. Siliques linear, 4-angled, bilocular. Seeds wingless, in 1 row in each cavity.

1. **Conringia orientàlis** (L.) Dum. Hare's-ear Mustard. Stem usually simple, 1-3 ft. tall, somewhat succulent; leaves light green, obtuse, $\frac{1}{3}$ in. long; petals nearly twice as long as the sepals; pods spreading.

Adventive from Europe, becoming a bad weed, more common in the Northwest. Cuyahoga, Geauga, Lake.

22. **Hésperis** (Tourn.) L. Dame's Rocket.

Biennial or perennial erect herbs, pubescent with forked hairs, with simple leaves and large purple flowers in racemes. Stigma 2-lobed. Siliques long, slender, dehiscent. Seeds marginless, globose, in 1 row in each cavity.

1. **Hesperis matronàlis** L. Dame's Rocket. Stem branched, 2-3 ft. tall; leaves lanceolate, serrate, acuminate, lower leaves long petioled, 3-8 in. long, upper leaves smaller, sessile; flowers an inch broad, fragrant, petals spreading; pods linear, 2-4 in. long.

A native of Europe, escaped from cultivation. Belmont (Laughlin Herbarium), Franklin, Hamilton, Portage.

23. **Arabidòpsis** (DC.) Schur. Mouse-ear Cress.

Annual erect branching herbs, pubescent with forked hairs, with entire or toothed leaves and small white flowers in terminal racemes. Siliques linear, dehiscent. Seeds wingless, in 1 row in each cavity.

1. **Arabidopsis thaliàna** (L.) Britt. Mouse-ear Cress. Stem slender, hairy at the base, 1-16 in. high; basal leaves rosulate, obovate, entire or toothed, petioled, 1-2 in. long; stem-leaves smaller, few, acute, sessile; flowers small, petals about twice the length of the calyx; pods pointed, spreading.

In old fields and rocky places, naturalized from Europe. Ashtabula, Clinton, Lucas, Montgomery.

24. **Barbarèa** R. Br. Winter-cress.

Biennial or perennial erect branching herbs, with angled stems, pinnatifid leaves and yellow flowers in racemes. Stamens 6. Siliques linear, 4-angled. Seeds wingless, in 1 row in each cavity.

1. Lateral leaf-segments 1-4 pairs. 2.
1. Lateral leaf-segments 4-8 pairs. *B. verna.*
2. Pods spreading. *B. barbarea.*
2. Pods appressed. *B. stricta.*

1. **Barbarêa Barbarêa** (L.) MacM. Yellow Winter-cress. Stems erect, glabrous, 1-2 ft. high, often in tufts; basal leaves rosulate, 2-5 in. long, lyrate with a large rounded terminal division, and 1-4 pairs of lateral segments; upper leaves nearly or quite sessile, obovate, cut-toothed at the base; flowers bright yellow; pods obtusely 4-angled, 1 in. long on slender spreading pedicels. The thick basal leaves are found in winter and used as a salad.

Indigenous in the Northwest, but apparently introduced in the Eastern States. General.

2. **Barbarea strícta** Andrz. Erect Winter-cress. Stem and leaves similar to **B. barbarea,** except that the lateral divisions of the leaves are broader and more acute; flowers pale yellow, corymbose, the rachis elongating in fruit; pods erect, appressed.

In fields and meadows, naturalized from Europe. Erie County.

3. **Barbarea vérna** (Mill.) Aschers. Early Winter-cress. Similar to **B. stricta,** but less stout, except the pedicels which are stouter; leaves 4-8 pairs of lateral segments; pods 1-3 in. long, sharply 4-angled, slightly compressed.

Introduced from Europe, and flowering earlier than the other species. Sometimes cultivated for salad and called Scurvy-Grass. Belmont, Harrison, Portage, Preble.

25. **Iodânthus** T. & G. Purple Rocket.

Perennial erect glabrous herbs, with dentate or lyrate leaves, and purplish flowers in panicled racemes. Siliques long, linear, somewhat flattened. Seeds oblong, wingless, in 1 row in each cavity. A monotypic genus.

1. **Iodanthus pinnatífidus** (Mx.) Steud. Purple Rocket. Stem slender, branching, 1-3 ft. high; lower leaves ovate or cordate, sometimes lyrate, dentate, 2-8 in. long, tapering into a long margined petiole which is clasping at the base; stem-leaves smaller, ovate-lanceolate, the upper nearly sessile; flowers many, small, lavender-purple; pods about 1 in. long, spreading or ascending.

Indigenous on low river banks or creeks. Rather general.

26. Árabis L. Rock-cress.

Annual or biennial erect, glabrous or pubescent herbs, with entire or lobed, sometimes pinnatifid leaves, and white or purple flowers in racemes. Siliques linear, dehiscent. Seeds in 1 or 2 rows in each cavity, winged or wingless.

1. Flowers white. 2.
1. Flowers purple or purplish; basal leaves spatulate; stem-leaves lanceolate. 8.
2. Basal and stem-leaves similar, pinnatifid; plant glabrous. *A. virginica.*
2. Basal and stem-leaves different. 3.
3. Basal leaves lyrate; stem-leaves spatulate to linear; plant glabrous above, pubescent below. *A. lyrata.*
3. Basal leaves on marginal petioles; stem-leaves clasping; plant pubescent. 4.
3. Basal leaves petioled. 6.
4. Petals as long as the calyx. 5.
4. Petals longer than the calyx; pods erect or appressed. *A. hirsuta.*
5. Flowers greenish white; pods spreading. *A. dentata.*
5. Flowers bright white; pods ascending. *A. patens.*
6. Plant glabrous and glaucous; stem-leaves clasping; petals slightly longer than the calyx; pods long. 7.
6. Plants glabrous above, pubescent below; stem-leaves not clasping; petals twice as long as the calyx; pods scythe-shaped. *A. canadensis.*
7. Petals yellowish-white; pods appressed. *A. glabra.*
7. Petals greenish-white; pods recurved-spreading. *A. laevigata.*
8. Plant glabrous and somewhat glaucous; pods close, erect. *A. drummondii.*
8. Plant glabrous above; purple-glaucous; pods spreading. *A. brachycarpa.*

1. **Arabis dentàta** T. & G. Toothed Rock-cress. Stems slender, upright, branching from the base, 1-2 ft. high; leaves broad-ovate or obovate, dentate, basal leaves 2-4 in. long, stem-leaves auricled; pods linear, ascending; seeds marginless, in 1 row in each cavity.

An indigenous biennial or perennial. Rather general.

2. **Arabis pàtens** Sull. Spreading Rock-cress. Stem simple, erect, leafy, 1-2 ft. high, densely pubescent; basal leaves dentate, 1-3 in. long, stem-leaves sessile, cordate-clasping, ovate or oblong, the middle ones largest; pods narrow, flat; seeds narrowly winged, in 1 row in each cavity.

An indigenous biennial. Franklin County.

3. **Arabis hirsùta** (L.) Scop. Hairy Rock-cress. Stem erect, nearly simple, rough-hairy or nearly glabrous, 1-2 ft. high; basal leaves obovate, obtuse, dentate, 1-2 in. long on margined petioles; stem-leaves lanceolate or oblong, partly clasping by a somewhat heart-shaped base; pods linear, 1-2 in. long; seeds narrowly winged, in 1 row in each cavity.

A European biennial, in rocky places. Rather general.

4. **Arabis glàbra** (L.) Bernh. Tower Mustard. Stems erect, usually simple or branched at the base, 2-4 ft. high, glabrous

and glaucous, pubescent below; basal leaves 2-10 in. long, oblanceolate, coarsely dentate or lyrate; stem-leaves smaller, lanceolate, usually entire, with a sagittate base; petals little longer than the sepals; pods linear, 2-3 in. long, erect and appressed; seeds marginless, in 1 row in each cavity.

A biennial in fields and rocky places, perhaps indigenous. Auglaize, Belmont, Cuyahoga, Franklin, Geauga, Hamilton, Lucas, Richland.

5. **Arabis laevigàta** (Muhl.) Poir. Smooth Rock-cress. Stems erect, 1-3 ft. high, glabrous and glaucous, nearly simple; basal leaves 2-3 in. long, obovate, dentate, rarely lyrate; stem-leaves sessile, lanceolate to linear, entire or few-toothed, clasping by an auricled base; pods 3-4 in. long, recurved-spreading; seeds winged, in 1 row in each cavity.

An indigenous biennial in rocky woods. General.

6. **Arabis canadénsis** L. Sickle-pod Rock-cress. Stems erect, simple, 1-3 ft. high, smooth above; basal leaves 3-7 in. long, dentate, narrowed into a petiole, early withering; stem-leaves sessile, pubescent, lanceolate, pointed at each end, toothed or entire; pods flat, 2-3½ in. long, scythe-shaped, pendulous on hairy pedicels; seeds winged, in 1 row in each cavity.

An indigenous biennial in woods and ravines. General.

7. **Arabis virgínica** (L.) Trel. Virginia Rock-cress. Stems low, diffuse, 6-12 in. long; leaves pinnatifid, 1-3 in. long; flowers very small; pods linear, ascending; seeds orbicular, winged, in 1 row in each cavity.

Indigenous in open situations. Clark, Clermont, Lawrence.

8. **Arabis lyràta** L. Lyre-leaf Rock-cress. Stems tufted, erect, 4-12 in. high; basal leaves lyrate, 1-2 in. long; stem-leaves spatulate or linear, entire or toothed, scattered; petals much longer than the calyx; pods linear, ascending; seeds wingless, in 1 row in each cavity.

An indigenous biennial in rocky places. Auglaize, Erie, Muskingum, Pike, Wood.

9. **Arabis drummondii** Gr. Drummond's Rock-cress. Stems erect, ⅔-3 ft. tall, glabrous, somewhat glaucous; basal leaves rosulate, oblanceolate, dentate or entire narrowed into a long petiole; stem-leaves sagittate-lanceolate, erect, entire; flowers pink-purple or white; pods blunt, 2-4 in. long; seeds winged, in 2 rows in each cavity.

An indigenous biennial in rocky places. No specimens.

10. **Arabis brachycàrpa** (T. & G.) Britt. Purple Rock-cress. Stems erect, simple or sparingly branched, 1-3 ft. high, glabrous except at the base, glaucous and purplish; basal leaves rosulate, densely stellate-pubescent, obovate, dentate, petioled, 1-3 in. long; stem leaves glabrous, sagittate-lanceolate, entire or few-toothed; flowers pink-purple or white; petals twice the length of the calyx; pods linear, 1-3½ in. long; seeds winged, in 2 rows in each cavity.

An indigenous biennial in sandy or rocky situations. Erie, Ottawa.

27. **Cardâmine** (Tourn.) L. Bitter-cress.

Erect and ascending branching herbs, mostly glabrous, with tuberous rootstocks or fibrous roots, simple or pinnately divided leaves, and white or purplish flowers in racemes or corymbs. Stamens 6 or 4. Siliques long, flat, elastically dehiscent. Seeds flat, wingless, in 1 row in each cavity.

1. Leaves simple, entire or coarsely dentate. 2.
1. Leaves simple, pinnately divided. 4.
2. Stems erect from a tuberous base; basal and stem-leaves different. 3.
2. Stems decumbent; roots fibrous; basal and stem-leaves similar; flowers white, small. *C. rotundifolia*.
3. Plant early, pubescent, purplish; flowers purple. *C. douglassii*.
3. Plant later, glabrous, green; flowers white. *C. bulbosa*.
4. Stems erect. 5.
4. Stems weak; flowers white, very small. *C. parviflora*.
5. Flowers white or purplish, showy. *C. pratensis*.
5. Flowers white, small. 6.
6. Stems mostly leafless; leaves rosulate, pubescent; stamens 4. *C. hirsuta*.
6. Stems leafy; leaves glabrous. 7.
7. Leaflets obovate or oblong; plant 8 in. to 3 ft. tall, branched. *C. pennsylvanica*.
7. Leaflets linear; plant 6 in. to 1 ft. tall, branched from the base. *C. arenicola*.

1. **Cardamine douglássii** (Torr.) Britt. Purple Bitter-cress. Stems clustered from a perennial tuberous rootstock, usually simple, 4-15 in. high; basal leaves slender petioled, ovate-orbicular, 1 in. broad, cordate, somewhat angular, purple beneath; stem-leaves close, sessile, nearly dentate; flowers in a lengthening raceme, corymbose at first, showy; pod 1 in. long, pointed, erect.

Indigenous in low, shady, moist places. General and abundant.

2. **Cardamine bulbòsa** (Schreb.) B. S. P. Bulbous Bitter-cress. Stems several from a slender tuberous rootstock, 6-20 in. high; basal leaves oblong or cordate-ovate, 1-1½ in. long, on long petioles; stem-leaves scattered, lower petioled, upper sessile, toothed or entire; pods as in **C. douglassii.**

Perennials in wet meadows and along streams, blooming two or three weeks later than **C. douglassii.** Indigenous and general.

3. **Cardamine rotundifòlia** Mx. Round-leaf Bitter-cress. Stems branching, stoloniferous; leaves ranging from petioled at the base to sessile near the end of the stem, oval, undulate or entire, often cordate, 1 in. broad, occasionally with a pair of small leaflets on the lower petioles; pods linear, pointed, $\frac{1}{2}$-$\frac{2}{3}$ in. long.

Indigenous perennials in cool springs or shallow shaded streams. Belmont, Noble.

4. **Cardamine praténsis** L. Meadow Bitter-cress. Stem from a short rootstock, 8 in. to 2 ft. high, nearly simple; leaves pinnately divided; leaflets 7-15, dentate or entire, the lower large, broad and petioled, the upper sessile and narrow; petals white or rose-color, three times the length of the sepals; pods $\frac{2}{3}$-$1\frac{1}{3}$ in. long, style thick.

Perennials in wet meadows or bogs, introduced from Europe but indigenous in the North and Northwest. Portage County.

5. **Cardamine hirsúta** L. Hairy Bitter-cress. Stem nearly simple, 4-10 in. high; leaves chiefly basal, 1-4 in. long; leaflets 5-11, somewhat pubescent on the upper surface, the terminal segment orbicular, entire or few-toothed, larger than the lateral segments; stem-leaves, if any, much reduced; pods linear, appressed, 1 in. long.

Annual or biennial in waste places. Perhaps introduced from Europe. Lake County.

6. **Cardamine pennsylvánica** Muhl. Pennsylvania Bitter-cress. Stems usually much branched, 8 in. to 3 ft. tall, somewhat fleshy, leafy; basal leaves 2-6 in. long, larger and broader then the stem-leaves, segments 7-11, the terminal part obovate, all more or less confluent along the rachis; racemes lateral and terminal; pods linear, 1 in. long.

Indigenous annual, or biennial in damp places. General.

7. **Cardamine arenícola** Britt. Sand Bitter-cress. Stem much branched from the base, leafy, 6-12 in. high; leaves with numerous linear divisions, usually entire, the basal leaves slightly larger; pods erect, less than 1 in. long.

Indigenous annuals in wet sandy soil. Perhaps a form of **C. parviflora.** Lake County.

8. **Cardamine parviflòra** L. Small-flowered Bitter-cress. Stem erect or ascending, branching, 2-15 in. high, very slender, with scattered leaves; leaves with 5-11 segments, oblong or linear, the terminal ones often rounded, basal leaves largest; flowers scarcely a line broad; pods slender, scarcely 1 in. long, on a somewhat zigzag peduncle.

Indigenous annuals or biennials, in dry, rocky or barren soil. Delaware, Fairfield, Hocking, Lawrence.

28. **Dentària** (Tourn.) L. Toothwort.

Perennial, mostly glabrous herbs, with scaly or toothed rootstocks of a pungent taste. Stems leafless below, leaves 2 or 3, palmately parted or compound. Flowers white or purplish, in a short raceme or corymb. Siliques linear, flat, dehiscent from the base. Seeds oval, wingless, in 1 row in each cavity.

1. Basal and stem-leaves similar. 2.
1. Basal and stem-leaves different; rootstock jointed. *D. heterophylla.*
2. Stem-leaves 2, opposite; rootstock continuous. 3.
2. Stem-leaves usually 3; rootstock jointed. 4.
3. Leaf segments ovate or ovate-oblong. *D. diphylla.*
3. Leaf segments linear. *D. multifida.*
4. Leaves alternate, sometimes 2-7. *D. maxima.*
4. Leaves whorled. *D. laciniata.*

1. **Dentaria diphýlla** Mx. Two-leaf Toothwort. Stem stout, erect, glabrous, 8-12 in. high, from a continuous toothed rootstock; basal leaves long-petioled, 4-5 in. broad, ternate, ovate, dentate, often found in winter; stem-leaves similar, 2, opposite; flowers white, petals twice the length of the sepals; pods 1 in. long, but seldom maturing.

Indigenous in woods and meadows. Eastern half of the state.

2. **Dentaria máxima** Nutt. Large Toothwort. Similar to **D. diphylla,** but larger. Rootstock interrupted, tubercled; leaves 2-7 (usually 3), alternate; flowers sometimes purple-tinged.

Indigenous in damp woods, but local. No specimens.

3. **Dentaria heterophýlla** Nutt. Slender Toothwort. Stem slender, scapose, glabrous or slightly pubescent; rootstock jointed, near the surface; whole plant purplish, flowers deepest; stem-leaves generally 2, opposite, ternate, divisions linear, entire, 1-1½ in. long; flowers few; pods 1 in. long, ascending.

Indigenous in damp woods. Blooms later than **D. laciniata** and the whole plant soon disappears. Auglaize, Belmont, Clermont, Hocking, Vinton.

4. **Dentaria laciniàta** Muhl. Cutleaf Toothwort. Stem glabrous or slightly pubescent, 8-15 in. high, from a deep, jointed rootstock; stem-leaves 3, whorled, petioled, 2-5 in. broad, 3-cleft, the lateral divisions often 2-cleft, all laciniate; basal leaves similar, long-petioled, appearing after flowering time; flowers white or purplish; pods linear, ascending.

Indigenous in woods, blooming earlier than **D. diphylla.** General and abundant.

5. **Dentaria multífida** Muhl. Multifid Toothwort. Stem slender, scapose, glabrous; rootstocks continuous; basal leaves long-petioled, about 2 in. broad, ternate, segments linear, bipinnatifid; stem-leaves similar, but smaller; petals white, nearly twice as long as the sepals; pods slender, ascending, long-beaked.

In rocky woods in North Carolina to Tennessee and Alabama. Hamilton County.

29. **Lunària** (Tourn.) L. Honesty.

Annual or biennial erect pubescent herbs, with broad dentate cordate leaves and large purple flowers in racemes. Lateral sepals saccate at the base. Silicles stalked, flat, elliptic or oblong, dehiscent. Septum hyaline, silvery. Seeds large, circular, winged, in 2 rows in each cavity.

1. **Lunaria ánnua** L. Honesty. Stems stout, branching, 2-4 ft. tall; earliest leaves opposite, broadly cordate, dentate, 3-6 in. long, petioled, later leaves alternate; flowers large, purple; pods $1\frac{1}{2}$-2 in. broad, elliptic, drooping on a slender stipe. A European garden flower, cultivated for its shining septum.

Escaped from gardens or persisting after cultivation. No specimens. Belmont County (Laughlin Herbarium).

30. **Sinàpis** L. Mustard.

Annual erect, more or less hispid herbs, with lobed leaves and large yellow flowers in racemes. Siliques terete, constricted between the seeds and tipped with a long flat beak. Seeds large, spherical, light-colored, in 1 row in each cavity.

1. Leaves lyrate; pods hispid-pubescent. *S. alba.*
1. Leaves slightly lobed; pods glabrous. *S. arvensis.*

1. **Sinapis álba** L. White Mustard. Stem branching, hispid-pubescent, 1-2 ft. high; lower leaves with a large terminal leaflet and several pairs of smaller ones, dentate, 6-8 in. long; upper leaves smaller, to lanceolate, dentate; pods bristly, constricted, ascending, beak as long as the pod.

A European herb, escaped from cultivation. Lucas County.

2. **Sinapis arvénsis** L. Corn Mustard. Stem branching 1-2 ft. high; leaves like those of **S. alba,** but less lobed, the upper leaves rhombic, sessile; pods glabrous, knotty, ascending, beak $\frac{1}{3}$ as long.

A troublesome annual from Europe. General, except in southern part.

31. **Brássica** (Tourn.) L. Cabbage, Mustard, Turnip.

Annual or biennial erect branching herbs, sometimes tall, with pinnatifid or lyrate basal leaves, dentate or entire upper leaves, and showy yellow flowers in long racemes. Siliques long, sessile, terete or 4-sided, tipped with a conic, often 1-seeded beak. Seeds globose, wingless, in 1 row in each cavity.

1. Leaves not clasping at the base. 2.
1. Upper leaves clasping at the base. 3.
2. Plant green, hirsute; pods appressed. *B. nigra.*
2. Plant pale glaucous, glabrous; pods spreading. *B. juncea.*
3. Leaves auricled. 4.
3. Leaves not auricled; plant glaucous-blue. *B. oleracea.*
4. Plant hispidulous. *B. campestris.*
4. Plant entirely glabrous. *B. napus.*

1. **Brassica nìgra** (L.) Koch. Black Mustard. Stems 2-7 ft. high, branching, bristly, with scattered hairs; leaves hispid or hirsute, lower leaves with one large terminal lobe and several small lateral ones; upper leaves lanceolate, nearly entire; flowers bright yellow; pods linear, 4-sided, appressed; seeds dark brown, pungent.

A common weed, introduced from Europe.

2. **Brassica júncea** (L.) Cosson. Indian Mustard. Stems 1-4 ft. tall, coarse, pale, glabrous and somewhat glaucous; lower leaves lyrate, 4-6 in. long, petioled; upper leaves much smaller, lanceolate or oblong, nearly entire, sessile; flowers larger than those of **B. nigra;** pods long, spreading.

In grain fields and waste places, recently introduced from Asia. Portage, Wayne.

3. **Brassica campéstris** L. Common Turnip. Stem 1-3 ft. high, glaucous, branching; lower leaves lyrate, petioled, pubescent; upper leaves lanceolate, sessile, glabrous; flowers large, pale yellow; pods long, spreading; root fleshy; biennial.

Introduced from Europe and persisting in cultivated ground. Auglaize, Franklin, Miami, Wayne.

4. **Brassica nàpus** L. Rape. Similar to **B. campestris,** but entirely glabrous. Racemes dense.

Introduced from Europe. Franklin County.

5. **Brassica oleràcea** L. Cabbage. Stem thick and hard. Leaves large, fleshy, strongly-veined, forming a head the first year.

A biennial, occasionally spontaneous. No specimens.

32. **Diplotáxis** DC. Rocket.

Annual or perennial herbs, similar to the Brassicas, with pinnatifid or lobed leaves, and rather large yellow flowers in loose terminal racemes. Siliques elongated, flat. Seeds wingless, in 2 rows in each cavity.

1. **Diplotaxis tenuifòlia** (L.) DC. Wall Rocket. Stem 1-4 ft. high, leafy, branched, glabrous and slightly glaucous; leaves 3-6 in. long, thin, deeply pinnatifid, divisions narrow; pods 1-1½ in. long, erect on slender pedicels.

A perennial in waste places, adventive from Europe. Cuyahoga County.

33. **Ráphanus** (Tourn.) L. Radish.

Annual or biennial erect herbs with lyrate leaves and showy flowers in racemes. Siliques oblong, acuminate, coriaceous, spongy, indehiscent. Seeds spherical.

1. Flowers yellow, turning purple or white; pods moniliform. *R. raphanistrum.*
1. Flowers pale purple; pods short and thick. *R. sativus.*

1. **Raphanus raphanístrum** L. Wild Radish. Stem 1-2½ ft. high, much branched, slightly pubescent; lower leaves rough, 4-8 in. long, lyrate with a large terminal lobe and smaller lobes, all dentate; upper leaves smaller, oblong; flowers ½-¾ in. broad, purple veined; pods 1-1½ in. long, constricted somewhat like those of **Sinapsis arvensis;** root slender.

A troublesome weed in fields from Europe. Lake County.

2. **Raphanus satìvus** L. Garden Radish. Similar to **Raphanus raphanistrum,** but with pale purple flowers, and shorter pods not moniliform.

Cultivated for the fleshy root and persistent for a year or two. Rather general.

34. **Cakìle** (Tourn.) Mill. Sea Rocket.

Fleshy, diffuse, annual herbs of the seashore, with glabrous freely branching stems, and purplish flowers in racemes. Siliques short, 2-jointed, indehiscent; the joints 1-seeded, or the lower part seedless, and the upper part breaking off when mature.

1. **Cakile edéntula** (Bigel.) Hook. Sea Rocket. Stems about 1 ft. high, ascending from a deep root, bushy; leaves obovate, sinuate-dentate, narrowed at the base, the lower ones 3-5 in. long; flowers small, petals purplish, clawed; pods short, upper joint larger than the lower.

Indigenous in wet sands of the seashore and of the Great Lakes. Ashtabula, Cuyahoga, Erie, Lake.

Barnesville, Ohio.

NOTES ON THE FRINGILLINE GENUS PASSERHERBULUS AND ITS NEAREST ALLIES.

By Harry C. Oberholser.

A careful examination and comparison of the species of *Passerherbulus* at once discloses the fact that this genus as at present constituted is a composite group. The structural discrepancies between several of its species are such that it seems necessary to place them in different genera. The only other consistent course seems to be to merge *Passerherbulus* with *Ammodramus* and *Centronyx*, for the differences that separate these genera from *Passerherbulus* are no more important than the structural differences between the species of *Passerherbulus* itself. There seem to be four well-marked groups in *Passerherbulus* which are thus in need of generic definition, and this is the purpose of the present discussion.

The generic name *Passerherbulus* was first proposed by Mr. C. J. Maynard in 1895,[1] but from that date it is merely a nomen nudum, since the only indication of type is the citation of the name "LeConte's Bunting" without authority or other statement of origin; furthermore, this name does not occur elsewhere in Maynard's book, for on a previous page where the bird is described it is called LeConte's Sparrow. Therefore, according to the International Code of Nomenclature, the name *Passerherbulus* can not be cited as valid from this publication. Its earliest proper use seems to be by Stone in 1907,[2] when the type was given as *Ammodramus lecontei;* and thus, if only a single generic term be employed for this group, it must be *Ammospiza* Oberholser, 1905.[3] However, as above indicated, this group should be separated into four, which are defined below.

Thryospiza, gen. nov.[4]

Chars. gen.—Similar to *Passerherbulus* Stone (type, *Emberiza lecontcii* Audubon), but tail shorter than the wing—about nine-tenths of wing or somewhat more; first primary (counting from the outermost) shorter than the seventh; bill much lengthened, the wing only four to

[1]Birds Eastern North Amer., ed. 2, pt. 40, 1895, p. 707.
[2]Auk, XXIV, April, 1907, p. 193.
[3]Smiths. Misc. Coll., Vol. 48, May 13, 1905, p. 68.
[4]From θρύον, juncus; and σπίζα, fringilla.

four and one-half times the length of the exposed culmen; bill relatively more slender, the length of exposed culmen decidedly more than twice the height of bill at base, the height at base very much less than the length of the gonys; and exposed culmen about equal to middle toe without claw.

Description.—Tail about nine-tenths of wing or somewhat more, but never as long as wing; first primary (counting from the outermost) shorter than the seventh, usually about equal to the eighth; bill much lengthened, the wing four to four and one-half times the length of exposed culmen; length of exposed culmen two and one-fourth to two and one-half times the height of bill at base; the height of bill at base about three-fourths of the length of gonys; exposed culmen about equal to middle toe without claw.

Type.—*Fringilla maritima* Wilson.

Remarks.—The seaside sparrows are, as above shown, very distinct in structural characters from the other birds commonly associated with them in the same generic group, and there is no doubt of the propriety of their generic segregation. The very long bill and much rounded wing, together with their other proportions, easily distinguish them. The species and subspecies included in this group are as follows:

Thryospiza maritima maritima (Wilson).
Thryospiza maritima macgillivraii (Audubon).
Thryospiza maritima peninsulæ (Allen).
Thryospiza maritima sennetti (Allen).
Thryospiza maritima fisheri (Chapman).
Thryospiza nigrescens (Ridgway).

Ammospiza Oberholser.

Ammodramus Swainson, Zool. Journ., III, August to November, 1827, p. 348, (type by original designation, *Fringilla caudacuta* Wilson) (nec *Ammodramus* Swainson, Philos. Mag., new series, I, June, 1827, p. 435, qui *Coturniculus* Bonaparte).

Ammospiza Oberholser, Smiths. Misc. Coll., Vol. 48, May 13, 1905, p. 68, (type by original designation, *Oriolus caudacutus* Gmelin).

Chars. gen.—Similar to *Thryospiza*, but tail decidedly shorter, not over seven-eighths of wing; first primary (counting from the outermost) longer than sixth; bill stouter and only moderately lengthened, the length of exposed culmen about twice the height of bill at base; and exposed culmen very much less than middle toe without claw.

Description.—Tail three-fourths to seven-eighths of wing; first primary (counting from the outermost) longer than the sixth, sometimes equaling the fifth; bill moderately lengthened, the wing four to four and one-half times the length of exposed culmen; length of exposed culmen about twice the height of bill at base; height of bill at base about three-fourths of length of gonys; exposed culmen much less than middle toe without claw, often barely more than length of the two basal phalanges.

Type.—*Oriolus caudacutus* Gmelin.

Remarks.—The above-given characters clearly show that the sharp-tailed sparrow (*Oriolus caudacutus* Gmelin) is not congeneric with the seaside sparrow (*Fringilla maritima* Wilson). The applicability of the generic name *Ammodramus* Swainson has already been fully discussed.[1]

Some recent authors have considered the Nelson sparrow (*Ammodramus caudacutus nelsoni* Allen) specifically distinct from *Ammospiza caudacuta*, but the examination of a large amount of material now shows that intermediate specimens of varying degrees entirely connect the two, and that consequently the former must be a subspecies. The same is true of the Acadian sharp-tailed sparrow (*Ammodramus caudacutus subvirgatus* Dwight), which authors now consider a subspecies of *Ammospiza caudacuta nelsoni*.

The forms of this genus should, therefore, now stand as follows:

Ammospiza caudacuta (Gmelin).
Ammospiza caudacuta subvirgata (Dwight).
Ammospiza caudacuta nelsoni (Allen).

Passerherbulus Stone.

Passerherbulus Stone, Auk, XXIV, No. 2, April, 1907, p. 193 (ex Maynard, Birds Eastern North Amer., ed. 2, pt. 40, 1895, p. 707, *nomen nudum*) (type by original designation and monotypy, *Ammodramus lecontei* [= *Emberiza leconteii* Audubon]).

Chars. gen.—Similar to *Ammospiza*, but tail about equal to wing (sometimes a little shorter, sometimes slightly longer); first primary (counting from the outermost) longer than the fifth; bill short, but moderately slender, the wing five to five and one-half times the length of exposed culmen.

Description.—Tail slightly longer to slightly shorter than wing, usually about equal to wing; first primary (counting from the outermost)

[1] *Cf.* Oberholser, Smiths. Coll., Vol. 48, May 13, 1905, p. 67.

longer than the fifth, sometimes about equal to the fourth; bill short, but moderately slender, the wing five to five and one-half times the length of exposed culmen; length of exposed culmen about twice the height of bill at base; height of bill at base less than length of gonys; exposed culmen less than middle toe without claw.

Type.—*Emberiza lecontcii* Audubon.

Remarks.—The very short, somewhat slender bill and long tail of the type species of this monotypic group sufficiently distinguish it almost at a glance from the other related forms. The applicability of the name *Passerherbulus* Stone, ex Maynard, has been discussed above.[1]

The sole species of this genus will now stand as:

Passerherbulus leconteii (Audubon).

Nemospiza, gen. nov.[2]

Chars. gen.—Similar to *Passerherbulus*, but tail decidedly shorter than wing; first primary (counting from the outermost) shorter than the fifth; bill short and very stout, the wing only four and one-half times the exposed culmen; length of exposed culmen one and one-half to one and three-fourths times the height of bill at base; height of bill at base about equal to the length of gonys.

Description.—Tail about ninety-five percent. of wing; first primary (counting from the outermost) usually longer than sixth and shorter than fifth; bill short, but very stout; wing four and one-half times the length of exposed culmen; length of exposed culmen one and one-half to one and three-fourths times the height of bill at base; height of bill at base about equal to gonys; exposed culmen less than middle toe without claw.

Type.—*Emberiza henslowii* Audubon.

Remarks.—The very short, stout bill and its big proportions at once separate the type of this genus from all of the species here treated.

The only forms of this genus are:

Nemospiza henslowii henslowii (Audubon).
Nemospiza henslowii occidentalis (Brewster).

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[1]*Antea*, p. 332.

[2]From νέμος, pascuum; and σπίζα, fringilla.

The following key to the genus *Passerherbulus* and the three allied genera above diagnosed may serve to set forth more graphically their distinguishing characteristics:

a^1. Exposed culman not decidedly less than middle toe without claw; exposed culmen decidedly more than twice the height of bill at base; first primary (counting from the outermost) shorter than the seventh *Thryospiza*.

a^2. Exposed culmen decidedly less than middle toe without claw; exposed culmen not decidedly more than twice the height of bill at base; first primary (counting from the outermost) longer than the seventh.

- b^1. Wing decidedly more than four and one-half times the length of exposed culmen; tail about equal to wing; first primary (counting from the outermost) longer than fifth................*Passerherbulus*.
- b^2. Wing not decidedly more than four and one-half times the length of exposed culmen; tail decidedly shorter than wing; first primary (counting from the outermost) not longer than fifth.
  - c^1. Tail more than seven-eighths of wing; exposed culmen much less than twice the height of bill at base; height of bill at base about equal to length of gonys........................*Nemospiza*.
  - c^2. Tail not more than seven-eighths of wing; exposed culmen about twice the height of bill at base; height of bill at base decidedly less than length of gonys............................*Ammospiza*.

Date of Publication, June 2, 1917.

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