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ON THE LIFE HISTORY OF TABANUS VIVAX.

JAMES S. HINE.

EGGS.—Deposited in masses composed of several hundreds, on stones that project above the water in riffles. Mass nearly round in outline, only slightly convex, composed of about three layers one above the other. Color of the whole mass brown, mottled over the top with whitish. Female observed ovipositing June eighth.

LARVA.—In September and October of various years, when the water was low, I have taken a number of larvae among stones and rubbish in riffles. Sometimes they are taken in nets used for collecting Corydalis larvae, and like them appear to be at home in the swiftest part of the the stream; in this respect differing from most tabanid larvae with which I am acquainted. Larvae taken late in the fall and kept in wet earth and fed on angle-worms or other animal food pass through their transformations and reach the adult stage in late spring or early summer. Since I have never come across these larvae in nature in spring their exact habits at this time of year are not known, but suppose they leave the water and pupate in the earth near at hand.

General color yellowish white, anterior margin of each thoracic segment and a narrow band including the prolegs on the anterior half of the first seven abdominal segments opaque and appearing darker than the other parts, which are more or less shining and usually finely striate longitudinally. Prothoracic segment divided by longitudinal grooves into four nearly equal parts, which may be called the dorsal, ventral and lateral areas. The lateral areas are shining and finely striated on posterior third and opaque on anterior two thirds: the dorsal and ventral areas are opaque on about anterior fourth and distinctly shining on the remaining parts. The ventral space is quite evidently divided into two equal parts by a longitudinal grove. In order to see the characters of this segment it must be fully extended. The mesothoracic and metathoracic segments have a number of longitudinal grooves, some of which are very narrowly bordered by opaque darker coloring, which proceeds backward from the narrow anterior border of these segments. Each of the first seven abdominal segments has on its anterior part a transverse row of eight tubercles which encircles the segment. These all bear spines or claws at the apexes, excepting a dorsal pair on each of the first three or four segments. They may be called prolegs, since they have the parts necessary to such organs. On the posterior dorsal border of most of the abdominal segments there may be a narrow, irregular, opaque marking of the same color of the narrow band in the region of the prolegs; eighth segment on each side with two narrow, curved markings, which have the appearance of being composed of contiguous punctures. These markings are of the same shade of color as the other darker areas, and the lower one is more than twice as long as the upper.

Length, 20 millimeters. The size of these larvae is rather difficult to give, since a specimen fully extended is longer than at other times.

PUPA.—Length 18, diameter 4 millimeters. Light brown in color, thorax somewhat paler than the abdomen. Antennal and other tubercles of the head and thorax prominent and darker than the surrounding parts. Prothoracic spiracular tubercle slightly elevated, reniform, oblique ; rima uniformly curved for nearly its whole length, but just before the anterior end the curvature is stronger but no hook is formed. First abdominal spiracle nearly round ; rima nearly uniformly curved, posteriorly very slightly widened just at the end, anteriorly slightly narrowed and curved so as to form a short hook. The other abdominal spiracles agree with the first one in general, but there appears to be slight variation in the enlargement and curvature of the extreme ends. Terminal teeth prominent, shining brown in color, darkest at the extreme tips. Dorsal pair of teeth smallest and closer together than the ventral, lateral teeth longer and larger than the ventral and located much beneath the dorsal, in fact they are nearly midway between the dorsal and ventral.

I have never found the adults of this species especially common, neither have I observed that they molest stock. The male has been procured fully as often as the female on protruding stones in swift-flowing streams, and in sunny spots in woods near such streams. Most of the specimens in my collection were taken during the first half of June.

All the stages of this fly have been procured from the Scioto River in the vicinity of Jones' Dam, near Columbus.

THE DEVELOPMENT OF THE SPIKELET AND GRAIN OF CORN.*

C. C. Poindexter.

With a view to a later study of the subject of xenia in corn, a preliminary observation of the development of the carpel and endosperm was attempted in order to see what relation exists between them, since some of the authorities mentioned claim that the effect of double fertilization is shown in the carpel wall, while others assert that it is shown only in the endosperm and embryo-sac. The embryology of the corn grain also was studied and figures were made of the ovule at different stages beginning with the archesporial cell and ending with the fully developed embryo. These drawings and observations not being complete will be reserved for another paper. As there are few recent descriptions and figures of the development of the spikelet and grain, it was thought advisable to publish this general part at the present time.

The writer wishes to acknowledge his indebtedness to Professor John H. Schaffner for invaluable suggestions and criticisms in the preparation of the paper.

The material used was common white field corn gathered at different stages of maturity from the corn field of the Ohio State University in the summer of 1902. The very young ears were left whole or cut in two, while the larger were quartered lengthwise and, after killing, cut into pieces convenient for use. The material was killed in chrom-acetic acid and preserved in 70 per cent alcohol and later imbedded in paraffin. Pieces of the younger ears were cut from three to six grains in length, while single grains were used of the older stages. The sections were cut 12–18 μ in thickness, and stained on the slide in anilin-safranin and gentian-violet and iron-alum-haematoxylin. All things considered, corn is an easy object to work with, but in using the older grains precaution should be taken to guard against shrinkage of the endosperm tissue. This may be practically obviated by puncturing the grain with a dissecting needle before killing. The outer covering of these grains may also be sliced off on either side to permit of rapid penetration. The iron-alum-haematoxalyn proved to be the most efficient stain and was soon the only one used.

The production and development of new varieties of plants depends upon the fact that the offspring of a cross partakes of the characters of both parents, which, according to Mendel (1) follows a definite law of proportion in some species. Some plants appear to be more susceptible to hybridizing than

*Contributions from the Botanical Laboratory of Ohio State University. XIV.

others, and the first offspring shows the characters of the staminate parent in a marked degree, especially in the character of seeds and fruits. This immediate, or direct effect of pollen upon the character of seeds and fruits Focke, (5) has termed xenia, a phenomenon which has long been more or less puzzling to botanists and plant breeders. Just how such an effect was brought about was not definitely understood, and it is only a few years since that any phenomenon has been known which could be called upon for a reasonable solution of the problem and that a tentative explanation has been offered. In 1898 Nawaschin (10) reported the process of double fertilization in Lilium martagon and Fritillaria tenella. Guignard (6) soon followed with a full description of the process, adding figures of the more interesting phases, and claimed that the process was not peculiar to the Liliaceae but very general in the Phanerogams. In corroboration of this author's statement, the process has been observed in many plants by a number of investigators. The corn plant, however, is the one among the many observed in which the process of xenia is well established and belief in the phenomenon seems to rest mainly upon its constant occurrence in this plant. Vilmorin (12) observed xenia in corn as early as 1866. Hildebrandt also reported it the following year and in 1872 Koernicke (8) made a similar report. These authors used seeds that were pure so far as known. Some years later American botanists took up the subject for investigation. Sturtevant in 1883 made the first report. Burrill reported the process in 1887; Kellerman and Swingle in 1888, and McCluer in 1892. But some doubt attaches to their findings because the seeds used were not known to be pure. Moreover, the process was apparently contrary to certain well-established laws of reproduction and embryology, errors could easily have been made in conducting the experiments; and until some explanation could be given for the phenomenon, botanists looked upon the matter with some suspicion. The explanation was left to DeVries (3). In a recent preliminary article "On the hybrid fecundation of the Albumen," he suggests the act of double fertilization as explanatory of the phenomenon of xenia; and although as late as 1900 no detailed researches on the embryology of corn or any of the cereals or grasses had been made, nor any direct observations that were conclusive that double fertilization occurred in corn, Webber (13), holding the same opinion as DeVries (3), proceed to conduct some experiments on the subject. His seed corn was pure so far as known, and the results, published in 1900, elicited his conclusion "that xenia does occur in maize, whatever its interpretation may be." Correns (2) about the same time reported observations practically similar to those of De Vries. The following year Guignard (7) removed all doubt of the occurrence of double fertilization in corn by his publication of a paper on "La Double Fécondation Dans Le Mais." It is much regretted that this author produced no drawings with his excellent paper.

The ovulary of the maize has been defined by Guignard (7) as being constituted of a single carpellary leaf turning its ventral suture from the side of the axis of the ear. In the very young spikelet (Fig. 1) the incipient carpel appears in longitudinal section as two rounded protruberances, due to a depression in the top. The carpel wall begins to develop rapidly on one side, and immediately begins to develop the young silk, or style (Fig. 2). The inner empty glume at this stage is quite prominent and a rudimentary flower appears on the side away from the axis of the ear. The grain grows rapidly from the beginning and the style and ovule soon become more distinct. The silk elongates (Fig. 3), and the carpel begins to close, while at the same time the integuments make their appearance, the inner one developing more rapidly than the outer one. At this stage the archesporial cell is becoming prominent. A little later (Fig. 4), the floral organs pecome perfectly distinct and the integuments diverge, the inner one inclining toward the ovule and the outer one pointing toward the opening of the carpel. When the carpel wall closes, there is left a small prominence at its summit. A double funnel effect is produced as the walls close up around this opening, the bowls of the funnel arising at the two extremeties (Fig. 5). Guignard (7) terms this opening the "stylar canal." Later on this canal closes up completely at the lower extremity, but the funnel effect at the top persists throughout (Fig. 10). "It is at the base and upon the inner side of the protuberance," says Guignard (7), "that is to say, on the side of the axis of the ear, that the long style of the flower is inserted; the style does not occupy, then, as one might believe at first glance, the organic summit of the ovary." The writer's observations, as shown by the figures, agree with this statement. In this connection it might be well to call attention to the carpel of Typha as described by Schaffner (11). The development of the carpel and style of this plant appears to be quite similar to that of the corn. The writer saw the pollen tube after fertilization had taken place, but in all the study failed to see its entrance into the canal, through which one might expect it to pass. According to Guignard (7) the tube probably passes through the canal, although he does not state that he actually observed it. He describes its course in the following terms: "Arrived at the base of the style, the pollen tubes must evidently direct themselves toward the ovarian prominence in order to enter it and to follow the course of the canal which conducts then into the cavity of the ovary." When the 8-celled embryo-sac appears (Fig. 5) the nucellus has not greatly enlarged. The semi-anatrophus ovule occupies the base of the cavity of the ovulary. The tip of the nucellus emerges slightly between the integuments, the inner of which extends entirely around the ovule, while the short outer integument does not go beyond the middle of the ovule. Just at the base of the stylar canal the outer integument, rising freely from the inner one, bends itself abruptly upward as if to form a stopper to the cavity of the ovulary which at this place is quite large. Guignard (7) says that this upward bending accounts for the shortness of the the outer integument, and also states that the inner integument became thicker where it was not covered by the outer; but the writer saw but little difference in the thickness and if any, the reverse was true. Immediately after fertilization development of the nucellus is very rapid (Fig. 6) so that at that stage of the ovule the embryo-sac occupies only a very small portion of the entire body. Endosperm also begins to develop, spreading upward and backward from the young embryo. When the nucellus has about completed its development the endosperm takes on a rapid growth, destroying the large mass of nucellar tissue. Simultaneous with this growth, the embryo also develops with rapidity, evidently being well nourished by the large endosperm cells (Fig. 8). This growth continues until the endosperm entirely replaces the nucellar tissue, leaving only a vestige of the latter surrounding it (Figs. 9–11).

The young embryo, protected by the scutellum, lies on the ventral side of the grain, somewhat above the base of the endrosperm and outside of it, except for a very thin layer one or two cells in thickness. It is shielded on the outside by the remaining nucellar tissue and the carpel wall (Figs. 9–10).

In Figure 11 is shown a nearly mature grain cut in longitudinal section transverse to the ear. The remains of the nucellus is very thin or entirely absent. A little above the base of the grain is the young embryo, showing the plumule and the scutellum, below which the large suspensor extends with its end surrounded with elongated endosperm cells. Across the upper end of the grain is shown a strip of endosperm with larger and quite irregular cells. There are sixty or more cells across the entire width, the cells being comparatively minute in comparison to the size of the grain and not large as is usually figured in the text-books.

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EXPLANATION OF PLATES I AND II.

All figures originally magnified 75 diameters, except figures 8 and 9, which are magnified 190 and 30 diameters respectively. Figures were drawn under the camera with Bausch & Lomb microscope, and subsequently reduced to about 1/6 diameter. In the figures, S indicates style (silk) ; C, the stylar canal ; I, inner glume ; O, outer glume.

Fig. 1. Very young spikelet showing incipient carpel.

Fig. 2. Spikelet with young carpel, showing first definite appearance of style and ovule.

Fig. 3. Spikelet with style elongated ; ovule showing archesporial cell and first appearance of integuments.

Fig. 4. Spikelet in which the carpel is nearly closed, leaving only a small pore into the ovulary.

Fig. 5. Spikelet with ovule containing 8-celled embryosac.

Fig. 6. Spikelet with ovule after fertilization and the development of considerable endosperm, showing decided enlargement of the nucellus.

Fig. 7. Carpel still further developed, showing great increase in nucellar tissue with only slight increase of endosperm.

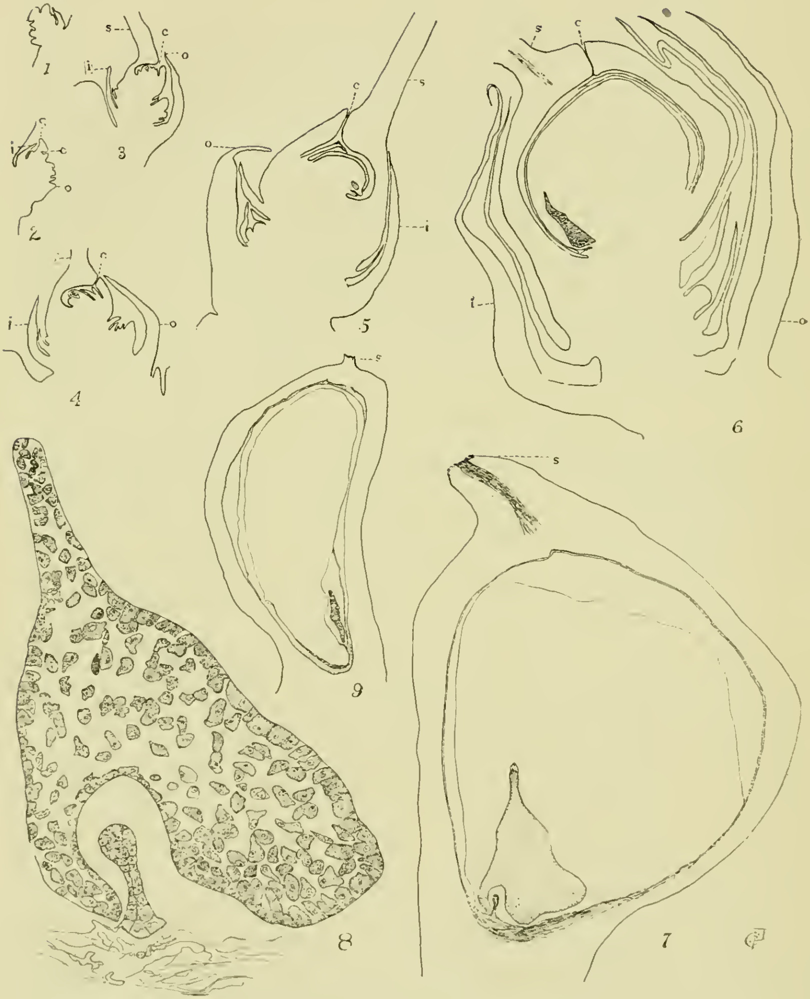
Fig. 8. Endosperm and embryo same as Fig. 7.

Fig. 9. Grain with large embryo, showing great development of endosperm and the remains of the nucellus.

Fig. 10. Nearly mature grain, showing relation of carpel wall, integuments, endosperm and embryo. Endosperm somewhat shrunken.

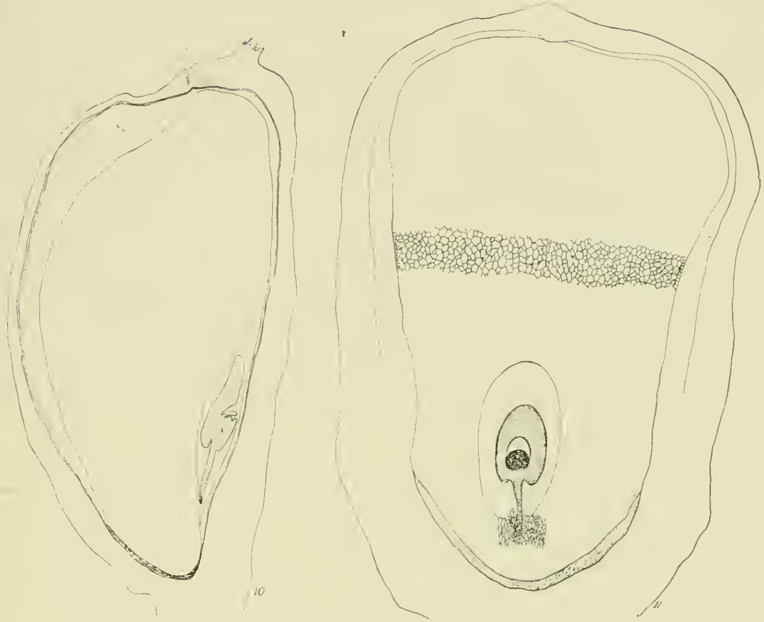
Fig. 11. Nearly mature grain, showing section of embryo and comparative size of endosperm cells.

OHIO NATURALIST. *Plate I.*



POINDEXTER on "Corn."

OHIO NATURALIST. *Plate II.*



POINDEXTER on "Corn."

NOTE ON TINOBREGMUS VITTATUS (Van Duzee).

HERBERT OSBORN.

Tinobregmus vittatus was described by Van Duzee in 1894 from two specimens collected in Florida, females only being represented. Since then no further record of the species has been made and the male has remained unknown. The species is an extremely interesting one, possessing a number of unique characters, and remains still the only species known to the genus which was erected by Van Duzee for its reception.

As I can now give two additional records and a description of the male, a note on the species seems warranted.

Some time ago I received a female specimen in a collection of Homoptera collected in Bermuda and kindly given to me by Dr. C. M. Weed. Quite recently Prof. J. S. Hine has placed in my hands several specimens including both sexes, collected at the Gulf Biologic Station, Cameron, Louisiana, in August, 1903.

He informs me that the two forms which he felt confident were male and female were taken at the same time and on the same plant, *Iva frutescens*. While none were observed mating, the fact that they occurred so closely associated and that no other species of the genus was found to occur with them, makes the supposition almost a certainty. Furthermore, they agree so closely in all generic characters that I do not hesitate to regard them as sexual complements and present herewith a description of the male. This differs strikingly in some respects from the female, though no more than is common to many species of Jassidae.

Male.—Black, pronotum, and elytra, except at tip, silvery white with latter barely reaching to tip of anal style, beneath black, tips of femora and most of tibiae and tarsi, except at the apex, brown.

Length, 3.5mm. Width, 1.75 mm.

Head as in female and face very long, pronotum very short and hind border evenly but very slightly convex, scutellum scarcely visible. Legs long, femora and tibiæ much compressed but not foliaceous.

Color.—Head piceous black, the sutures between the vertex and eyes pale, as also the triangular area between the vertex and eye and a narrow margin of the occiput. Front black with middle line slightly paler and sides showing very obscure transverse markings. Pronotum above silvery white, changing to fuscus black on sides. Elytra silvery white to near the apex, apical margin deep piceous black. Abdomen above whitish, anal style light orange-yellow, black at tip, pygofer black.

The females agree closely with the description of the Florida specimen. The markings appear to vary in the different individuals somewhat, and the elytra in these specimens are distinctly brownish between the broad, whitish veins. Ovipositor is black, except a narrow ventral border, the inner faces of tibiæ, and somewhat broken line on the femora and the inner face of the hind tibia black.

The Bermuda specimen appears somewhat darker in general color, the head being somewhat infuscated, the elytral spaces a darker brown, and there is an additional short, broken fuscus stripe on the pronotum between the first and second stripes of either side. The apical spots extend further upon the cells, and one line in the outer cell is elongated and extends fully two-thirds of the length of the cell. These variations seem to me, however, to be entirely within the limits of specific variations.

The distribution of the insect based on these specimens would extend from Louisiana around the gulf coast and to Burmuda, and it seems probable that it will be found at intervening points on the Gulf coast, especially in the salt marshes where its host plant occurs, as well as westward and southward in suitable locations.

NOTES ON INTERESTING OHIO WILLOWS.

ROBERT F. GRIGGS.

Among the willows there are, as is well known, very many hybrids and freaks. These escape description in general works because each has an individuality of its own and the treatment of one is of suggestive value only for others. But to the student of dynamic nature these forms are of the most extreme interest as giving some clue to nature's methods of evolutiou. Likewise they are of interest to the systematist in a negative way because they stand in his way and prevent the perfect classification of all plants into genera and species which he aims to accomplish. This general interest is the apology, if apology be needed, for reporting some of the forms of this sort that have come under observation.

SALIX INTERIOR VAR. WHEELERI Rowlee.

Since Prof. Rowlee's publication not long ago of the variety wheeleri of the common long leaved willow, there has been some question as to its validity. Dr. Rydberg omitted it entirely from his revision of the willows in Britton's Manual. These doubts may be in a great measure due to lack of material of the variety as, indeed, Prof. Rydberg intimated to me in a letter not long since. Neither at Washington nor New York are there specimens nor at the time of publication did Prof. Rowlee himself have flowering material. Fortunately the plant grows abundantly on Cedar Point, and in close proximity to the species, so that there are exceptional opportunities for comparative study of the two.

The two characters on which Prof. Rowlee named the variety were the greater wooliness of the leaves and their relatively greater breadth. All who know the long-leaved willow know how very variable the leaves are, both in shape and pubescence. Young leaves and those at the bases of secondary twigs are broader than others, and when they first appear they are frequently densely covered with wool, though becoming entirely glabrous.

The hairiness does not seem to have much taxonomic significance. Leaves on the same plant vary from one extreme to the other. Narrow leaved plants are almost as likely to be woolly as broad leaved. Variation in hairiness is, so far as the writer can observe, entirely unconnected with variations in other directions.

But in the breadth of the leaves, the Cedar Point plants much exceed the measurements given by Prof. Rowlee. Remaining about the length he describes, they are frequently more than two cm., or twice as broad. In its extreme development this broad leaved form is almost glabrous, not at all hairy as are many of the half-way forms from which, unfortunately, the type was taken. The extreme forms are generally low, not more than one m. tall, and very bushy in habit, making them easily distinguishable from the typical forms of the species at a distance. Rarely, however, it grows into a more open shrub eight or ten feet tall.

In its flowering habits it carries the peculiarities of Salix interior to an extreme. The species has a habit of sending out secondary aments just below the first to open, so continuing the flowering period until late in the season. In the variety these secondary catkins become so prominent that the inflorescence sometimes takes on a cymose character. Half a dozen catkins are often seen in a cluster, all of about the same age. In the species they come on one by one and are much less noticeble even when as numerous. The flowering period is also distinctly later than with the species. On Cedar point it seems to be at its height about the first of July and continues through the month, tapering off into August. The species growing near by has by the first of July almost passed its flowering time and only a few straggling catkins can be found. It must be added in this connection that nearly all of the plants are staminate. Not over 1 per cent. of them are carpellate. What significance this may have cannot be told as yet.

Altogether the variety is so different from the species that it would be taken for a distinct species on first sight. Because of numerous intermediates such an assumption could not be maintained, but it is the best marked willow *variety* we have in the State.

Salix pentandra in Ohio.

Salix pentandra, the European species corresponding to *Salix lucida*, is not infrequently cultivated in Ohio for its twigs, which are of good quality for basket weaving. It is very similar to the American species and in some forms they can hardly be distinguished. But the European species never has the very long attenuate, ovate leaves so characteristic of vigorous shoots of *Salix lucida*. Its leaves are rather thinner and less glossy, not so different from the ordinary willow leaf as those of *Salix lucida*.

Salix pentandra has not, to my knowledge, been reported as an escape in America. At least it is not included in the Manuals. This makes it of considerable interest to note that two plants have been detected escaped in Ohio. One is from Bridgeport, Belmont county, by Dr. W. A. Kellerman, the other from Columbus. Any possible uncertainty as to identification owing to the similarity to the native species, is much reduced by the fact that both cases are in territory out of the range of *Salix lucida*, which occurs only in the northern part of the State. The reports of the collectors also make it certain that the plants were really wild and not cultivated.

Salix babylonica x S. fragilis.

This cross is common in Europe but so far as I know has not hitherto been reported in America. It is altogether to be expected and it is very strange that it is so scarce. As is well known, *Salix babylonica* exists in America—with extremely rare exceptions—only as a carpellate plant. The flowers, however, genearlly seem to be fertilized for the capsules fill out well. The natural inference is that the pollen came from either *S. alba* or *S. fragilis*, the most closely related forms. If such be the case it is very strange that these hybridized seeds do not grow into trees more often than they do.

The single plant which I was fortunate enough to find is growing in a quarry near Sandusky, where it has taken root in a waste place from which the stone has been removed. There are no other trees near by, and neither of the parents was seen in the immediate vicinity, though both are common in the region, *Salix babylonica* as an ornamental tree planted in the city yards, and *Salix fragilis* as a very common escape.

Its habit is striking, from a hundred feet away. When I first saw it I commenced to wonder what it could be. The first thought was *Salix nigra*. The leaves are narrow and about the the same color as *S. nigra*. But there is something which gives an impression, when at a distance, different from *S. nigra*, though you cannot tell what it is. When you get up to it you find the leaves glaucous below ! It cannot be *S. nigra*, it does not look like *S. amygdaloides*, nor *S. alba*, nor *S. fragilis*, and so you may go over the catalogue successively denying it a place in any of the species, so peculiar does it seem.

Most of the twigs are long, slender, semipendent. The buds on slender twigs are small, as in the weeping willow, on ranker growth, larger, about midway between the two species. The leaves on the upper branches are small, 6-7 cm. long, 8-10 mm. broad, quite glaucous or only paler beneath, close and even, sharp serrate, with a venation more irregular than that of *Salix fragilis*, primaries close with a strong suggestion of a marginal. On water shoots, the leaves approximate *S. fragilis* more closely in form, being long, 16 cm., and narrow, 2 cm., with more distinct teeth. The veins, too, are more similar to *S. fragilis*, but more irregularity is evident and the marginal is still suggested.

The flowers, especially if they were carpellate, would be very interesting. They might show some peculiarities worthy of note. The identification without them cannot be said to be as positive as it might be. But the leaves are so closely intermediate as to leave but little doubt. If it should turn out to be something else it would be of even greater interest, for it is evidently very different from anything else hitherto discovered in our Ohio flora.

Salix nigra x Salix amygdaloides.

The two parents of this hybrid are so common and so closely related—one was formerly considered a variety of the other—that one would expect it to be one of the commonest crosses. But such is not the case. Less than half a dozen plants of it have been found within our borders. This is probably because *Salix amygdaloides* blooms two weeks earlier than *Salix nigra* and the two do not normally overlap, so that there is no chance for crossing. The scarcity of hybrids in this region is more remarkable from the fact that in some localities intermediates are very abundant. In the vicinity of St. Louis, where the southern *Salix longipes* enters in and complicates the matter, Dr. Glatfelter reports that not half the plants are nominal and that there are all sorts of intermediates connecting them.

Prof. A. D. Selby collected the first plant from this State. It is, however, not a good intermediate, but is much closer to *S. nigra*. Later one or two trees were discovered around Columbus. These also were not as nearly half way between the two as might be desired. During the summer just passed a very fine example was found within a stone's throw of the new Lake Laboratory building on Cedar Point.

It is a very fair intermediate between the two species. From a distance it resembles *Salix amygdaloides;* though only a bush in a thicket it has the clean branching habit of *Salix amygdaloides* in contrast to the scraggly habit of the other species. The slender-petioled leaves hang with that peculiar grace characteristic of the Peach-leaved Willow. The buds are nearly as large as in that species, i. e., twice as large as in the Black Willow. But the leaves are lanceolate, neither as broad as one nor as narrow as the other commonly is. The coarser venation is that of *Salix amygdaloides;* there is scarcely any marginal and the primaries are close, ascending. But the smaller veins show a reticulation as fine as in *Salix nigra*. The under surfaces of the leaves show no sign of the glaucescence of *Salix amygdaloides*, but are only slightly paler as in the other species.

An Abnormality of Salix sericea.

South of Columbus is a swamp, now nearly drained, which is one of the few places near the city where *Salix sericea* flourishes in abundance. Among several interesting forms growing here is one plant which may be somewhat contaminated with some other species or simply abnormal.

Part of its flowers are exactly as they should be in *Salix sericea* but others have a very peculiar appearance. The rhachis and scales are very wooly, covered with long white hair which all but conceals the capsules. The latter are sometimes covered with long hair, rather thinly, or are almost glabrous, this last suggesting *Salix cordata*. The leaves, however, show no sign of divergence from *Salix sericea*.

Carpeliferous Filaments in Salix nigra.

There is one class of willow freaks reported commonly by others from other places which have escaped observation, if present, in Ohio. The class contains those forms, certainly more common in *Salix* than in almost any other genus, of plants which have mixed up in some way their staminate and carpellate flowers. All sorts of combinations and mixes of the two kinds of flowers are reported. These forms would be very interesting to experiment upon from a physiologcal point of view, as well as anatomically, for they might throw some light on the problems connected with heredity and plasticity of cells.

The plant is growing in the limestone bed of Jonathan creek at White Cottage, Ohio. It is a shrub 8°–10° tall, with the usual apperance of *Salix nigra*. At the time of collection, 23d of May, it had passed its prime but an abundance of flowering material was yet to be had. At first sight it looked as though it was monœcious, with both sorts of flowers on one plant. Some aments were normally staminate ; others were apparently all carpellate ; and still others were partly staminate and partly carpellate. But on closer examination it developed that none of the ovularies had stigmas, but that in every case the place of that organ was taken by an anther. The ovularies, moreover, were not one to a flower, but each scale supported several, sometimes as many as five, but more often three or four. Sometimes they were joined together at their bases and radiated in all directions like prongs to some burr. Sometimes the stigmiform anther was sessile without a style ; or the style might be quite long. Occasionally the anther was supported on a long filament bearing a conical thickening at the base. Again one carpel may bear two styles, each with an anther. The anthers were all polleniferous and functional ; not one appeared withered or blasted. None of the carpels, however, under a low power, show developing ovules. They are frequently hairy-like filaments and were colored yellow like them. It seems most rational to conclude that these pseudocarpels were homologous to filaments and were influenced in some way to assume their thickened form.

Summer-Flowering Willows.

Occasionally when collecting, one meets with willows flowering late in the summer. In the long-leaved willows this is no remarkable thing, for they have a special adaptation to secure a long flowering period. But in the other groups it is an occurrence rare enough to call for note. During several seasons collecting four such instances have come to the writer's attention. At least one other instance has been reported previously.* In Ottawa county three years ago a good sized bush of *Salix discolor* was found with many catkins in August. They are not normal but much whiter than ordinary pussies, and many of the capsules are aborted. At Washington, late in the summer of 1902, a solitary carpellate ament was found at the tip of a leafy branch of *Salix sericea*. This lone catkin was of normal appearance but about ready to drop off when noticed The third was a plant of *Salix candida*, at Castalia, the past summer, which had two carpellate aments just about at anthesis in July. These were normal and ordinary in every way except in being borne on leafy branches. Near Big Darby creek, in Franklin county, two plants (carpellate) of *Salix cordata* were found in August, full of blossoms. The two were about a hundred feet apart and entirely unconnected. Why they should both be blooming at the same time is very peculiar—one of the interesting things which have yet to be explained or chance.

All these instances are from among the species which flower earliest in the spring and hence develop their flowers furthest in the fall. It would be quite surprising to find *Salix nigra*, for instance, flowering a second time. In each case, except the reported instance of *Salix humilis*, the flowers were carpellate. This may be mere coincidence. It is difficult to see what reason there could be that the carpellate flowers should be especially liable to be affected in this way. Rather one would expect the staminate aments to furnish the most frequent examples because they seem to develop first in the spring.

*O. A. Farwel, Second Flowering of *Salix humilis*. Bot. Gaz , 11 : 317.

POISONOUS AND OTHER INJURIOUS PLANTS OF OHIO.

John H. Schaffner.

In the following catalogue of plants an attempt has been made to furnish students with a convenient reference list of the injurious plants of Ohio, in the hope that it may be of service to those who wish to make a study of the subject. The list is believed to be fairly complete except the thallophytes, where only a small number of the most important Fungi have been included.

I am under very great obligation to Mr. V. K. Chesnut, of the U. S. Department of Agriculture, who has kindly added a large number of plants to the original list and furnished many of the notes given under the species. I wish here to express my thanks and appreciation of his invaluable assistance and criticism.

I. Thallophyta. Fungi.

1. Aspergillus herbariorum (Wiggers). (A. glaucus (L.) Link.) Apparently the cause of "staggers" in horses, when eaten with food on which it grows.
2. Claviceps purpurea (Fr.) Tul. Ergot. Very poisonous to stock.
3. Ustilago maydis (DC.) Corda. Corn Smut. Causes death to cattle, although not supposed to be very poisonous.
4. Ustilago avenae (Pers.) Jens. Oat Smut. In large quantities it is poisonous to cattle.
5. Tilletia tritici (Bjerk.) Wint. Stinking Smut of Wheat. Poisonous to stock. Deleterious in the flour.
6. Coleosporium solidaginis (Schw.) Theum. Parasitic on species of Solidago. Supposed to be poisonous to horses, when eaten with the host plant.
7. Puccinia graminis Pers. Wheat Rust. Uredo stage. The spores cause inflamation of the mucous membrane of the mouth and nose of persons harvesting wheat. The soreness of the lips caused by the rust is often severe.
8. Boletus felleus Bull. Bitter Boletus. Poisonous to man.
9. Boletus piperatus Bull. Poisonous to man.
10. Cantharellus aurantiacus (Wulf.) Fr. Supposed to be poisonous.
11. Hygrophorus conicus (Scop.) Fr. Poisonous to man.
12. Lentinus stipticus (Bull.) Schr. (Panus stipticus Fr.) Poisonous to man.
13. Marasmius peronatus (Bolt.) Fr. Supposed to be poisonous to man.
14. Marasmius urens (Bull.) Fr. Supposed to be poisonous.
15. Chalymatta campanulata (L.) Karst. Poisonous.
16. Hypholoma lacrimabundum Fr. Supposed to be poisonous.
17. Pholiota squarrosoides Peck. Poisonous.
18. Hyporhodius clypeatus (L.) Schr. (Entoloma clypeatum L.) Poisonous.
19. Volvaria glojocephala (DC.) Quel. Poisonous.
20. Volvaria volvacea (Bull.) Sacc. Poisonous.
21. Agaricus illudens Schw. (Clitocybe.) Poisonous.
22. Lepiota morgani Peck. Poisonous to man.
23. Amanita mappa (Batsch.) Sacc. Poisonous.
24. Amanita muscaria (L.) Pers. Fly Amanita. Very poisonous when eaten and causes death. Poisonous also to cattle. Used as a fly poison.
25. Amanita phalloides (Fr.) Quél. Death Cup. (A. bulbosa Bull.) Poisonous. Probably the most dangerous of all the American fungi.

26. Amanita umbrina (Pers.) Schr. (A. pantherina (DC.) (Quél.). Poisonous to man.
27. Amanita verna Fr. Destroying Angel. Poisonous to man.
28. Amanita virosa (Fr.) Sacc. Poisonous.
29. Globaria bovista (L.) Quél. Giant Puff-ball. (Lycoperdon giganteum Batsch.) Poisonous if eaten after the white interior changes to a brownish color.

II. Archegoniata.

30. Pteridium aquilinum (L.) Kuhn. Eagle Fern. Leaves supposed to be poisonous to cattle and horses.
31. Equisetum arvense L. Common Horsetail. Supposed to to be injurious to horses, at least when it is in the form of hay.

III. Spermatophyta. Gymnospermae.

32. Taxus canadensis Marsh. American Yew. Leaves supposed to be poisonous to stock.
33. Juniperus communis L. Common Juniper. Goats are poisoned from eating the leaves.
34. Juniperus virginiana L. Red Cedar. Poisonous to goats.

Angiospermae. Monocotyledones.

35. Arisaema triphyllum L. Jack-in-the-pulpit. Underground parts somewhat poisonous, but edible when boiled or roasted a short time.
36. Calla palustris L. Water Arum. Poisonous.
37. Spathyema foetida (L.) Raf. Skunk Cabbage. Has an acrid juice and a disagreeable odor which seems to cause headache.
38. Alisma plantago L. Water Plantain. Has poisonous effect on cattle.
39. Sagittaria latifolia Willd. Broad-leaved Arrow-head. The rootstalk contains a bitter milky juice in the raw state, but is edible when cooked.
40. Nelumbo lutea (Willd.) Pers. American Nelumbo. The rootstock is sometimes used to kill roaches.
41. Chaetocloa italica (L.) Scrib. Millet. Hungarian. The hay, if fed in large quantities and too frequently, is injurious to horses.
42. Lolium temulentum L. Darnel. Poisonous. Grain noxious and injurious when ground in with flour.
43. Zygadenus elegans Ph. Zygadene. Swamp Camas. Poisonous to cattle and sheep, sometimes causing death.
44. Melanthium virginicum L. Bunch-flower. Rhizome is poisonous.

45. Veratrum viride Ait. American White Helebore. Roots are poisonous.
46. Veratrum woodii Robb. Wood's False Helebore. Poisonous like the preceding species.
47. Lilium superbum L. Turk's-cap Lily. The pollen is said to cause skin poisoning.
48. Asparagus officinalis L. Asparagus. Will sometimes blister the skin of those who work with it. The seeds are used as a substitute for coffee.
49. Convallaria majalis L. Lily-of-the-valley. All parts of the plant are very poisonous to man, horses and cattle.
50. Trillium grandiflorum (Mx.) Salisb. Large-flowered Wake-robin. Emetic. Contains saponin.
51. Trillium erectum L. Ill-scented Wake-robin. Rhizome somewhat poisonous.
52. Smilax rotundifolia L. Round-leaved Greenbrier. A case of poisoning from eating the young leaves is reported.
53. Iris versicolor L. Large Blue-flag. Underground parts are poisonous.
54. Cypripedium reginae Walt. Showy Lady's-slipper. (C. spectabile Swz.) Poisonous to the skin, much like Poison Ivy. At least 50 per cent. of persons are susceptible.
55. Cypripedium hirsutum Mill. Large Yellow Lady's-slipper. (C. pubescens Willd.) Poisonous like the preceding species.
56. Cypripedium parviflorum Salisb. Small-flowered Lady's-slipper. This species is also poisonous, but to a less extent than the other two.

Dicotyledones.

57. Toxylon pomiferum Raf. Osage Orange. The thorns produce poisonous wounds in the skin. Horses acquire a strong liking for the young shoots and eat them in large quantities without apparent ill effects.
58. Humulus lupulus L. Hop. Hop pickers often have an inflammation of the hands.
59. Cannabis sativa L. Hemp. The resin of this plant is a powerful narcotic. An intoxicating drink is prepared from the dried leaves. The leaves and other parts are smoked for their intoxicating and narcotic effects.
60. Urtica dioica L. Stinging Nettle. Stinging and injurious to the skin.
61. Urtica gracilis L. Slender Nettle. Injurious to the skin of man and horses.

(To be continued.)

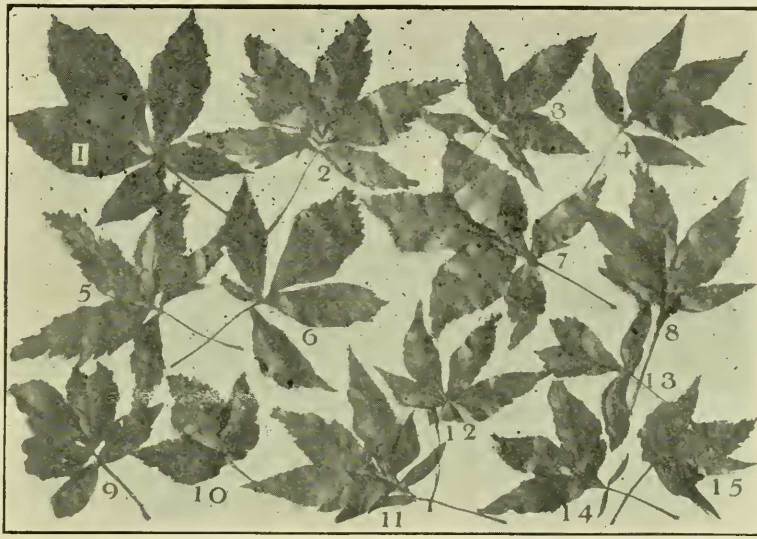
MINOR PLANT NOTES, No. 5.

W. A. KELLERMAN.

WHITE HEATH ASTER.—Some notes were given in a former number of the OHIO NATURALIST concerning the Aster ericoides, the White Heath Aster. Opportunity was afforded in 1903 to see the behavior of this species in Washington County, Ohio. Here, as was the case in Adams County, the plant, if unmolested, soon takes full possession of the pastures and roadsides, and all neglected arable ground. While it does prevent washing of the hillsides, it would not seem to be a profitable plant to grow or to let grow for this purpose; grasses rather should be cultivated. The thrifty farmer apparently has no annoyance from this weed, since it does not venture to grow on ground *occupied with properly cultivated crops.* It is believed that the former estimate and judgment relative to Aster ericoides does not need revision.

BEAT THAT?—At the end of the previous growing season there was found in a garden, a beet (not a dead beet) that had been evidently struggling heroically against adverse circumstances. Adjacent sweet pea vines, not properly supported, had fallen over and partially smothered a row of garden beets. One of these made an effort to reach up to the light but was caught again and dragged down. It evidently persisted in its efforts and the result is shown in the marginal figure reproduced from a photograph. The stem sent up many many small branches whose small leaves obtained the necessary sunshine. This struggle for existence also awakened the instinct of reproduction and accordingly an elongated inflorescence was formed. Numerous flowers and some fruits were produced. The total length of the stem was six feet.

ABNORMAL LEAVES OF AESCULUS GLABRA.—A very striking case of abnormal leaves was recently noticed near Columbus, in a grove of small trees of the Ohio Buckeye, Aesculus glabra. Earlier in the season they had been quite denuded of leaves by insect depredation. A dense tuft of leaves terminated each of the twigs—in itself conspicuous—and nearly half of the new leaves were more or less aborted and abnormal. The leaflets were seldom of the normal shape, the lamina generally extendining downward to the petiole—a suggestion of a pinnate type—and the whole affair presenting a crumpled and distorted aspect. The accompanying sketches indicate some of the commoner outlines.



ABNORMAL LEAVES OF AESCULUS GLABRA.

LARGE OHIO TREES.—From time to time as opportunity offered, trees of unusual size have been measured with the results here tabulated—the measurements taken about three or four feet from the ground :

Name.	Locality.	Circumference.
Acer negundo, Box Elder.	Columbus	8 ft. 2 in.
Acer saccharinum, Silver Maple.	Symmes Creek, Lawrence County	8 ft. 6 in.
Aesculus glabra, Ohio Buckeye.	Marblehead, Ottawa Co.	9 ft. 2 in.
Aesculus octandra, Sweet Buckeye.	Manchester, Adams Co.	9 ft. 7 in.
Asimina triloba, Papaw.	Symmes Creek Valley, Lawrence County	3 ft. 8 in.
Betula nigra, River Birch.	Hocking Co.	7 ft. 1 in.
Castanea dentata, Chestnut.	Brush Tp., Scioto Co.	13 ft. 3 in.
Catalpa catalpa, Catalpa.	Symmes Creek Valley, Lawrence County	9 ft. 2 in.
Celtis occidentalis, Hackberry.	Columbus	10 ft. 5½ in.
Cercis canadensis, Red Bud.	Cedar Hill, Fairfield Co.	5 ft.
Cornus florida, Dogwood.	Symmes Creek Valley, Lawrence County	3 ft. 4 in.
Crataegus mollis, Red-fruited Thorn.	Marblehead, Ottawa Co.	5 ft. 9 in.

Name.	Locality.	Circumference.
Crataegus punctata, Thorn.	Amanda, Fairfield Co	1 ft. 6 in.
Diospyros virginiana, Persimmon.	Cedar Hill, Fairfield Co.	5 ft. 7½ in.
Fagus americana, Beech.	Arion, Scioto Co	12 ft. 4 in.
Fraxinus quadrangulata, Blue Ash.	Columbus	7 ft. 7½ in.
Gleditsia triacanthos, Honey Locust.	Sandusky	10 ft. 2 in.
Gymnocladus dioica, Kentucky Coffee Tree.	Columbus	7 ft. 9½ in.
Liriodendron tulipifera, Tulip Tree.	Hocking Co	13 ft.
Magnolia acuminata, Cucumber Tree.	Lawrence Co	4 ft. 8 in.
Malus coronaria, Crab Apple.	Amanda, Fairfield Co	2 ft. 7½ in.
Nyssa sylvatica, Sour Gum.	Otway, Scioto Co	8 ft. 10 in.
Ostrya virginiana, Ironwood.	Waynesville, Warren Co	3 ft. 7 in.
Oxydendrum arboreum, Sorrel Tree.	Saltpetre Cave, Hocking Co	4 ft. 8 in.
Platanus occidentalis, Sycamore.	Groveport, Franklin Co	23 ft. 5 in.
Quercus acuminata, Yellow Oak.	Waynesville, Warren Co	8 ft. 5 in.
Quercus alba, White Oak.	Bainbridge, Ross Co	15 ft. 6 in.
Quercus leana, Lea's Oak.	Cedar Point, Erie Co	4 ft. 5 in.
Quercus macrocarpa, Bur Oak.	Cedar Hill, Fairfield Co	12 ft. 1 in.
Quercus palustris, Pin Oak.	Bainbridge, Ross Co	8 ft. 1½ in.
Quercus prinus, Chestnut Oak.	Bainbridge, Ross Co	9 ft. 8 in.
Quercus stellata, Iron Oak.	Cedar Hill, Fairfield Co	10 ft. 10 in.
Rhamnus carolinianus, Buckthorn.	Cedar Mills, Adams Co	11 in.
Rhus hirta, Staghorn Sumach.	Geneva, Ashtabula Co	2 ft. 9 in.
Robinia pseudacacia, Black Locust.	Waynesville, Warren Co.	10 ft. 4 in.
Sassafras sassafras, Sassafras.	Bainbridge, Ross Co	6 ft. 4 in.
Ulmus americana, American Elm.	Columbus	15 ft. 8 in.

NOTE ON ARADUS ORNATUS (Say).

HERBERT OSBORN.

Aradus ornatus was described by Say in 1831, since which time it has remained almost unrecognized, the only record being that of Bergroth who mentions a specimen* and suggests that the species that had usually borne this name in collections was one to which he gives the name "duzei."

A short time ago in looking over Mr. Dury's interesting collection I found three specimens of this species, which was new to me, and with his kind permission they were brought to Columbus for study. Careful comparison with the related species and Say's description proved them to be certainly his ornatus and it is no small pleasure to add this rare and handsome species to our local fauna. As Say's description was written from specimens taken in Indiana, presumably in New Harmony, these captures at Cincinnati may be considered quite near to the type locality, and since they agree in the minutest details with Say's description, they may be considered as typical examples for the species.

The species agrees with *robustus* and *duzei* in having swollen antennae but differs from both in the three shiny spots at the hind border of the pronotum, and from *robustus* in the much lighter color.

* Proceedings Entomological Society, Washington, II, 332.

THE MAXIMUM HEIGHT OF PLANTS. V.

JOHN H. SCHAFFNER.

The plants listed below were measured during the past season in Ohio and Kansas. All are considerably taller than given in Britton's Manual:

OHIO.

Bromus tectorum L.,	3⅓ feet.
Urtica gracilis Ait.,	10⅓ "
Thalictrum purpurascens L.,	8 "
Impatiens aurea Muhl.,	7½ "
Angelica atropurpurea L.,	10 "
Daucus carota L.,	5¼ "
Pastinaca sativa L.,	10 "
Carduus altissimus L.,	12½ "
Lactuca canadensis L.,	11½ "

KANSAS.

Sagittaria latifolia Willd.,	5 "
Phleum pratense L.,	5 "
Elymus virginicus L.,	5 "
Elymus canadensis L.,	7¼ "
Rumex crispus L.,	5⅓ "
Saponaria officinalis L.,	4 "
Brassica nigra (L.) Koch.,	8 "
Penthorum sedoides L.,	2½ "
Geum canadense Jacq.,	3¾ "
Althaea rosea Cav.,	10 "
Asclepias syriaca L.,	7½ "
Marrubium vulgare L.,	4 "
Aster vimineus Lam.,	6¾ "
Chrysanthemum leucanthemum L.,	3½ "

NEWS AND NOTES.

The thirteenth annual meeting of the Ohio State Academy of Science will be held a Denison University, Granville, Ohio, Nov. 27th and 28th.

The Ohio State Academy of Science has this year published three important "Special Papers." The first is Special Paper No. 5, Tabanidae of Ohio, by James S. Hine. This is a pamphlet of 63 pages and, in addition to a general discussion of the life history and anatomy of these insects, it contains a catalogue of Tabanidae from America North of Mexico and a systematic treatise of Ohio species with keys for their identification.

Special Paper No. 6 is entitled "The Birds of Ohio," A Revised Catalogue, by Lynds Jones. It contains 241 pages and gives a general view of Ohio in relation to its bird life and a list of the

Ohio birds with notes on each species. This paper is an important contribution to our knowledge of the local avifauna and will certainly do much to advance the study of ornithology in Ohio.

Special Paper No. 7, by Thomas A. Bonser, is entitled "Ecological Study of Big Spring Prairie," Wyandot County, Ohio. It contains 96 pages with maps and numerous illustrations and is a very complete presentation of the ecology of the area under consideration. J. H. S.

A specimen of the Paddle-fish, Polydon spathula (Wal.), was seen by the undersigned in the Post Company's Fish House, Sandusky, Ohio, in August of the present year. According to Osburn (Fishes of Ohio, Special Paper 4, O. Ac. Sc., p. 18), records of its occurrence in the Great Lakes are not abundant. From the fishermen, I learned that the fish is seen at irregular intervals but not commonly. MAX MORSE.

MEETING OF THE BIOLOLICAL CLUB.

ORTON HALL, June 1, 1903.

After the reading of the minutes of the previous meeting the committee on nominations reported the following board of editors for the NATURALIST:

Editor-in-Chief,	J. H. SCHAFFNER.
Business Manager,	J. S. HINE.
Associate Editors.	
Geology,	J. A. BOWNOCKER.
Zoology,	F. L. LANDACRE.
Archaeology,	W. C. MILLS.
Botany,	W. A. KELLERMAN.
Ecology,	O. E. JENNINGS.
Ornithology,	MAX MORSE.

Upon motion the Club adopted the report and elected the editors as recommended.

Mr. C. W. Mally spoke to the Club of his experience in South Africa. The climate is adapted to grow most of our temperate crops. There is great need of a vegatable pathologist. Entomology is strictly economic and the strictly scientific work is done in England and in this country.

Under reports on theses, Mr. J. G. Sanders reported the addition of 21 or 22 species and 4 genera of scale insects to the State list and the description of three new species. Mr. Swezey reported work on the life histories of some of the Fulgoridae. Mr. E. A. Sanders reported a joint thesis with Mr. A. W. Whetstone upon the forest ecology of Franklin County.

ROBERT F. GRIGGS, *Secretary.*

The Ohio Naturalist,

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THE TRANSMISSION OF ACQUIRED CHARACTERS.*

MAX MORSE.

I shall invite your attention this evening to a theme which like the poor, "Ye have always with you." It is the old question whether the changes in the growing organism, or the adult, produced by the direct action of the environment about it, are carried, through heredity, to the offspring. Jean Lamark first used the term "acquired character" to designate characters such as these and to him are we to look for the first clear statement of the case. By this it is not to be understood that the idea of the transmission of acquired characters arose with Lamark. No great generalization ever arose or ever can arise with one man alone. The attribution of the idea of the transmission of acquired characters to Lamark falls in the same category as attributing evolution to Darwin. And as Darwin first attempted to *answer* the question how organisms change, Lamark first *raised* the question how they change at all. The Greeks in the dawn of history accounted for diversity in living forms by the direct effect of environment. Indeed, not until the time of Darwin was there a rival theory advanced. And we can easily see the reason for this when we consider the directness and naïveté of the transmission theory as against the negative action of selection. The history of science shows that hypotheses created as explanations of natural phenomena are at first simple and that it is only when the phenomena are better understood that the hypotheses become more complex. The Corpuscular Theory of light in Newton's sense sufficed for a

*Presidential Address, Biological Club, Nov. 2, 1903.

long time to explain that phenomenon and it has been revived in a refined, augmented and complex form to stand as the modern theory of light. And so, had selection been advanced at first as an explanation of diversity in plants and animals, it would have meant a far deeper insight into the ways of Nature than the Greeks had at that time.

What, we may ask, is an acquired character? That it is a difficult task to answer this question one may infer from the fact that in the periodical *Nature* for 1895, a discussion, ranging over six or seven numbers and led by some of the greatest workers in biology was carried on, each contributor offering a different definition of varying length and complexity. And it is doubtful whether the discussion ended because a conclusion had been reached or whether no more space could be given by the publishers. The most comprehensive definition of the term is that an acquired character is a modification of an organism in its ontogeny, produced by reactions to external stimuli. Its opposite is the congenital character which arises from the genital cell irrespective of external conditions. Now, obviously, these definitions involve severe difficulties, if not in themselves, at least in their application. For the sake of clearness, let us consider the development of an organism in ontogeny and phylogeny.

The Protozoa or Protophyta cannot be said to have an ontogeny. Whatever may be said to be the method of reproduction in them, we may reduce it to its simplest terms—binary fission. Consequently, we cannot speak of palingenesis or cenogenesis in in the protozoa or protophyta. Since there is no division of labor whereby one portion of the organism is set apart to perform the function of nutrition, another for reproduction, etc., we can say that the environment exerts a direct effect on the reproductive element and the transmission of acquired characters in unicellular forms is a reality. But when we pass the line between the unicellular forms and multicellular forms, our problem is different Here we have division of labor. One cell has as its special function the elimination of waste; another, movement, while the third reproduces the animal or plant in its entirety. The question arises, is the method here the same as in the unicellular forms? Or is there a modification necessary to meet the new conditions? In the case of the one celled forms, the *environment* of the reproductive element is the environment of the organism as a whole, while in the multicellular forms the environment of the germinal cell is the group of cells surrounding it—the *environment* of the multicellular organism being the medium outside the body which rarely or never comes in contact with the germ cell, at least until that cell is mature. Hence the case is different. In the latter case—i. e , the multicellular organisms, the generative cell would react to such stimuli as are furnished by the surrounding body.

We may sum up these stimuli as nutritive, respiratory, mechanical, thermic, perhaps electrical and finally, what some will have—a stimulus due to irritability, a virtual vital force. Now one school holds that there is no connection or direct communication between germ cell and body cell,* while another says there is and has shown that there is a possible means of communication by certain protoplasmic bridges that are known to occur at least in some cases. It is obvious what application this has to the subject in hand. The germ-cell in the multicellular forms, located as it is deep in the tissues of the body and away from the surroundings of the organism to which it belongs, may react in one of two ways: it may react to simply the stimuli given by the cells immediately surrounding it or to this *plus* an effect induced by something such as a nervous force, as was mentioned as a possible means of communication between more distant cells. The existence of such a force is not countenanced by modern biologists and it is useless to follow the theme longer. This leaves us with but the hypothesis of Darwin which he termed that of Pangenesis. Darwin early saw the necessity of some such hypothesis, if acquired characters are inherited, in accounting for a means of communication between the body-cells and the germ-cells. In place of a subtle force, Darwin postulated an actual material transmission of a portion of the body-cell to the germ-cell. He assumed protoplasm to be composed of pangens or corpuscles and that these might pass from cell to cell carrying with them the characters, hereditary and acquired, of the cell from which they came. The pangens migrate from the body-cell to the germ-cell and becoming resident there, are transmitted to the offspring, in which they pass to the several parts of the body, thus reproducing the form of the parent. An acquired character could thus be inherited. From other considerations Darwin was led to believe strongly in the transmission of acquired characters and it is a mark of farsightedness on his part when he saw the necessity of some such hypothesis, and met it. It is well to note in passing that the so-called Neo-Darwinians are more Darwinian than the man himself, paradoxical as it may seem. Darwin believed, and that strongly, in the transmission of the direct effects of environment and attempted to explain it, and it is only his followers that have dropped it from the creed.

So much, then, for the à priori condition of the subject. We have seen that in unicellular forms, acquired characters are inherited and that in so far, in multicellular forms, as we can treat the germ-cell as a single cell, and apart from the somatic

*The term "germ-cell" is meant to desigate such cells as reproduce the parent form—all other cells being "body-cells." Obviously the argument which was originally applied to sex-cells will apply to cases of vegetative reproduction equally well, as in cases of budding, spores, polyembryony, etc.

cells, its acquired characters are inherited; but when we begin to consider that it may be affected in a larger way by remoter portions of the body, either through pangens or some other means, the question takes another turn. Is it not difficult to imagine how some specific change in a remote portion of the body can be registered on the germ-cell with the result that the offspring has reproduced in it the same specific modification? Of course, inconceivability can never be advanced as an argument, pro or con, unless an easier explanation is at hand, and in this case many think there is.

Let us turn now to another phase of the subject. Breeders and fanciers have long insisted that their produce show case after case of the inheritance of acquired modifications. Nay, indeed are not our social institutions themselves built on this assumption? Educate the father and the child will profit thereby. Raise the man of the slums and thereby better his offspring. What teacher that will not on first thought answer that the child of an educated parent learns more easily than that of an ignorant and illiterate father? And so we may read in the stock journals and the fanciers journals of the transmission of acquired traits and an outbreak of discussion is probable at any time. Of discussions on this topic the most noteworthy is the Spencer-Weismann controversy that was carried on in the pages of the *Contemporary Review* in 1893. The discussion arose from an article by Herbert Spencer entitled "The Inadequacy of Natural Selection." In it he attempted to show that coadaptation of the various parts of the body of an organism could be explained far easier by admitting the transmission of functional changes than by the theory of Natural Selection. From the law of probability he attempted to show that the chance of two characters that were mutually adapted arising in the same individual was almost infinite. As a concrete example he took the case of the stag with its antlers weighing pounds. Now in an adult stag we find the most beautiful coadaptation of parts to parts. The shoulder muscles are immense, the front legs are much stronger than the hinder pair, there is an increased blood supply to these parts, etc. How, he asks, can we assume that all these adaptations arose simultaneously in the same individual as variations, so that from the other less favorable conditions these were selected by natural selection? How much easier, he says, is the transmission hypothesis to be applied here!

In answering this and admitting the force of the argument, Weismann submits that if one case could be shown whereby there is no possibility of the transmission of acquired characters the burden of proof would fall to the transmissionists. As such a case he brings forward that of the worker bee. It is well known that the worker bee as well as the soldier termite produce no offspring, as in their development the organs of generation atrophy.

Obviously, selection of favorable variations is the only explanation here. If, then, we must assume that, for instance, the immense jaws with the corresponding muscles of the termite soldier are produced by selection, why must we assume a different cause in the case of the antlers of the stag? When all evidence is weighed, it must be admitted that here is a solution of the problem.

The problem has been attacked from other points of view. Thus, Henry Fairfield Osborn, in an article in the *American Naturalist*,* shows the plausability of the transmission of functional changes being the method of evolution in organic life. It is too much to assume, he says, that the tubercles in the teeth of mammals have been formed in any way other than by the the transmission of mechanical mouldings. Eimer, the friend of Weismann, is the author of an elaborate volume in which he presents an array of facts in support of the transmission theory. He lays special stress on the matter of the pigmentation of the races of man. He finds that in the Nile valley there is a gradation, as one passes from Alexandria southward, in the color of the native races from an intense black to lighter complexions through various intermediate shades. How, he asks, are we to account for such gradations by the preservation of favorable variations? Is it not more logical to assume that they have been the direct effect of environment from generation to generation? Eimer's work is written in German and J. T. Cunningham of England has translated it. This author himself is a firm believer in the transmission hypothesis and is a frequent contributor to the subject. To him is due partly the prominence that the question occupies at the present time.

We have considered thus far proofs from the à priori point of view and also deductive proofs. There remains but one class of evidence—experimental. The classic experiments of Brown-Sequard on the guinea pig, in which he attempted to show that epilepsy, caused by the severance of the spinal cord in adults was transmitted to the offspring, are now considered invalid since germs of disease may be transmitted in the germ-cells as syphillis is known to be. There have been thousands of cases reported of the so-called transmission of mutilations. Absolutely no dependence can be put on the large majority of these because of insufficient data. Moreover, regeneration is so general that it is à priori improbable that amputations and the like are ever transmitted.

The acme of attempts at experimental proof is found in the work of John Cossar Ewart, the Scotchman. The experiments in breeding zebras, horses, sheep, dogs, rabbits, etc., that he has carried out are of the highest type of scientific work. Environed

* American Naturalist, 23 : 561.

as he is by transmissionists, both as men of science on the one hand and with fanciers on the other, one would expect him to follow. But he does not, and as a conclusion to these remarks and as an expression of what the speaker deems the sentiment of those biologists who have worked more especially in this field, the following summary of his experiments, given by himself before the British Association, is appended: "In my experiments I have never seen anything that would point to the transmission of an acquired character."

NOTE.—Since the above was prepared, a volume from Macmillan & Co., written by Thomas Hunt Morgan and entitled "Evolution and Adaptation" has appeared. In this book is found a treatment of the general subject in the light of recent research. It may be said that the transmission hypothesis is not countenanced by this author.

NOTES ON THE NUTATION OF PLANTS.

JOHN H. SCHAFFNER.

In the summer of 1896, the writer studied the nutation of Helianthus annuus (1) and found that in this plant we have one of the most remarkable and striking diurnal phenomena to be observed in the plant kingdom. It has been believed quite generally that the disc of flowers follows the sun but Kellerman (2) showed conclusively that this is not the case. The nutation occurs in the upper part of the stem before anthesis, the terminal rosette following the sun from morning until sunset. Along with H. annuus, H. scaberrimus was studied and found to act in the same way.

In 1900, the cultivated variety of H. annuus was reported (3) to nutate as strongly as the wild variety, and the same was observed in regard to H. petiolaris.

More recently Stevens (4) has shown that a similar nutation occurs in various other genera of widely separated families. He found nutation in Bidens frondosa and Ambrosia artemisaefolia. He also mentions the genera, Amaranthus, Lespedeza, Melilotus (especially M. alba), Medicago, and Trifolium, as containing species which show more or less nutation.

During the past summer numerous observations were made on various plants in Clay county, Kansas.

The writer had himself noticed the nutation of Ambrosia trifida in 1897, but it was not included in a previous report as no careful observations had been made. The giant ragweed nutates very decidedly when conditions are favorable, often bending 90° to the west in the evening. In the morning the bending of the stem is usually not more than 20°–30° east. During dry weather the amount of nutation was increased by watering the plants. As in the sunflower, the stem is usually straight by 10 o'clock at night. Ambrosia artemisaefolia was studied and found to nutate well, as reported by Stevens. Ambrosia psylostachya and Xanthium speciosum also nutate, considerable movement of the stem being readily observed during favorable conditions. Helianthus maximiliani, H. grosseserratus, H. hirsutus, and H. tubersus nutate well before anthesis. H. maximiliani is especially striking on

FIG. 1.

FIG. 2.

FIG. 1. Helianthus annuus nutating to the west at 7 P. M.
FIG. 2. Ambrosia trifida at 7 P. M. Both from Clay Co., Kansas.

occount of its stout stem and slender, rigid leaves. On favorable days the nutation is 90° west in the evening and 20° or more east in the morning.

Although Stevens gives Amaranthus as a genus which shows nutation, he does not name the species observed. During the past summer two species were studied by the writer, namely, Amaranthus hybridus and A. retroflexus. The first nutates the more prominently both in the morning and evening, probably because of its more slender stem. The process is much the same as in the sunflowers, but the curve in the stem is not nearly so abrupt. However, on favorable evenings the terminal rosette faces the setting sun to such an extent that the rays of light fall on the broad surface of the leaves at right angles.

The wild variety of Helianthus annuus still appears to the writer to be *the* nutating plant. For on certain cloudy days when nutation is very slight in such plants as H. maximiliani and Ambrosia trifida it is still very decided in this species.

Occasionally there are days in which all the factors favorable to nutation are at a maximum. Such days may be distinguished as special "nutation days." One of the most remarkable in the writer's experience was August 5, 1903. The ground was moist but the sky was exceedingly clear. The sunlight was very intense during the entire day. Toward evening all the nutating plants in the fields and roadsides presented an appearance not soon to be forgotten. The various sunflowers, ragweeds, and amaranths were all nodding to the west at an angle of 90°, giving to the landscape a very peculiar and even unnatural appearance.

In the account given above, fifteen species of nutating plants are named. There are probably scores of others in the United States which show a diurnal bending or nutation of the stem to a greater or less extent.

1. Schaffner, John H. Observations on the Nutation of Helianthus annuus. Bot. Gaz. **25**: 395–403. 1898.
2. Kellerman, W. A. Observations on the Nutation of Sunflowers. Trans. Kan. Acad. Sci. **12**: 140–158. 1889–90.
3. Schaffner, John H. The Nutation of Helianthus. Bot. Gaz. **29**: 197–200. 1900.
4. Stevens, F. L. Nutation in Bidens and Other Genera. Bot. Gaz. **35**: 363–366. 1903.

POISONOUS AND OTHER INJURIOUS PLANTS OF OHIO.

John H. Schaffner.

(Continued from p. 19.)

62. Urtica urens L. Small Nettle. Produces irritation of the skin. A severe case of poisoning is reported, caused by drinking a hot infusion of this plant.
63. Urticastrum divaricatum (L.) Ktz. Wood Nettle. (Laportea canadensis Gaud.) Injurious to the touch.
64. Phoradendron flavescens (Ph.) Nutt. American Mistletoe. Berries poisonous when eaten by children.
65. Rumex acetosella L. Sheep Sorrel. Seeds said to poison horses and sheep. Leaves, when eaten in large quantities, are poisonous.
66. Fagopyrum fagopyrum (L.) Karst. Buckwheat. Causes the formation of a rash on some persons, when eaten. Buckwheat straw is considered injurious.

67. Polygonum hydropiper L. Smart-weed. Very acrid. Sometimes causes inflammation when applied to the skin.
68. Polygonum punctatum Ell. Dotted Smart-weed. Sometimes causes inflammation of the skin.
69. Chenopodium anthelminticum L. Worm-seed. A fatal case of poisoning from the oil has been reported.
70. Chenopodium ambrosioides L. Mexican Tea. Goosefoot. Probably has much the same properties as the preceding.
71. Phytolacca decandra L. Pokeweed. Roots and seed contain a virulent poison. Poisonous to cattle.
72. Agrostemma githago L. Corn Cockle. (Lychnis githago Lam.) Seeds poisonous to poultry. The seed is sometimes mixed with wheat and ground into flour which is injurious.
73. Silene antirrhina L. Sleepy Catchfly. Said to be poisonous.
74. Saponaria officinalis L. Bouncing Bet. Soapwort. Somewhat poisonous.
75. Vaccaria vaccaria (L.) Britt. Cow Cockle. Seeds probably poisonous to stock.
76. Asimina triloba (L.) Dun. Papaw. Is edible, but a case of severe poisoning from the fruit is recorded.
77. Caltha palustris L. Marsh Marigold. Somewhat poisonous
78. Helleborus viridis L. Green Hellebore. Plant poisonous. Leaves poisonous to cattle.
79. Actaea rubra (Ait.) Willd. Red Baneberry. Poisonous, although animals usually do not eat it. Berries poisonous.
80. Actaea alba (L.) Mill. White Baneberry. Poisonous like the last.
81. Cimicifuga racemosa (L.) Nutt. Black Snakeroot. Underground part poisonous. Slightly emetic.
82. Delphinium consolida L. Field Larkspur. Poisonous and fatal to cattle.
83. Delphinium ajacis L. Garden Larkspur. Probably poisonous to stock. Also the two following species:
84. Delphinium urceolatum Jacq. Tall Larkspur. (D. exaltatum Ait.)
85. Delphinium carolinainum Walt. Carolina Larkspur. (D. azureum Mx.)
86. Delphinium tricorne Mx. Dwarf Larkspur. Fatal to cattle.
87. Aconitum noveboracense Gr. New York Monk's-hood. Leaves, roots, flowers, and seeds poisonous to man, horses and cattle.

88. Aconitum uncinatum L. Wild Monk's-hood. Poisonous like the preceding species.
89. Anemone quinquefolia L. Wind Flower. Poisonous to cattle.
90. Clematis virginiana L. Common Virgin's-bower. Probably somewhat poisonous. Most of the species of Clematis contain an acrid poison.
91. Clematis viorna L. Leather Flower. Probably somewhat poisonous.
92. Ranunculus sceleratus L. Cursed Crowfoot. Very poisonous. Juice acrid and blistering. Poisonous to cattle.
93. Ranunculus acris L. Tall Buttercup. Acrid, poisonous and blistering, inflaming the mouths of cattle.
94. Ranunculus bulbosus L. Bulbous Buttercup.
95. Ranunculus repens L. Creeping Buttercup.
96. Ranunculus arvensis L. Corn Crowfoot. The above three species, as well as all other species of Crowfoot, are more or less poisonous.
97. Ficaria ficaria (L.) Karst. Lesser Celandine. Has a somewhat acrid taste.
98. Berberis aquifolium Pursh. Trailing Mahonia. The berries are injurious to birds. When eaten fresh they are emetic and cathartic.
99 Podophyllum peltatum L. May Apple. Roots, stems and leaves drastic and poisonous, but the ripe fruit less so. Leaves when eaten by cows produce injurious milk. The ripe fruit may be eaten in small quantities.
100. Menispermum canadense L. Canada Moonseed. A case is reported of the death of three boys from eating the berries in mistake for grapes.
101. Sassafras sassafras (L.) Karst. Sassafras. The berries are poisonous. Excessive doses of sassafras tea have produced narcotic poisoning.
102. Papaver somniferum L. Opium Poppy. Narcotic and poisonous. Animals killed by eating seeds and seed-pods.
103. Papaver rhoeas L. Red Field Poppy.
104. Papaver dubium L. Long Smooth-fruited Poppy.
105. Papaver argemone L. Pale Poppy. All the above more or less narcotic and poisonous.
106. Argemone mexicana L. Mexican Poppy. Poisonous to stock. Seeds narcotic.
107. Sanguinaria canadensis L. Bloodroot. Acrid and somewhat poisonous.
108. Chelidonium majus L. Celandine. Narcotic and poisonous. Stock refuse to eat the plant.

109. Drosera rotundifolia L. Round-leaved Sundew. Poisonous to cattle.
110. Sedum acre L. Wall-pepper. Produces inflammation and vesication when applied to the skin. The fresh herb is emetic and cathartic.
111. Fragaria vesca L. European Wood Strawberry. The fruit produces an irritation of the stomach, in some persons, which lasts about a day.
112. Sorbus aucuparia L. European Mountain Ash. The berries are poisonous to man, but are eaten by some birds.
113. Pyrus communis L. Pear. Horses are reported to have been killed by eating rotten pears.
114. Malus malus (L.) Britt. Apple. Seeds poisonous.
115. Prunus pennsylvanica L. Wild Red Cherry. Leaves poisonons, but less so than the two following species. Kernels probably poisonous.
116. Prunus virginiana L. Choke Cherry. Leaves poisonous. Kernels probably poisonous.
117. Prunus serotina Ehrh. Wild Black Cherry. Leaves very poisonous to cattle, especially the half-wilted leaves. Kernels very poisonous.
118. Amygdalus persica L. Peach. Leaves and kernels poisonous.
119. Gymnocladus dioica (L.) Koch. Kentucky Coffee Tree. Leaves and pulp of the fruit or beans poisonous. Leaves reported to be used as a fly poison.
120. Baptisia australis (L.) R.Br. Blue Wild Indigo. Emetic.
121. Baptisia tinctoria (L.) R.Br. Yellow Wild Indigo. Emetic. Supposed to be poisonous.
122. Crotalaria sagittalis L. Rattlebox. Leaves and seeds poisonous to horses and cattle. Poisonous also in hay.
123. Lupinus perennis L. Wild Lupine. The seeds are probably poisonous to stock.
124. Melilotus alba Desv. White Sweet Clover. Objectionable in wheat because of the foul odor the seed imparts to flour.
125. Melilotus officinalis (L.) Lam. Yellow Sweet Clover. Said to be poisonous. Also imparts a foul odor to flour.
126. Cracca virginiana L. Goats Rue. Used by the Indians as a fish poison.
127. Robinia pseudacacia L. Common Locust. Black Locust. Roots, leaves and bark very poisonous to man.
128. Robinia viscosa Vent. Clammy Locust. Underground parts somewhat poisonous.
129. Vicia sativa L. Common Vetch. Caution must be observed in feeding this plant to pigs. It is not injurious to cows.

(To be continued.)

ARADIDAE OF OHIO.*

HERBERT OSBORN.

The *Aradidae* are a very interesting group of *Hemiptera*, being adapted by their flattened bodies to live under the loose bark of stumps and dead timber.

The species are many of them quite rare and it seems probable that their numbers have diminished rapidly with the deforestation of the region and the destruction and manufacture of the dead timber that constitute their natural habitat. It is of particular interest, therefore, to collect them as carefully as possible since the chance of securing a full knowledge of our local fauna is growing constantly less.

Some of the species seem to show a preference for certain kinds of timber and possibly careful study would show some decided predilection; so far, however, little accurate record has been kept of the kind of bark under which they occur. In many cases, no doubt, the determination of the kind of a tree which has become a rotting log or stump is difficult, but records, whenever possible, would have a distinct interest. Neuroctenus simplex Uhler has been taken under the bark of beech at Columbus, but I have specimens from Iowa in a locality where I think the beech does not occur.

Mr. Dury has collected a number of species in sifting dead leaves and forest rubbish in fall and winter.

Our native species are dark brown or black and have wings much reduced in size, the elytra or fore wings covering only the disk of the abdomen. The beak is rather short in some genera—not reaching beyond hind border of head. Our species so far recognized in the State fall into three genera, *Aradus*, *Brachyrhynchus* and *Neuroctenus*, but we most probably have representatives of *Aneurus* also.

These genera are separable as follows:

A. Hemelytra with distinct veins.
  a. Prosternum with distinct sulcus. Beak (except in niger) reaching or passing prosternum. *Aradus.*
  aa. Prosternum without sulcus. Beak short, not passing hinder edge of head.
    b. Abdominal segments without keel between spiracles and lateral margin. *Brachyrhynchus.*
    bb. Abdominal segments with a distinct keel on marginal space between spiracles and border. *Neuroctenus.*
AA. Hemelytra without evident veins. *Aneurus.*

ARADUS AEQUALIS SAY.

Aradus aequalis Say. Heterop., Hemip. p. 29 (1831). Coll. Writ., I, 352. Stal. Enum. Hemip. III, p. 136. Uhler Bull. U. S. Geog. and Geol. Sur., I, 321.

Large, dark fuscous, with gray spots, joints 2 and 3 of antennae of very nearly equal length, all joints cylindric. Length, 10 mm.

*Contributions from the Department of Zoology and Entomology, No. 14.

Head a trifle longer than wide, anterior process coarsely granulate, pronotum widening slightly, anterior margin with irregular denticles. Disk with four rough longitudinal elevations on posterior half and two approximate and still more elevated ridges on anterior half. Elytra moderately dilated at base, nearly reaching the tip of abdomen.

Abdomen moderately broad, sides subparallel, appearing somewhat crenulate. Color dark fuscous with grayish suffused spots on sides of pronotum, base of elytra and connexivum, and indistinct annulations on the legs.

This species may be mistaken for *crenatus* Say as it approaches that species in length and has the margin of the abdomen similarly ornamented. It is, however, narrower, the abdomen with sides distinctly fuscous instead of grayish. Say gives the equal length of joints 2 and 3 of the antennae as the distinctive character, but in the specimens in hand I find a slight deviation from an exact equality, the second joint being a trifle longer.

Two specimens collected by Prof. Hine at Cincinnati, also a pair collected by Mr. Dury at same place.

Aradus crenatus Say.

Aradus crenatus Say. Heterop. Hemip. (1831). Coll. Writ. I, 350. Stal Enum. Hem. III, 137. Osborn. Proc. O. S. A. S. VIII, p. 77.

The largest of our native Aradids, the abdomen broad, the margins crenate. Color grayish brown. Length 11 mm.

Head slightly longer than broad. Anterior process rather slender, antennae, joints 2 and 3 nearly equal, two usually a trifle longer, fourth about two-thirds of three. Pronotum widening anteriorly, anterior margin denticulate, disk with subparallel, elevated granulate ridges. Scutellum elongate, triangular. Elytra expanded at base, distinctly narrower at apex and occupying only the central disk of the abdomen.

Abdomen broad, oval, margin crenate, the posterior lobes rounded behind. Beak reaching the posterior edge of anterior coxae.

Color gray, with light grayish or pallid area on the sides of prothorax, base of elytra and occupying a large part of the exposed portion of the dorsal abdominal segments; beneath gray, the venter suffused with reddish, legs light fuscous with gray annulations.

This elegant species seems to be of rare occurence, or, at least, it is rarely taken, though from its color it would seem to be fully as conspicuous as many of the other species. It is longer and broader and the abdomen more dilated than aequalis. The antennal joints 2 and 3 "sub-equal," according to Say, are in my specimen in proportion of 5 to 6, the second being the longer.

One specimen collected at Columbus, and I have before me one collected at Cincinnati by Mr. Dury.

Aradus robustus Uhler.

Aradus robustus Uhl. Proc. Bost. Soc. Nat. Hist. (1871) p. 104 and (1878) p. 419.

This species is of a dark gray to blackish color, the antennae very robust. Length 5½ -6 mm.

The head wide, antennae very robust, joint 2 a little longer than joint 3, about equally thick, 4th joint smaller, shorter than third.

Pronotum rounded on the margin, surface coarsely granulate and with four elevated ridges on the disk, the outer ones not reaching the anterior margin. Scutellum with sides parallel at base. Elytra moderately dilated at base, not reaching end of abdomen. Beak reaching middle of mesosternum. Color dull fuscous or blackish, a ring near the tip of tibiae and the base of the tarsal joints slightly paler.

Widely distributed over the United States but has been taken in Ohio only in Columbus and Cincinnati. Other records place it in Iowa, Canada, Mass., N. J., N. Y., Md., Ill., Wis. and Minn. It is at once separated from other native species with thick antennae by the dull fuscous or blackish color.

Aradus ornatus Say.

Aradus ornatus Say. Heterop. Hem. (1831), p. 21. Coll. Writ. I, 352. Bergroth, Proc. Ent. Soc. Wash. II, 332 and 335.

Antennae robust, third joint largest, second longest. Rusty brown with yellow spots. Length, male, 5 mm.; female, 6 mm.

Head broad, the antennae much swollen, joint one short, two longest and considerably swollen, three about half as long as two and equally thick, four smaller. Beak reaching to middle of prosternum. Pronotum with lateral borders strongly curved, edge roughened but not dentate, disk with distinct rugosities and three conspicuous glabrous spots on hind border. Scutellum triangular. Base of elytra strongly dilated. Abdomen reddish with pale margin bordered with black. Genital lobes with a transverse light yellow spot.

So far this species has been recorded from Indiana, Pennsylvania, and Cincinnati, Ohio.

A handsome species, described in 1831 from Indiana, and for a long time unrecognized, but Bergroth called attention to it a few years ago, his specimen being credited to Pennsylvania. (Montandon collection.)

Recently Mr. Dury has collected it at Cincinnati and kindly placed three excellent specimens of males and, later, one female in my hands for study. (Ohio Naturalist, IV, p. 22.)

Aradus duzei Bergroth.

Aradus duzei Bergroth. Proc. Ent. Soc. Wash. II, p. 333.

Resembles *ornatus* but lacks the polished spots of the hind border of prothorax. Fuscous with light yellowish markings. Length, male, 6 mm.; female, 6.5 mm.

Head broad, antennae robust but less dilated than in ornatus, joint two longest, three about two-thirds of two, scarcely as thick.

Margin of prothorax subangulate, the disk with four rough carinae.

Elytra dilated at base, barely reaching tip of abdomen, suffused with yellowish on basal third, membrane brown, veins concolorous.

Color brown. First joint, except at the base, tip of scutellum, margin of abdominal segments and legs, yellow. Tergum and disk of venter suffused with rufous.

This species has been collected at Westerville by Mr. Jas. G. Sanders, and at Cincinnati by Mr. Chas. Dury. It is recorded also for Canada and Pennsylvania by Bergroth, and this author suggests that this species has been mistaken for *ornatus* and so recorded in some earlier papers.

It is a little more slender than that species, the general color more distinctly brown, base of elytra less dilated, and the depressions on the pronotum not polished.

Aradus duryi n. sp.

Broad, sides subparallel. Brown with ochery markings. Antennae, joints 2 and 3 nearly equal. Length, female, 9 mm. Width of abdomen, 4 mm.

Head with anterior process much swollen, rounded at apex. Antennae cylindric, joints of nearly equal diameter, first joint short, barely passing lateral spine and much short of anterior process ; two and three almost equal, one side two is slightly longer than three, on the other the reverse. Beak extends to hind border of prosternum. Prothorax broad, lateral angles rounded, anteriorly narrowed; margin reflected, disk with four elevated ridges, the inner ones approximate on anterior half, the outer ones broken before the middle but continued to anterior margin. The carinae are coarsely granulate, the intercarinal spaces smooth but not polished.

Scutellum elongate triangular, margins raised and a median carina on basal half, the margin at base and central carina granulate. Elytra with basal fourth strongly dilated, membrane broad, widening to broadly rounding apex, which reaches nearly half way upon the genital lobes. Abdomen oval, broadly rounded behind, the sides subparallel ; genital lobes long, separate, divergent, obliquely subtruncate, the inner angles rounded. Fifth ventral segment as long at margin as on median line, excavated, truncate on median section, sixth segment at middle about one and one-half times longer than fifth, slightly convex and medially notched. Seventh segment half as long as sixth, notched on middle, terminal segment short, subangulate.

Color, ashy brown, with lighter areas on base of wings and veins of corium, and darker fuscous marks and veins on membrane. Antennae yellowish brown, lightest at base, and terminal joint nearly black. The connexiva are brown with posterior border yellowish, and the inner margin of genital lobes of the same color. Beneath rather deeply infuscated, with reddish yellow diffuse spots on the abdomen. The legs yellow with wide fuscous annulations on femur and tibiae, and black tarsal claws.

Described from one specimen, female, from Mr. Chas. Dury, collected at Cincinnati, May 2, 1902.

This species has the general facies of *duzei* though less widened posteriorly, but it is much larger and differs in color of antennae, joints of pronotal carinae, genital segments and other points.

I have named it in honor of Mr. Chas. Dury, who has so generously placed his material in this family at my disposal.

Brachyrhynchus lobatus, Say.

Aradus lobatus Say. Heterop. Hem. (1831.) Coll. Writ. I, 354.
Brachyrhynchus lobatus Say. Stal. Enum. Hem. III, 145.

Elongate, oval. Black, the pronotum lobate with acute emargination on lateral border and production of anterior angle. Length, male, 7.5 mm–8 mm.

Head as wide as long, anterior process truncate, not incised; antennae slender, joint three longest, one, two and four about equal length, each about two-thirds of three.

Pronotum as wide as base of abdomen, the lateral margin acutely emarginate which, with the projection of the anterior angles, give it a distinctly lobate form; disk coarsely granulate with four distinct elevated ridges on the anterior half.

Originally described from Indiana, this species seems to be rather rare in collections, and in some cases specimens of *granulatus* have stood under its name. It is much larger than that species, as stated by Say, and the deeply indented margin of pronotum separates from any of the other species. I have a specimen from Florida collected by Mrs. Slosson, and Mr. Dury has sent me an example collected at Cincinnati—both males. Bergroth cites its occurrence in Canada, Penn., Md., Mich., Ind., Ill., Mo., Texas and California.

Neuroctenus simplex, Uhl.

Brachyrhynchus simplex Uhl. Bull. U. S. Geol. & Geog. Surv. I, 323.
Neuroctenus simplex Uhl. Bergroth Proc. Ent Soc. Wash. II, p. 336. Osborn Proc. Ohio State Acad. Sci. VIII, p. 77 (record only).

Elongate ovate; black. Surface finely granulate, elytra white. Length, male, 4.5–5 mm.; female, 6 mm.

Head about as broad as long, antennae slender, third joint slightly longer than the others, which are about equal.

Pronotum trapezodial, the lateral margins sloping towards the head from the basal third, surface granulate, without trace of elevated carinae. Abdomen very flat. Elytra occupying about one-third of dorsal surface.

Color dark brown or black throughout, except elytral membrane, which is white, though sometimes infuscated on central part, and disk of abdomen under the elytra, which is red. Some specimens are less intensely black than the others, but except in immature individvals such cases are rare.

This seems to be our most abundant species, having been taken in large numbers at different points in the State, Columbus, Cincinnati, Williamsburg and Hanging Rock.

It is also widely distributed over the country from New Eng- to Cuba, and west to Iowa, Indian Territory and Texas. Uhler says under bark of oak, but it has been taken here under beech bark also.

Neuroctenus ovatus, Stal.

Mezira ovatus Stal. Stet. Ent. Zeit. XXIII. 339.
Neuroctenus ovatus Stal. Bergroth. Pr. Ent. Soc. Wash. II, 336

Broad ovate, larger, broader than simplex. Black. Length, male, 6 mm.; female, 7 mm. Width of abdomen, male, 3 mm.; female, 3.5 mm.

Head with anterior process deeply cleft, that is, the lateral lobes extending well beyond tylus and not fused. Antennae, joints subequal, third slightly larger than the others. Pronotum slightly sinuate on lateral margin, anterior margin slightly concave, granulate, without carinae. Scutellum triangular, basal margin longest Elytra with two whitish spots at base of membrane.

Male genital segment oval, baoader than long ; female genital segment quadrate, the hind border lobate, lateral lobes divergent.

The above description is written for a male and a female collected by Mr. Dury at Cincinnati. While there is a slight difference in measurements and in incision of anterior lobe of head as compared with Stal's description, I believe it should be referred to his species.

The species was described from Mexico by Stal and has been accredited to North Carolina by Bergroth. The specimens collected by Mr. Dury at Cincinnati extends its range to our State. It is similar to simplex except in larger size and broader, more ovate form.

Neuroctenus elongatus n.sp.

Elongate, narrowing slightly and anteriorly. Brown. Length of male, 5.5 mm ; width of abdomen, 2.25 mm.

Head with anterior process slender, the apex slightly notched. Antennal joints subequal. Pronotum narrowing toward head from near the base, scarcely sinuate. Anterior border slightly concave, surface finely granulate. Scutellum triangular, pronotal border slightly longer than the others, a faint median carina, surface minutely granulate. Elytra narrow, the neuration weak but distinct.

Color dark brown, the apical half of the fourth antennal joint rufous; the elytra have two diffuse yellowish spots at base of membrane, the membrane brown. Abdomen uniformly red-brown. Beneath red-brown. The legs darker.

Genital segment, male, broad oval, the posterior margin subangulate, the lateral lobes small.

This species described from one specimen, male, collected at Cincinnati by Mr. Dury, is nearly the size, slightly larger, than simplex, but it differs in shape, being narrower proportionately, and its color is quite distinct from any specimens of simplex that have come under my observation. It also differs in the carina on the scutellum, the shape of the genital segment, and the smaller lateral lobes.

In addition to the species treated above, I have a specimen of larval Aradus from Mr. Dury, which from antennal characters appears to be different from any American species known to me, and it is hoped adult individuals may be secured so that it may be properly characterized.

A SUBTERRANEAN ROOT—INFESTING FULGORID (Myndus radicis n. sp.)

Herbert Osborn.

On May 10th of the present year (1903), I found a specimen of Fulgorid in the larval stage occurring upon the roots of several different kinds of plants, Impatiens, nettles and some grasses, in a river bed near the Olentangy river. The insects occurred in galleries and cavities usually connected with open cracks and about ½ to 1½ inches below the surface, in some cases and on later days, individuals were found attached to roots of plants above ground, but always where they were well protected by drooping or dead leaves or underrubbish of the surface. Frequently two or three larvae were found in the same cavity, but seldom more than this, and the cavity was lined with a cottony fibre secreted from the posterior abdominal segment of the body of the insect. The insects were found only in one small area, but during the two or three weeks in which the specimens were found, adults and nymphs of different stages were taken in some numbers, so that it has been possible to trace a part of the life history. The adults were evidently all derived from larvae developed in the preceding weeks, and it seems quite certain that the larvae must hatch in early May either from eggs deposited in the spring by hibernating adults or, what is less probable, in the preceding autumn. So far all efforts to find adults or nymphs during the autumn have failed and the status of the insect during that period can only be surmized. There would seem to be abundant time for two broods, that is, for a second generation resulting from the eggs deposited in June, the individuals of which are usually matured by late summer, but no proof of this has been secured. Actual knowledge of the life history is, therefore, confined to the development of nymphs during May and the occurrence of imagos during the latter part of this month and early June.

As the life habits of related species of Myndus are unknown, it seems quite possible that others may prove to be subterranean and the rarity of these forms in collections readily accounted for by this protected habit.

What appears to be the larva or a pre-pupa stage has a length of two and sixty hundredths mm. and a width of one mm. It is pallid greenish, sutural lines appearing white, and the cottony secretion of the posterior segment of the abdomen scant; the beak extends just beyond the second coxae. The mature nymph or pupa stage has a length of four mm., or, including the cottony secretion, four and one-half mm. and a width of one three-tenths mm. It is mostly of a pale yellow or whitish color; some individuals appear more decidedly greenish and some dusky or dirt color. There is a well marked median dorsal stripe and fainter lines laterally, marking the margins of the wing pads. The three terminal segments with the projecting cottony filaments extend one-third the length of the abdomen and when fully extended appear as a wide tuft. The tuft, however, is easily shed and when the abdomen is denuded only very narrow margins of white thread appear around the terminal borders of the segments. The surface of the thorax and abdomen is faintly dusky, contrasting with the white sutural lines. The eyes are red. The body of the segments are dusky with broad sutures yellow, a dusky patch on the thorax and another on the posterior border of the hinder wing pad. The legs are whitish, the beak reaches to the base of the third coxae.

The Imago is pallid yellowish green, the front above and on lower border with black. Length, male, 3.5, mm., to tip of elytra 5 mm.; female, 4 mm., to tip of elytra, 5.5 mm.

Head wider than long, vertex one and one-half times longer than wide, tapering to apex which is broadly rounded, margins slightly raised, disk slightly raised towards apex. Front much widened towards apex. Lateral keels thin, broad, median keel weaker. Clypeus triangular, keels obtuse. Pronotum short, posterior margin deeply concave. Posterior angles scarcely rounded. Scutellum longer than head and pronotum together acutely angled behind. Keels slightly divergent. Elytral nervures strong and set with minute hairs, slightly setigerous

Color greenish or pallid, the vertex unmarked, but the front bears the black spots just beneath the apex of vertex and a band across its apex, either yellowish or infuscated, in some specimens distinctly blackish. The scutellum outside the lateral carinae, and in some cases in posterior portion of intercarinal spaces infuscated, appearing as obscure longitudinal stripes. Elytra hyaline with veins infuscated, a faint stigmal and post-claval spot and the apical portion of whole elytron sometimes slightly smoky. Ovipositor of female black.

Male pygofers nearly truncate, a minute median process, the styles broadly expanded apically, curving outward but their inner borders touching.

Described from numerous specimens of both sexes collected at Columbus, Ohio, in 1903.

This species resembles *viridis* Ball, but is larger, with more pronounced coloring, especially the black spots of the front. The vertex is less elongate and genitalia different.

While the root inhabiting habit is unusual in this family there are, of course, abundant instances in other homopterous families, as Aphidæ. Membracidæ and Cercopidæ.

NEW SPECIES OF OHIO FULGORIDAE.

HERBERT OSBORN.

PHYLLODINUS KOEBELEI N. SP.

Brachypterous, female. With transverse markings on vertex and front, pronotum except anterior border, all of scutellum, a broad apical margin of the aborted elytra and the first two joints of the tarsus and margin of the pygofer white, with terminal joint of the antennae, base of the legs, most of the coxae and a series of marks on the abdomen, dirty white. Length, 2.7 mm ; width, 1½ mm.

The head narrower than pronotum, vertex quadrangular, carinae distinct, front with sides parallel; two times longer than wide; median carina distinct and continued to apex, and a faint carina intermediate between median and lateral. Clypeus longer than width at base, polished black. Pronotum about as long as vertex, anterior border truncate between the eyes, posterior border nearly straight or slightly concave. Scutellum wider than long, a short divergent lateral carina at base, median carina continued to apex. Elytra reaching to base of the second abdominal segment ; veins well marked, becoming indistinct, on posterior margin. Legs dilated about as in nervatus.

Color dull black or fuscous black. Vertex with a soiled occipital white margin, a broken polished band just in front of the middle and two quadrate spots just behind the apex. Front black, with short quadrangular bars just beneath the vertex margin. Three interrupted bars across its disk, two spots about the middle of the lateral margin and a band across the apex, yellowish white. Clypeus black, labrum brownish or yellowish. Pronotum white, the anterior margin blackish, the dusky line extending further along the curved carinae. Scutellum entirely white. Elytra pitchy black with broad apical margin, narrower at apex of clavus. Abdomen fuscous with a series of dorsal triangular spots, a lateral suffused spot on second abdominal segment, a series of round spots on first to third segments and longitudinal stripe, one on third, three on fourth, three on fifth, one broken stripe on sixth, and margins of terga yellowish white. Anal style white; legs, yellowish brown at base ; femora yellowish brown at base ; the anterior and middle tibiae, dull black; hind tibiae, fuscous, indistinctly annulated with yellowish; tibial spur and first and second joints of tarsus, yellowish white. Third joint of tarsus and claws, black.

Brachypterous, male. Color as in the female, but the black of elytra and head more intense and white a purer white. Length, 2.3 mm.

Structural characters of the body as in the female, the difference lying in the size and the intensity of the color marking. The tibiae slightly more dilated.

Genitalia. Pygofer excavated ventrally; styles narrow, nearly parallel, slightly curved dorsally.

Macropterous, male. Black with the white bars on the vertex and front and tip of scutellum faintly white. Length to tip of elytra, 3.2 mm.

Head as in brachypterous forms, the carinae of the vertex apparently a little stronger. The hind border of pronotum broadly sinuate. Scutellum larger, broader than in the brachypterous form, with the posterior lateral margins concave. Elytral neuration strong, veins tuberculate, having short setae. Almost entirely black. Differs from the brachypterous form in not having white on pronotum and scutellum. Vertex barely shows traces of white margin, front has the transverse bars and lateral spots distinct, with apical border distinct but narrow; tip of scutellum is faintly whitish; the antennae are brownish; the apex of the first joint, black; femora, yellowish brown; anterior and middle tibiae, black; tip of tibiae and first and second tarsal joints, white; hind legs mostly brownish; tips of spines and claws, black.

Macropterous, female. Black with margins of vertex in front and tarsal joints white, as in the brachypterous forms.

Elytra hyaline with a fuscous spot at vertex of clavus. This form agrees with the macropterous male, except that the hind border of the pronotum is more broadly whitened. White markings of the vertex more distinct near the apex. The color as a whole somewhat less intensely black. A single specimen of this form, which must evidently be associated with the preceding.

Described from two brachypterous females, two brachypterous males, and one macropterous male, collected in Columbus, O., by Mr. Albert Koebele, September, 1903. One macropterous female collected in "D. C.," May.

This is one of the most elegant Delphacids which has yet come to light in Ohio fauna, and I take special pleasure in dedicating it to my friend, Mr. Albert Koebele, who collected these and a number of other interesting fulgorids here the past summer.

It resembles nervatus but differs particularly in the white tarsal joints and in the extent of the frontal bars, and in the coloring of the pronotum and scutellum.

Phyllodinus fuscous n. sp.

Brachypterous, female. Somewhat larger, lighter colored than Koebelei but similarly marked. Length, 3 mm.

Head narrower than prothorax; vertex quadrate, carinae well marked; front with sides parallel, median carina small with very faint carinae about one-third of the distance from the median to the lateral. Clypeus triangular; median and lateral carina strong; pronotum as long as vertex; posterior margin faintly sinuous; scutellum scarcely longer than pronotum; median carina becoming obsolete before the apex; elytra reaching the middle of the first segment. Veins moderately elevated, becoming obsolete towards apex.

Color brownish and fuscous; markings very similar to those of Koebelei, but those of pronotum white with median anterior portion black. A somewhat interrupted band on either side close to the anterior margin and the anterior angles directly beneath the eyes, black. Scutellum white, with an irregular transverse broken band of fuscous-black. Elytra brown, somewhat fuscous; on costal margin a broad apical band of soiled white. Abdomen medially polished brown, laterally fuscous with white markings, quite similar to those of Koebelei. Tibiae moderately dilated.

Described from one specimen collected at Columbs in September by Mr. Albert Koebele.

This may possibly be an extreme variety of Koebelei or the brachypterous female of nervatus, but without sufficient material to connect them definitely it would better stand by itself. It is a large and handsome specimen, but the color markings are much less intense than in Koebelei.

Myndus fulvus n.sp.

Light orange or yellow-orange, immaculate. Length, to tip of elytra, female, 4.5 mm.; male, 4 mm.

Vertex quadrate, carinae indistinct; front broad, widened to near apex, then narrowing abruptly to clypeus; lateral carinae of clypeus sharp. Pronotum shorter than vertex, hind bordor sinuate; carinae of scutellum weak.

Color uniformly tawny or light yellow-orange. The elytra hyaline but tinged with tawny. Tips of spines and tarsal claws black.

Male styles long, expanded on apical half, bent at about the middle.

Described from four females and two males collected at Sandusky and Castalia, Ohio, in late June and July.

Easily recognized by the bright tawny color and the absence of spots.

NEWS AND NOTES.

The thirteenth annual meeting of the Ohio State Academy of Science was held at Denison University, Granville, on Nov. 27. A very interesting program was given in the three sessions of the meeting, and some important business was transacted, with a view toward better organization and publication. Prof. E. L. Moseley of Sandusky, was elected President.

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IMPORTANT NOTICE.—By a special arrangement the OHIO NATURALIST is sent to members of the Ohio State Academy of Science who are not in arrears for annual dues. Members of the Academy wishing to receive the NATURALIST regularly should see that their dues are paid promptly to Prof. Herbert Osborn, the Treasurer of the Academy. The reports of the Academy will be sent from time to time, as heretofore, to members who have not neglected to pay their annual dues for more than a year.

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During the past summer I have observed fasciation in the following plants which should be added to Miss Riddle's list on p. 348, OHIO NATURALIST, Vol. 3: Cassia marylandica, Viola tricolor, Ambrosia trifida. J. H. S.

MEETINGS OF THE BIOLOGICAL CLUB.

ORTON HALL, October 5, 1903.

The Club was called to order by the President, Mr. Morse, and after the adoption of the minutes of the previous meeting, the regular program was taken up, consisting of reports by the members upon the work of the summer.

Prof. Prosser reported two months spent in the field in the north, central and southern portions of the State. The so-called Huron shale was studied in northern Ohio, and the exposures near Monroeville were referred to the Cleveland. The name Huron is not acceptable, having been applied in 1861 to a Michigan formation. The shale along Vermillion river appears to be interlocking with the Ohio shale from the south. Exposures of the Prout limestone at the base of the "Huron" were found.

In Highland county, at Hillsboro, the Cedarville limestone shows abundant remains of a large Brachiopod shell. Cavities in the rock are filled with asphalt.

Mr. Mead reported on some exposures of the Huron studied by him between Sandusky and Rye Beach. He further reported on the fishes and Orthoptera of Cedar Point and vicinity. Seventeen species of fish were washed up along the shore, although some of the more common species, for instance, the white fish, were not observed. About twenty-seven or twenty-eight species were found in the orthopterous fauna of Cedar Point.

Prof. Schaffner reported on observations made in Kansas. He studied nutation in plants and nectaries outside of floral organs. Plants new to the Kansas list and added by Prof. Schaffner are Bertoroa incana, Lysimachia nummularia and Taraxacum erythrospermum. To the Ohio list he added Lacinaria punctata.

Prof. Osborn reported fourteen mammals in the Cedar Point fauna. Late in the summer he collected Hemiptera at Columbus and at Sugar Grove.

Prof. Landacre reported the addition of forty-six species of Protozoa to the State list, three of which are probably new to science.

Prof. Hine reported on collections at Sandusky, and at the Gulf Biological Station, in Louisiana.

Prof. Lazenby reported circumference measurements of growing trees.

Mr. Morse reported one new snake added to the State list, Valeria virginica.

Mr. Jennings reported work on the flora of Cedar Point. The herbarium of Cedar Point now contains 312 mounted specimens, all collected on the Point.

The Committee on Nominations named by the President was as follows: Prof Prosser, Prof. Lazenby, Prof. Davis.

Club adjourned to the first Monday evening in November.

Orton Hall, November 2, 1903.

The program consisted of the address of the retiring President, Mr. Morse, which is presented in full in another portion of this issue.

Officers were elected for the year as follows: President, O. E. Jennings; Vice President, J. G. Sanders; Secretary, E. D. Coberly.

E. D. Coberly, *Secretary.*

The Ohio Naturalist,

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NOTE.—Titles on pages 49 to 62 inclusive, are Papers and Abstracts given at the Annual Meeting of the Ohio State Academy of Science for 1903. Not all titles appear in table of contents. Each author appears once.

TABLE OF CONTENTS.

NOTES ON THE INTRODUCTION OF THE ASIATIC LADYBIRD (Chilocorus similis) IN OHIO.

A. F. BURGESS.

It is now a little over two years since the first shipment of this insect was made to this country. Mr. C. L. Marlatt, First Assistant Entomologist to the United States Department of Agriculture collected the beetles while making explorations in Japan and China to ascertain the native home of the San Jose scale. In northern China he found that this scale was present on native trees and also on the fruit exposed for sale in the markets; very few scales were found on the fruit and the trees were not seriously infested. Ladybirds of this species were very common and were frequently found feeding on the scales.

Three shipments were sent to Washington, D. C., but only two of the beetles survived the winter of 1901–1902. They were placed on trees infested with *Diaspis pentagona* and a large number of adults had developed late the following summer so that a few shipments were made to different points in the United States.

Chilocorus similis is a small black lady beetle, the distinctive markings being a dark red and somewhat circular spot on each elytron. The adults resemble our native species *Chilocorus bivulnerus*, so closely that it is almost impossible to distinguish between them in this stage. The larvae and pupae, however, have characteristic differences, hence it has been found that this is the easiest way of determining the species. The imported species appears to be more prolific than its native congener and when food was abundant about five generations were produced annually at Washington, D. C., according to Mr. Marlatt.

On August 12, 1903, through the courtesy of Dr. L. O. Howard, Entomologist to the United States Department of Agriculture, a shipment of twenty of these beetles was sent to the writer. Unfortunately, it was not received until August 17, and only three of the insects were alive. The beetles were immediately taken to an orchard infested with the San Jose scale near Withamsville in Clermont county. One of these escaped from the box before arriving at the orchard but the other two were placed on an infested peach tree. They were observed for some time after being liberated and, although they were quite active, made no attempt to fly away. After crawling about for some time both beetles began to feed upon the scales and young lice.

Owing to the fact that only two individuals were placed in the orchard it was feared that they might disappear, but five days after they were liberated the orchard was visited by Mr. Otto H. Swezey, one of my assistants, and both beetles were found feeding upon the scales on the same tree where they had been placed. No further observations were made until October 28, when a hasty examination revealed twelve adults present on the tree where the planting was made. Empty larval skins and pupa cases were also noted, but no beetles or larvae could be found on any of the adjoining trees in the orchard.

Another shipment of this insect was made to Mr. P. J. Parrott, Entomologist to the Ohio Experiment Station, and were placed in an orchard in Danbury, Ottawa county. I am informed by Mr. J. S. Hauser, Assistant Entomologist to the Station, that none of the beetles were found at the time the last examination was made.

It is interesting to note that this species will breed in southern Ohio, but the question of its ability to survive the winter is still to be determined. Colonies have successfully passed the winter at Washington, D. C., and Marshallville, Georgia, but I understand that no shipments were placed last fall at a latitude north of the former locality.

Although this ladybird, if it succeeds in surviving the winter season, will add another insect to the list of beneficial species in Ohio, it is still an open question whether it will prove as beneficial in holding the San Jose scale in check as it does in its native home. For this reason it would be very unwise for any orchardist to neglect to treat his trees that are infested with the San Jose scale until the efficiency of the work of the beetles has been thoroughly demonstrated.

Columbus, Ohio.

PRELIMINARY REPORT ON THE DEVELOPMENT OF THE GILL IN MYTILUS.

EDWARD L. RICE.

(*Abstract.*)

The early development of the gill of this form was very thoroughly worked out by Lacaze-Duthiers in 1856. To his account of the development of the earlier filaments the present writer has nothing to add. As described, a papilla is formed, growing downward from the gill axis, and is reflexed on itself, giving rise to the familiar U-shaped filament. Later filaments follow a very different scheme, there being no such bending of an originally simple filament. At the posterior end of the curiously bent gill axis a series of thin transverse ridges are developed. At first the edge of each ridge is entire; but growth is very early checked in the center, so that the ridge is divided into two flat, rounded lobes, corresponding respectively to a filament of the outer and one of the inner gill plate. As the lobe elongates it becomes perforated at its proximal end, thus being resolved into the two branches of a U-shaped filament identical in form with those first developed. This mode of development of the later filaments has been observed in Modiola, Arca, Anomia, and Mya; the earlier filaments have been studied only in Mya, where they correspond with Mytilus.

An interesting parallel is seen in the development of the interlamellar connections. The interlamellar connection, in its finished form, is a simple bar, containing a blood channel, and connecting the two branches of one and the same filament. In an early stage the two branches are connected by a continuous plate of tissue extending from the bend of the filament upward for a short distance. This stage is exactly comparable with the adult conditions in Arca and Modiola. Later a perforation appears in the plate, and the portion above the perforation is transformed into the characteristic bar-like connection.

As yet the examination of sections is too little advanced to allow any detailed statement concerning the mode of perforation in either case.

Ohio Wesleyan University.

COMPARATIVE CHART OF THE VERTEBRATE SKULL.*

Charles S. Mead.

In compiling the following chart, an attempt has been made to show the history of the cranial bones in the different classes of vertebrates. To make it general as well as specific from one to four types are given under each class, and where possible, an unspecialized and a highly specialized form have been taken. As a rule, the same bone occurs in the different classes of vertebrates, but it may fail to develop, as in the Amphibians, or several bones may fuse to form larger elements, as in the Mammals, and it is the purpose of this chart to show these irregularities.

In the higher types, especially the birds, there is a great tendency for bones that are separate in the immature stages to fuse in the adult, the sutures being obliterated. In Lacerta and the Amphibia many elements that are indicated as bones remain cartilaginous. Where two or more bones in one type fuse to form one bone in another type the line between them has been omitted.

In the Urodeles, Ophidians, and Chelonians no particular type has been taken.

Different authors have used different names for the same bone in the same class or different classes, or the same name may be used for as many as four different bones. Below is given a list of synonyms:

Jugal, malar, zygoma, zygomatic.
Quadrato-jugal, zygomatic.
Squamosal, supratemporal of Ophidians.
Supra-angular, surangular.
Coronoid, coronary.
Lacrymal, supraorbital.
Sphenotic, postfrontal.
Prootic, petrosal.
Periotic, petrosal of Mammals.
Epipterygoid, columella.
Transverse, ectopterygoid, transversum, transpalatine.
Pterygoid, ectopterygoid.
Mesopterygoid, entopterygoid.
Mesethmoid, ethmoid, supra-ethmoid, median ethmoid.
Ectoethmoid, ectethmoid, parethmoid, lateral ethmoid.
Turbinal, ectoethmoid.
Maxilla, maxillary, supermaxilla, superior maxilla.
Premaxilla, intermaxilla, anterior maxillary, incisive.

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* From the Zoological laboratory of the Ohio State University.

The pterotic has been called the squamosal, but the latter arises from a separate ossification and is not present in fishes. The turbinals are derived from outgrowths of the bones surrounding the nasal chamber and represent true ossifications in Mammals, but may remain cartilaginous in the lower groups. They are first recognized in the Amphibians, where they are merely cartilaginous protuberances on the bones of the floor and side walls of the nasal chamber.

Characteristics of the different classes:

FISH.—One occipital condyle. Opercles present only in the fish. Some fish have bones which are lacking in others, there being a great difference between some of the families in this respect.

AMPHIBIANS.—Two occipital condyles; no trace of supra– or basioccipitals. The skull is remarkable for the extent to which the chondrocranium is retained and the consequent small number of primary bones. The prootic alone forms the auditory capsule in the frog, the other otic ossifications not being developed; in the Urodels an opisthotic is added.

REPTILES.—One occipital condyle. The transverse is present in all reptiles, except the turtles, and in no other vertebrates. The zygomatic arch, formed by the quadrato-jugal and the jugal, is wanting in the Ophidians. In turtles there are no teeth, and the basisphenoid is the only one of the sphenoidal bones present. Of the otic bones the prootic is always distinct, the epiotic is fused with the supraoccipital, while the opisthotic (free in turtles) is usually united to the exoccipital.

BIRDS.—One occipital condyle. The bones of the cranium fuse early so that the sutures between them are obliterated. Teeth are lacking in modern birds. The anterior end of the parasphenoid forms the rostrum and the posterior the basitemporal.

MAMMALS.—Two occipital condyles. The lower mandible articulates with the squamosal and is composed of five elements on each side, as the articular has been taken into the middle ear to form the malleus. The quadrate has gone into the ear and become the incus. The stapes is derived from the hyomandibular and from some membranous elements.

EXPLANATION OF PLATES III AND IV.

S=Salmon; F=Frog; U=Urodele; L=Lacerta; O=Ophidian; T=Turtle; A=Alligator; D=Duck; P=Pigeon; C=Chicken; H=Dog; R=Rabbit; M=Man. In the first column after the name of the bone, c=cartilage bone and m=menbrane bone.

OHIO NATURALIST. *Plate III.*

	Fish	Amphibian	Reptile	Bird	Mammal.	
Inter parietal m					HR	Occipital M (Interparietal–Basioccipital)
Supraoccipital c	S		LOTA	DPC	HR	
Exoccipital c	S	FU	LOTA	DPC	HR	
Basioccipital c	S		LOTA	DPC	HR	
Paroccipital			LOA			
Quadrato-jugal m		F	TA	DPC		
Jugal m	S	FU	LTA	DPC	HRM	
Squamosal m		FU	LOTA	DPC	HR	Temporal in M (Squamosal–Prootic)
Tympanic m					HR	
Sphenotic c	S		LOTA		Periotic HR (Sphenotic–Prootic)	
Pterotic c	S					
Opisthotic c	S	U	LOTA	Periotic DPC (Opisthotic–Prootic)		
Epiotic c	S		LOTA			
Prootic c	S	FU	LOTA			
Opercle m	S					
Pre opercle m	S					
Inter-opercle m	S					
Sub opercle m	S					
Metapterygoid	S					
Mesopterygoid	S					
Basipterygoid			LO	DPC		
Epipterygoid			LA			
Transverse			LOA			
Symplectic	S					
Supra-temporal m			L			
Orbitals m	S					
Lacrymal m			LA	DPC	HRM	

Chas S Mead

MEAD on the "Vertebrate Skull."

OHIO NATURALIST. *Plate IV.*

	Fish	Amphibian	Reptile	Bird	Mammal
Pterygoid c	S	Fu	LOTA	DPC	HR — Sphenoid in M (Pterygoid to Orbitosphenoid)
Alisphenoid c	S	Fu	LA	DPC	HR
Basisphenoid c	S		LTAO	DPC	HR
Presphenoid c		Sphenethmoid Fu (Presphenoid to Ectoethmoid)	LO	DPC	HR
Orbitosphenoid c	S			DPC	HR
Mesethmoid c	S		LOA	DPC	Ethmoid HRM (Mesethmoid and Ectoethmoid)
Ectoethmoid	S			DPC	
Parasphenoid m	S	Fu	LO	DPC Rostrum; DPC Basitemporal	
Turbinal c			LOTA	DPC	HRM
Frontal m	S	U — Fronto-parietal in F (Frontal and Parietal)	LOTA	DPC	HRM
Parietal m	S	U	LOTA	DPC	HRM
Prefrontal m		U	LOA — Prefronto-nasal in T (Prefrontal and Nasal)		
Nasal m	S	Fu	LOA	DPC	HRM
Maxilla m	S	Fu	LOTA	DPC	HR — M (Maxilla and Premaxilla)
Premaxilla m	S	Fu	LOTA	DPC	HR
Palatine c	S	Fu	LOTA	DPC	HRM
Vomer m	m S	Fu	LOTA	DPC	HRM
Supra-angular m			LTA	DPC — Fused in adult (Supra-angular to Articular)	Inferior Maxillary HRM (Supra-angular to Angular)
Coronoid m			LOTA	DPC	
Splenial m		Fu — Fused in adult (Splenial to Articular)	LOTA	DPC	
Dentary m	S	Fu	LOTA	DPC	
Angular m	S	Fu	LOTA	DPC	
Articular c	S	Fu	LOTA	DPC	HRM Malleus
Meckel's cartilage c	S	F			
Quadrate c	S	Fu	LOTA	DPC	HRM Incus
Hyomandibular c	S	F Columella	LOTA	DPC	HRM Stapes

Chas S Mead

MEAD on the "Vertebrate Skull."

THE RELATIONSHIP OF VARIATION TO ENVIRONMENT IN CHRYSANTHEMUM LEUCANTHEMUM.

L. B. WALTON.

(*Abstract.*)

It is not sufficient to show that a particular species possesses a certain index of variability in a restricted locality. We must attempt to ascertain the component stimuli forming the environment and learn the effect which each group of stimuli has on the variability of the organism in question. Only by so doing can we draw accurate conclusions concerning the factors of evolution.

While natural environment does not furnish us with the best conditions for the solution of the problem, a study of the variability exhibited by two groups of *Chrysanthemum leucanthemum* (the common white daisy) has brought to light some facts of considerable interest.

In a comparison of two groups of 500 each, obtained on the same day from localities less than a mile apart, it was found that the group having the greater nourishment had the greater variability as measured by the "index of variability"

$$\left(\sqrt{\frac{\Sigma(x^2 f)}{n}}\right)$$

the "average deviation"

$$\left(\frac{\Sigma(x \cdot f)}{n}\right)$$

and the amplitude or range of variation. Thus the data obtained in this particular study suggest that the difference in variability is dependent on food supply, or, in other words, that chemical stimuli are one of the underlying factors producing variability. This is a conclusion that has been previously suggested but not definitely established by statistical methods.

It is evident that there is a need for further investigation in this direction on animals as well as plants, for only by the careful application of statistical methods can the fundamental principles of evolution be ascertained.

Kenyon College.

FURTHER FLORISTIC STUDIES IN WEST VIRGINIA.

W. A. KELLERMAN.

(*Abstract.*)

An account of a collecting trip through portions of Randolph and Webster Counties, especially in the Cheat and Point Mountains, with brief outline of the more conspicuous and interesting fungi—several of which are now reported for the first time.

ADDITIONAL INFECTION EXPERIMENTS WITH SPECIES OF RUSTS.

W. A. KELLERMAN.

(*Abstract.*)

General report of artificial cultures of Rust stages, both heteroecious and autoecious species, continuation of work reported the previous year. Over twenty species were used and inoculations of a very large number of host-plants were attempted. The experiments numbered nearly two hundred. In nine cases positive results were obtained—some being repetitions of previous successful experiments, others showing connections not previously known.

Of the latter it was shown that the Black Rust (Puccinia muhlenbergiae Arth.) on the common Muhlenberg Grass (Muhlenbergia mexicana) was the alternate stage of the Yellow Cluster-cup fungus (Aecidium hibisciatum Schw.) on the Marsh Mallow (Hibiscus moscheutos).

Cultures with the Black Rust (Puccinia cirsii-lanceolati Schroet.) of the Common Thistle (Carduus lanceolatus L.) resulted in the development of aecidia or Yellow Cluster-cup stage (as well as the red and black spores) but this has not before been reported in this country. The Rust has heretofore been called Piccinia cirsii Lasch, but the experiment showed it to be P. cirsii-lanceolati, a species described in Europe several years ago by Schroeter.

In a similar manner it was proven that the Western Sage Rust (Puccinia caulicola Tr. & Gall. on Salvia lanceolata)—material for cultures received from Kansas in the early spring (sent by Mr. E. Bartholomew)—has a hitherto unrecorded aecidial stage on the same host plant.

Cultures demonstrated experimentally for the first time the auteu-puccinial character of the Rust of Ruellia. That is to say, all of the four stages grow on one and the same host.

The paper is published in full in the December number of the *Journal of Mycology*. A summary of the successful cultures may be briefly stated thus, it being understood that the teleuto-spores (black or winter spores) were used when sowings were made on the host plants, and, in case of Puccinia lateripes, aecidiospores, also :

Puccinia angustata (on Scirpus atrovirens)—aecidia on Lycopus americanus.

Puccinia caulicola (on Salvia lanceolata)—aecidia on Salvia lanceolata.

Puccinia caricis-erigerontis (on Carex festucacea)—aecidia on Leptilon canadensis.

Puccinia caricis-solidaginis (on Carex stipata)—aecidia on Solidago canadensis.
Puccinia cirsii-lanceolati (on Carduus lanceolatus)—aecidia on Carduus lanceolatus.
Puccinia helianthi (on Helianthus mollis)—aecidia on Helianthus annuus and H. mollis.
Puccinia hibisciata (on Muhlenbergia mexicana)—aecidia on Hibiscus moscheutos and H. militaris.
Puccinia lateripes (on Ruellia strepens)—aecidia, etc., on Ruellia strepens.
Puccinia subnitens (on Distichlis)—aecidia on Chenopodium album.

ON THE OCCURRENCE OF FOSSOMBRONIA CRISTULA IN OHIO.

Edo Claassen.

This beautiful liverwort reported, so far as the writer knows, by Underwood from New Jersey only (Gray's Manual, 6th Ed.), occurs in numberless specimens, often associated with Dicranella heteromalla Schimp., on a clayey field southwest of Brookside Park in Brooklyn Township, Cuyahoga County, Ohio.

Although very small in size it is easily identified by its peculiar thallus and more or less dark purple rhizoids. The description of it in Gray's Botany should, however, be corrected since the pedicel of the capsule when ripe surpasses the thallus consideraby and the elaters contain one or two (mostly two) spirals.

One specimen was examined more closely as to its dimensions, and was found to be as follows:

1. Length of longest rhizoid, 1.36 mm.
2. Length of "rooting" part (broken off at end), 1.36 mm.
3. Height of plant from uppermost rhizoid on the horizontal stem to the top of the split capsule, about 5.1 mm.
4. Height of plant from uppermost rhizoid to top of thallus, 2.64 mm.
5. Length of pedicel (about 0.25 mm. thick) above the thallus, 1.36 mm.; or of entire pedicel from its origin, 3.4 mm.
6. Capsule (split and by depression expanded), height and width, about 1.1 to 1.2 mm. Capsules of other specimens (not split but ripe and globular in shape), diameter about 0.34 to 0.90 mm.
7. About a dozen spores were measured. Their diameter was between 0.044 and 0.048 mm.

Cleveland, Ohio.

REPORT FOR 1902 ON THE STATE HERBARIUM INCLUDING ADDITIONS TO THE STATE PLANT LIST.

W. A. KELLERMAN and O. E. JENNINGS.

There have been added to the State Herbarium, since the last report was made, 876 specimens of the Flowering plants and Ferns. The contributors and number of specimens contributed by each are as follows :

Bonser, Thos. A.	17	Louth, E. V	2
Burr, Harriet G	37	Mark, Clara	1
Case, Mrs. T. W	2	Mead, Chas. S	5
Clayton, W. M	1	Minns, E. R	92
Coberly, E. D	2	Morris, E. L	1
Coberly, E. D., and Long, J. Paul	5	Moseley, E. L	21
Hacker, Otto	70	Norman, L. M	3
Hopkins, L. S	1	Schaffner, J. H	9
Horlacher, S. E	171	Sharp, Mrs. K. D	3
Ingold, C. P	33	Shafer, John G	1
Jennings, O. E	211	Tyler, F. J	6
Kellerman, W. A	121	Wetzstein, A	54
Total			871

The number of specimens of the Flowering plants and Ferns in the State Herbarium at the close of 1901 was reported last year as 19,219. The addition of 871 specimens thus makes a total of 20,090 mounted specimens at the close of the year 1902. Species new to the State List and not previously reported in the Annual Reports of the Ohio State Academy of Science nor in the State Catalogue are as follows :

118*b*. Miscanthus sinensis Anders. (Eulalia japonica Trin.) Chinese Eulalia. Painesville, Lake Co. Otto Hacker.

124*a*. Paspalum muhlenbergii Nash. Muhlenberg's Paspalum. Sandusky, Erie Co. W. A. Kellerman.

366*a*. Carex gynandra Schw. Nodding Sedge. Buckeye Lake, Perry Co. W. A. Kellerman.

621*a*. Salix pentandra L. Bay Leaf Willow. Bridgeport, Belmont Co. W. A. Kellerman.

752*a*. Amaranthus lividus L. Purplish Amaranth. Montgomery Co. S. E. Horlacher.

805*a*. Nymphaea variegata Englem. Spatter Dock. Sandusky Bay, Erie Co. E. L. Moseley. Previously reported as N. advena but specimens sent to Gerrit S. Miller at Washington were verified as N. variegata Engelm.

890*a*. Coronopus didymus (L.) J. E. Smith. Lesser Wart Cress. Painesville, Lake Co. Otto Hacker.

924*a*. Sophia intermedia Rybd. Western Tansy Mustard. Troy, Miami Co. L. S. Hopkins.

990*a*. Rubus baileyanus Britt. Bailey's Blackberry. Painesville, Lake Co. Otto Hacker.

997*a*. Potentilla sulphurea Lam. Rough-fruited Cinquefoil. Painesville, Lake Co. Otto Hacker.

1004*b*. Potentilla reptans L. Creeping Potentilla. Painesville, Lake Co. Otto Hacker.

1120*a*. Vicia tetrasperma (L.) Moench. Slender Vetch. Painesville, Lake Co. Otto Hacker.

1127*a*. Lathyrus pratensis L. Yellow Vetchling. Painesville, Lake Co. Otto Hacker.

1131*a*. Phaseolus nanus L. Bush Bean. St. Mary's, Auglaise Co. A. Wetzstein.

1143*a*. Oxalis brittoniae Small. Britton's Oxalis. Painesville, Lake Co. Otto Hacker.

1143*b*. Oxalis rufa Small. Red Wood-Sorrel. Painesville, Erie Co. Otto Hacker.

1172*b*. Euphorbia exigua L. Common European Spurge. Painesville, Erie Co. Otto Hacker.

1260*b*. Viola palmata dilatata Ell. Painesville, Lake Co. Otto Hacker.

1262*a*. Viola papilionacea Ph. Hooded Blue Violet. Springfield, Clark Co. Mrs. E. J. Spence and others. This had been previously reported as V. cucullata Ait., but according to Mr. L. C. Pollard it is V. papilionacea Ph.

1287*a*. Lythrum salicaria L. Spiked Loosestrife. Painesville, Lake Co. Otto Hacker.

1344*b*. Scandix pecten-veneris L. Shepherd's Needle. Painesville, Lake Co. Otto Hacker.

1405*a*. Lysimachia vulgaris L. Golden Loosestrife. Painesville, Lake Co. Otto Hacker.

1415*a*. Ceratostigma plumbaginoides Bunge. Painesville, Lake Co. Otto Hacker.

1423*c*. Erythraea centaurium (L.) Pers. Lesser Centaury. Painesville, Lake Co. Otto Hacker.

1619*a*. Penstemon cobaea Nutt. Cobaea Beard Tongue. Painesville, Lake Co. Otto Hacker.

1691*a*. Galium mollugo L. European Bedstraw. Painesville, Lake Co. Otto Hacker.

1775*b*. Crepis virens L. Smooth Hawksbeard. Painesville, Lake Co. Otto Hacker.

2023*a*. Centauria scabiosa L. American Star Thistle. Painesville, Lake Co. Otto Hacker.

NOTES ON SOME RARE OR INTERESTING OHIO PLANTS.

OTTO E. JENNINGS.

(*Abstract.*)

Specimens were shown and notes given upon a few of the more rare or interesting plants represented in the Ohio State Herbarium. The specimens shown and the distribution in Ohio thus far indicated by specimens in the State Herbarium, together with other data, are as follows:

Asplenium ruta-mararia L. Spleenwort. Clifton, Greene Co. A. E. Cotes, 1896. Range—Vt. and Conn. to Mich., Mo. and Ala. Also Europe and Asia.

Asplenium montanum Willd. Mountain Spleenwort. Cuyahoga Falls, Summit Co. L. B. Tuckerman. Range—Conn. to N. Y., Ohio and Ga.

Scutellaria serrata Andr. Showy Skullcap. Rio Grande, Gallia Co. Miss Ruth Brockett. Range—N. Y., Pa. and N. C. to Ill. and Ky.

Teucrium occidentale Gr. Hairy Germander. Buckeye Lake, Perry Co. W. A. Kellerman, 1895. Painesville, Lake Co. Otto Hacker, 1901. Cedar Point, Erie Co. W. A. Kellerman, 1903. Range—Ont. and Pa. to N. M., Cal. and Brit. Col.

Cornus canadensis L. Dwarf Cornel. Newark, Licking Co. W. W. Stockberger, 1890. Canton, Stark Co. Mrs. T. W. Case, 1899. Range—Newf. to Alaska. N. J., Ind., Minn. and Cal.

Nelumbo lutea (Willd.) Pers. American Lotus. Licking Reservoir. E. E. Bogue, 1892. At Sandusky and westward along the Lake; see Moseley's "Sandusky Flora." Range—Ont. to Mass., Minn., Fla. and Tex.

Eryngium aquaticum L. Button Snakeroot. Oxford, Erie Co. E. L. Moseley, 1896. Wyandot Co. Thos. A. Bonser, 1902. Range—Conn. to S. Dak., Fla., Kans. and Tex.

Opuntia humifusa Raf. Western Prickly Pear. Sandusky, Erie Co. E. Claassen, 1891. Range—S. Dak. to Ky., Mo., Kans. and Tex. Also local in Ind. and Mich.

SHORE LINE TOPOGRAPHY BETWEEN TOLEDO AND HURON, OHIO.

LEWIS G. WESTGATE.

(*Abstract.*)

This paper gave a description of the shore line topography along the flat southern shore of western Lake Erie with an account of the development of bars across Maumee and Sandusky bays and at Catawba Island. This region is an illustration of a very young shore.

Ohio Wesleyan Univ.

THE CATALOGUING OF MUSEUM COLLECTIONS.

L. B. Walton.

The system by which specimens are catalogued in most museums of natural history is open to criticism. Insufficient data concerning the collections are buried in bulky volumes or files to such an extent that one may usually be considered fortunate if after a period of several hours the locality and date of collection of a specimen can be ascertained. Notes concerning the name of the person by whom the specimen was identified, date of identification, etc., are rarely present. The task of a systematist wishing to find the material in a given museum belonging to a particular group (phylum, class, etc.), or obtained from a given locality (country, state, etc.) is usually a most difficult and oftentimes an impossible one.

The use of the card index system, the value of which was long since recognized in business methods, will go far toward obviating the difficuties mentioned. A standard card of 4 x 6 inches has proved to be the most servicable. Following a chronological order the data which should be rendered accessible in an adequately catalogued collection, can be separated into three groups. These are :

(a) *The Accession Catalogue*, arranged numerically, containing a general record of all material received as whole. Consequently one accession card usually covers a large number of specimens.

(b) *The Department Catalogue*, arranged numerically, giving a complete history of each specimen or group of specimens (of a given species) acquired by each department (Zoology, Botany, Anthropology, etc.).

(c) *The Reference Catalogue*, arranged alphabetically, having the names of all specimens (genus and species in Zoology and Botany) in a given department at the top of the card.

The final disposition of each specimen is indicated, consequently it is an easy matter to at once locate any desired material.

While the Department Catalogue is the principal one, the other two are important and represent a comparatively small amount of labor, inasmuch as a single card contains data for a large number of specimens. Classification of material into groups (e. g., Protozoa, Porifera, etc., in Zoology) can be indicated by using cards with appropriate tabs in different positions, while geographical distribution can be represented, if desired, by different colored cards.

Kenyon College.

ON DIPTERA OF THE FAMILY EPHYDRIDAE.

JAMES S. HINE.

The literature on this family, so far as North American forms are concerned, is accessible to most students. In Monograph of N. A. Diptera, 1862, I, 129–172, and in Zeitschr. f. d. Ges. Naturw., 1878, LI, 192–203, Loew gives the results of his studies. In Berliner Entom. Zeitschrift, 1896, XLI, 91–276, Becker fully treats the European species, and it is necessary to refer to this work for a consideration of the species common to the two countries. Williston has described a number of species in North American Fauna, 1893, VII, 257–258, and in Diptera of St. Vincent, 1899, 389–404. The same author furnishes a contribution to the life history of one of the species and describes the adult of Ephydra californica Packard in Trans. Conn. Acad., 1883, VI, 83–86. Coquillett has published several papers in which new genera and species are described as follows: Ent. News, 1896, VII, 220; Can. Entom., 1899, XXXI, 8; Diptera of Puerto Rico, 1900, 259–262; Can. Entom., 1900, XXXII, 33–36; Diptera from the Harriman Alaska Expedition, 1900, 461–462; Journal N. Y. Ent. Soc. 1902, X, 182–184. Wheeler has reviewed the genus Octhera and described one new species in Ent. News, 1896, VII, 121–123. Howard has given a full account of Psilopa petrolei Coquillett, found breeding in crude petroleum in California, in Scientific American, 1899, LXXX, 75–76.

One who collects Diptera in marshes or along streams is likely, sooner or later, to become interested in the numerous species of this family. Among the various water plants that grow in the marshes at Sandusky, one finds them plentiful, and some of the forms are the most numerous of all insects during at least a part of the summer. From a row-boat one can see them running over lily pads, wild rice and other foliage, but they are difficult to capture, since they are very active and fly away before the cyanide bottle can be placed over them, or if one uses a net he has to strike so low that it is almost impossible to prevent dipping it in the water, and by so doing spoil the specimens he succeeds in entrapping. After a little experience the collector is led to realize that the specimens running over foliage are trifling with him. Better results may be obtained by collecting from flowers of water lilies. Locate one of these flowers and place the hand gently over its top in such a way as to entrap the flies that are feeding on its nectar; then without gripping tightly enough to crush the flower and with it the entrapped insects, pull it from its peduncle and drop into a wide-mouthed cyanide bottle prepared for the purpose. This is the most desirable method I have ever tried for procuring a supply of fine specimens of the small Diptera common in marshes.

The best of results in collecting Ephydrids may be obtained by sweeping grasses in low ground in the vicinity of water, or along the margin of streams, but specimens procured in this way are apt to be teneral and not so desirable as those taken from flowers.

DICHAETA Meigen.

There are three descriped North American species in this genus. Two of them, caudata and brevicauda, are distinguished from species of Notiphila by the uniform dark color of the body, but not so with furcata which has the abdomen distinctly bicolored. The males of all the species are characterized by the elongated bristles at the tip of the abdomen. The following key is offered for separating the species of the genus :

1. Abdomen uniformly dark, nearly black in color — 2.
   Abdomen bicolorous — *furcata* Coq.
2. Last segment of male abdomen distinctly prolonged into a conical point — *caudata* Fallen.
   Last segment of male abdomen not noticeably prolonged — *brevicauda* Loew.

NOTIPHILA Fallen.

This genus is represented in Ohio by a number of species. N. unicolor Loew is probably the most abundant species of insect to be found at Sandusky during a part of the summer. The eggs of this species are deposited on various leaves over the water, and so abundant are they at times that large areas of wild rice and other plants are colored white by them. Oviposition seems to take place mostly in the evening and in egg-laying season the flies collect on the plants by thousands, so that one in a row-boat at dusk may see water plants almost entirely covered by them. The adults are most abundant in July. When the eggs hatch the larvae drop into the water and sink to the bottom.

PSILOPA FULVIPENNIS n. sp.

Shining black or violaceous. Antennea red, except the third segment, which is partially fuscus, thorax and abdomen deep shining black with a violaceous tinge, legs black with the exception of the knees, apexes of the tibiae, and the tarsi, which are red. Wings uniformly brownish yellow all over, knob of halteres yellow. Length slightly under 2.5 millimeters.

Habitat: Three specimens procured at Cameron, Louisiana, August 20. Taken by sweeping from grasses growing in low ground.

The uniform brownish yellow wings, together with the shining black thorax and abdomen characterize this species.

CAENIA R. D.

1.	Wings fumid	2.
	Wings grayish hyaline	3.
2.	Legs red, abdomen uniformly colored	*spinosa* Loew.
	Legs black, abdomen with greenish gray cross-bands	*fumosa* Stehn.
3.	Wings uniform grayish hyaline, knees of all the legs plainly red, abdomen green, segments three to five with a middorsal row of bronze triangles, length, 6 millimeters	*virida* n. sp.
	Wings grayish hyaline with marginal cell dark gray, abdomen greenish with broad bases of last three segments violet bronze, length 4 millimeters	*bisetosa* Coquillett.

CAENIA FUMOSA Sten.

This is a European species, and so far as I can find has not been reported from this country heretofore. The seven specimens before me, taken at Castalia, Ohio, July 13, 1901, agree so well with the description of fumosa given by Schiner, and are so readily traced to this species by Becker's key, that I do not hesitate to identify them as such.

CAENIA VIRIDA n. sp.

General color dark green, thinly yellowish and gray pruinose. Antennae clear brown, arista rather long pectinate above on median third, hairy on basal part, proboscis dark nearly black, face and cheeks rather densely yellowish pruinose except on upper part where the green ground color is distinct, clothed with rather short black hairs, bristles of the oral border distinct; front green shining, with two pairs of orbital bristles, dorsum of thorax green, thinly yellowish pruinose and with five pairs of dorsocentral bristles, pruinosity of the pleura dense obscuring the ground color, scutellum green shining with two pairs of bristles, legs black except the knees which are narrowly but plainly red, wings uniformly grayish hyaline, veins brown, halteres yellow; abdomen shining green thinly gray pruinose, a middorsal row of bronze triangles on segments three to five and suggestions of bronze on the anterior margins of the sides of the same segments, two to four nearly equal in length, five much longer. Length 6 millimeters.

Habitat: Brownsville, Texas.

Several specimens collected by Charles Dury of Cincinnati in April and May, 1903.

THE BIRDS OF OHIO.

Quite recently a neat volume under the above title has appeared. The work contains 671 quarto pages; the author is William Leon Dawson, A. M., with introduction and keys by Professor Lynds Jones, of Oberlin College. The subject of Ohio birds is fully treated both from technical and popular standpoints, consideration being given to nesting habits, recognition marks and distribution of each species. Many of the species are represented by plates made after the tricolor process of photography, and besides over 200 first-class halftones add to the value and interest of the work. Most of the photographs from which the halftones were made are the author's own, but it is also a pleasure to note that a number of credits are given for photographs furnished by many others, some of whom are or have been students at the university. The volume will surely be an important factor in stimulating the study of Ornithology in Ohio and elsewhere. With the work which Professor Jones has recently done and published in a special paper of the Ohio State Academy of Science, the bird fauna of the State is so thoroughly known that it is not probable that many new records of species will be added. As careful keys have been prepared for all the species taken so far, the Ohio student has in "The Birds of Ohio" a monograph to which he can turn for satisfaction in all local matters concerned with the subject treated. The author has treated the species beginning with what are known as the highest birds, an arrangement which does not seem quite natural, but as he gives good reasons for so doing we do not feel like taking exceptions to the order adopted. The Northern Raven on account of his shrewdness and dignity is a splendid subject with which to begin so important a work.

For particulars regarding the work, address THE WHEATON PUBLISHING CO., 1216 The Hayden, Columbus, O.—J. S. H.

A PRACTICAL DISSECTING TRAY.

L. B. WALTON.

Various kinds of dissecting trays have been described by Hatschek and Cori, Kükenthal, Dodge, Pratt, Mark, Kellogg and others, all of which, however, are more or less unsuited to general conditions of laboratory work.

A tray which apparently meets all requirements can be made by selecting a suitable china dish, attaching the cloth called "cotton wool" or "cotton flannel" to the bottom, with the smooth side down, by means of Le Page's glue, and pouring in a mixture of melted beeswax and lampblack. The glue should previously be allowed to dry at least twelve hours. Furthermore, the dish should be heated slightly above the melting point of the beeswax before the wax is poured in, and then allowed to gradually cool before an open-front gas stove, thus allowing the bottom layers of the wax to harden first. This prevents the separation of the wax from the side of the dish as well as the formation of cracks on the surface. Trays such as described have been in use in the laboratory at Kenyon College for more than a year, and have been found practical in every respect.

Kenyon College.

THE THICKNESS OF THE COLUMBUS LIMESTONE.

Robert F. Griggs.

So far as is known there is no exposure of the total thickness of the Columbus limestone. On account of its lithological similarity to the Monroe limestone below, the two are not usually separated in well records so that exact determinations from this source have been hard to get.* In the fall of 1900, however, the city of Columbus, in connection with a proposed storage dam in the Scioto River, drilled several wells into the rock to test its ability to withstand hydraulic pressure. Most of these were at such high levels on the bank that they did not penetrate to the Monroe. Two, however, Nos. 9 and 10, were drilled from near the surface of the river and passed several feet below the base of the Columbus. No. 10 was located on the west bank, which is steep at that point. It was thought that by taking the section of this well and that of the bank the whole thickness of the Columbus could be obtained. The well was not driven in the ordinary manner, where the rock is broken into bits by a heavy drill and so mixed that the precise determination of any level is impossible, but a solid core was taken out, which broke only at the bedding planes and weak places. This core, together with a very complete record, are preserved in the City Engineer's office. It allows the determination of the line between the two formations to a fraction of an inch and the measurements throughout are much more accurate in the boring than those of the bank, which were taken with a Locke level, and so not susceptible of great accuracy.

The rock in the bank above is mostly covered, but fortunately a small quarry has been opened at the top of the hill which shows the top of the smooth layer. The quarry does not extend up to

*The well in the State House yard at Columbus, as interpreted by Newberry, shows a thickness of 138 feet for the Corniferous, which includes both Columbus and Sandusky formations. The upper component is shown to have a thickness of about 30 feet by numerous exposures in Franklin and Delaware Counties. Deducting this leaves a thickness of 108 feet for the Columbus. Unfortunately, however, the record of this well has been found to be unreliable in some particulars and so is of scant authority in this case.

the bone bed or top of the formation. As the quarry is at about the top of the hill it is probable that this bed has been carried away for some feet back from the brow of the bluff into the field. It might be wished that this layer were present to give a more certain determination, but as the interval between the smooth layer and the bone bed is fairly constant the presence of the latter is not so important as would appear at first.

The sections of the hill and well are given in the tables. It will be seen that the total thickness of the Columbus exposed is 109 feet. Assuming an interval between the bone bed and smooth bed of 9 feet (an inch or two less than that shown in the quarries a mile and a half below the dam site), we would have a thickness for the formation of 110 feet, thus checking to within 2 feet of the determination from the State House yard well.

Section of Bank.	Feet.	In.	Total Feet.	Total In.
To bone bed (not exposed)	? 1	2	126	2?
Top of quarry, no sign of bone bed	..	..	125	..
Upper Columbus exposed in quarry	8	..	...	..
Smooth layer	..	..	117	..
Quarry extends a few inches below smooth layer	..	..	...	..
Mostly covered, occasional ledges exposed to river level	64	..	53	..
Section of Well.				
Gravel and soil	2	..	55	..
River level	..	..	53	..
Gravel and soil to top of rock	2	7	53	..
Heavy bedded some layers come out more than 2 feet thick	24	8	50	5
Thin bedded much waste in core	7	2	25	9
Heavy porous breccia, base of Columbus	2	4	18	7
Hard course with dark bands top of Monroe	..	8	16	3
Mostly thin bedded, dark	3	10	15	7
Purer limestone	..	9	11	9
Dark thin bedded resisting acid	1	..	11	..
White, purer stone	..	9	10	..
Heavy bedded	1	9	9	3
Dark, very hard resisting acid	..	6	7	6
Hard, heavy, dark stone with little waste	7	..	7	..

The determination is subject to the following sources of error: 1, waste in the core of the well which would have the effect of making the base of the Columbus too high with a maximum value of 2 inches; 2, a variation in the level of the water between the time of boring the well and that of measuring the hill amouning to possibly 6 inches in the other direction; 3, errors in leveling amounting to possibly 3 feet either way; the city contour maps check the leveling and preclude the possibility of greater error, *i. e.*, the top of the quarry lies between two contour lines having a five foot interval; 4, variation in the interval between the smooth bed and bone bed with a probable maximum of 8 inches.

Fargo, N. D.

POISONOUS AND OTHER INJURIOUS PLANTS OF OHIO.

JOHN H. SCHAFFNER.

(Continued from p. 35.)

130. Oxalis violacea L. Violet Wood-sorrel. A case is recorded of a boy being thrown into violent convulsions from eating a considerable quantity of the leaves. The leaves and bulbs are very commonly eaten by children in large quantities without apparent ill effects.

131. Linum usitatissimum L. Flax. Causes death to cattle, probably due to the prussic acid evolved from the plant when wilting.

132. Ailanthus glandulosa Desf. Tree-of-heaven. Has a disagreeable and somewhat poisonous emanation. Water contaminated by the leaves is poisonous. Cows will not eat grass near the young shoots.

133. Polygala senega L. Seneca Snakeroot. The roots are emetic.

134. Ricinus communis L. Castoroil Plant. Seeds contain a deadly poison. Poisonous to horses, sheep, etc.

135. Euphorbia corollata L. Flowering Spurge. Supposed to produce disagreeable honey. Posionous to the skin of some persons.

136. Euphorbia marginata Ph. Snow-on-the-mountain. Produces disagreeable honey. Poisonous to the skin of some persons. Used for branding cattle.

137. Euphorbia lathyrus L. Caper Spurge. The seeds are poisonous when eaten. The milky juice is emetic and produces eruptions on the skin.

138. Euphorbia cyparissias L. Cypress Spurge. Poisonous to the skin.

139. Rhus vernix L. Poison Sumac. Swamp Sumac. (R. venenata DC.) The poison is in all parts of the plant. Poisonous to the skin of most persons.

140. Rhus radicans L. Poison Ivy. (R. toxicodendron L.) The leaves and stems are poisonous to the skin of most persons.

141. Celastrus scandens L. Climbing Bitter-sweet. Leaves poisonous to horses.

142. Aesculus glabra Willd. Ohio Buckeye. Leaves and young shoots and seeds poisonous to cattle.

143. Aesculus octandra Marsh. Sweet Buckeye. Plant pro ably poisonous. Seeds poisonous.

144. Aesculus hippocastanum L. Horse-chestnut. The seeds are poisonous. Symptoms of poisoning have been produced by eating the green rind.

145. Impatiens biflora Walt. Spotted Touch-me-not. Leaves acrid and burning to the taste. The plant is emetic and suspected of being poisonous to stock.

146. Rhamnus cathartica L. Buckthorn. Ripe fruit injurious.

147. Hypericum perforatum L. Common St. John's-wort. Poisonous to horses.

148. Hypericum maculatum Walt. Spotted St. John's Wort. Poisonous to horses.

149. Viola odorata L. Sweet Violet. Somewhat poisonous. Underground parts emetic and cathartic.

150. Dirca palustris L. Leatherwood. Berries narcotic and poisonous. Bark acrid.

151. Chimaphila maculata (L.) Ph. Spotted Wintergreen. Supposed to be poisonous to sheep.

152. Monotropa uniflora L. Indian Pipe. Contains a poisonous principle.

153. Ledum groenlandicum Oedr. Labrador Tea. Is supposed to be poisonous.

154. Azalea nudiflora L. Pink Azalea. Supposed to produce poisonous honey.

155. Azalea viscosa L. White Azalea. Supposed to produce poisonous honey.

156. Azalea lutea L. Flame Azalea. Supposed to produce poisonous honey.

157. Rhododendron maximum L. Great Laurel. Poisonous to stock. The nectar produces a poisonous honey.

158. Kalmia angustifolia L. Sheep Laurel. Lambkill. Poisonous to sheep and calves.

159. Kalmia latifolia L. Mountain Laurel. Calico-bush. All parts of the plant poisonous to cattle, sheep and other animals. The honey from the flowers is poisonous; also the flesh of game that has fed upon the leaves or berries.

160. Andromeda polifolia L. Wild Rosemary. Moorwort. Leaves poisonous to sheep.

161. Epigaea repens L. Trailing Arbutus. Supposed to be poisonous to stock.

162. Anagallis arvensis L. Poor-man's Weatherglass. Red Pimpernell. Poisonous.

163. Ligustrum vulgare L. Privet. Leaves and fruit poisonous to children; probably also to animals.

164. Menyanthes trifoliata L. Buckbean. The taste of the leaves is intensely bitter and somewhat nauseous.

165. Apocynum androsaemifolium L. Spreading Dogbane. Poisonous, although animals generally avoid it because of the acrid juice.

166. Apocynum cannabinum L. Indian Hemp.

167. Apocynum hypericifolium Ait. Clasping-leaved Dogbane. The above three plants are slightly poisonous.
168. Nerium oleander L. Oleander. Cultivated. Every part of this plant is dangerously poisonous. Leaves deadly poisonous to stock.
169. Asclepias tuberosa L Pleurisy-root. Leaves supposed to be poisonous to stock.
170. Ascelpias incarnata L. Swamp Milkweed. The root is emetic and cathartic.
171. Asclepias syriaca L. Common Milkweed. (A. cornuti Dec.) Poisonous.
172. Ipomaea pandurata L. Wild Potato Vine. Man-of-the-earth. Underground parts somewhat poisonous.
173. Convolvulus sepium L. Hedge Bindweed. Supposed to be poisonous to swine.
174. Cynoglossum officinale L. Hound's Tongue. Considered poisonous.
175. Cynoglossum virginicum L. Wild Comfrey. Considered poisonous.
176. Borago officinalis L. Borage. The short bristles produce irritation.
177. Echium vulgare L. Viper's Bugloss. Causes considerable itching if handled.
178. Glecoma hederacea L. Ground Ivy. Suspected of being poisonous to horses.
179. Hedeoma pulegioides (L.) Pers. American Peneroyal. A case of poisoning by oil of Hedeoma has been recorded.
180. Physalodes physalodes (L.) Britt. Apple of Peru. Used in Georgia for fly poison.
181. Solanum nigrum L. Black Nightshade. The leaves and green berries are poisonous to calves, sheep, goats and swine. The green berries are also poisonous to man, but the writer has seen boys eating large quantities of the ripe berries without ill effects.
182. Solanum carolinense L. Horsenettle. Narcotic.
183. Solanum dulcamara L. Bittersweet. Berries poisonous; also other parts. Leaves supposed poisonous to stock.
184. Solanum tuberosum L. Potato. The green parts, fruit and green-colored tubers are poisonous; also white sprouts from mature potatoes. The poison is dissolved out by boiling.
185. Nicotiana tabacum L. Tobacco. Cultivated. Narcotic and poisonous. Leaves poisonous to stock.
186. Hyoscyamus niger L. Black Henbane. Narcotic. Poisonous to stock, and is said to poison hogs. One of the most poisonous plants in the United States. It is called henbane on account of seed being poisonous to chickens.

187. Datura stramonium L. Jimson-weed. All parts narcotic and poisonous, especially the seed. Children frequently poisoned by eating the seeds, and occasionally by sucking the flowers. Poisonous to cattle, when eaten in hay.

188. Datura tatula L. Purple Jimson-weed. Poisonous like the preceding.

189. Verbascum thapsus L. Common Mullen. Said to be injurious to the skin of some persons.

190. Digitalis purpurea L. Purple Foxglove. Poisonous to horses.

191. Gerardia tenuifolia Vahl. Slender Gerardia. Poisonous to sheep and calves.

192. Pedicularis lanceolata Mx. Swamp Lousewort. Probably poisonous.

193. Pedicularis canadensis L. Lousewort. Wood Betony. Probably poisonous.

194. Catalpa catalpa (L.) Karst. Catalpa. The flowers are said to produce irritation of the skin.

195. Aralia spinosa L. Hercules Club. Irritating to the skin.

196. Conium maculatum L. Poison Hemlock. The plant contains a virulent, narcotic poison. The whole plant, especially the seed, is very poisonous to man and animals.

197. Petroselinum petroselinum (L.) Karst. Parsley. The seeds are injurious to birds. A case of the poisoning of several parrots from eating of this plant has been reported.

198. Cicuta bulbifera L. Bulb-bearing Water Hemlock. Supposed to be very poisonous.

199. Cicuta maculata L. Water Hemlock. The whole plant is violently poisonous, both to man and animals. Has destroyed many human lives.

200. Sium cicutaefolium Gmel. Hemlock. Water Parsnip. Reputed to be poisonous to stock.

201. Aethusa cynapium L. Fool's Parsley. A fetid poisonous herb.

202. Oxypolis rigidus (L.) Britt. Cowbane. (Teidmannia rigida C. & R.) Poisonous. Leaves and roots supposed to be poisonous to cattle.

203. Pastinaca sativa L. Parsnip. Persons are often poisoned by handling the plant, which causes inflammation and vesication.

204. Heracleum lanatum Mx. Cow Parsnip. Supposed to be poisonous, although the crisp leaves are said to be very palatable. The West Coast Indians eat the plant as a relish.

205. Daucus carota L. Wild Carrot. Persons handling the plant are often poisoned, especially when the plant is wet with dew. Causes large blisters to form.
206. Cornus florida L. Flowering Dogwood. The berries are reputed to be poisonous.
207. Cephalanthus occidentalis L. Button-bush. Contains a poisonous principle.
208. Lobelia cardinalis L. Red Lobelia. Cardinal Flower.
209. Lobelia syphilitica L. Blue Lobelia.
210. Lobelia puberula Mx. Downy Lobelia.
211. Lobelia spicata Lam. Pale Spiked Lobelia.
212. Lobelia leptostachys A. DC. Spiked Lobelia. All the above acrid and poisonous.
213. Lobelia inflata L. Indian Tobacco. Very poisonous, narcotic and acrid.
214. Lobelia kalmii L. Kalm's Lobelia.
215. Lobelia nuttallii R.&S. Nuttall's Lobelia. Both the above acrid and poisonous.
216. Ambrosia artemisiaefolia L. Roman Ragweed. The pollen has an irritant action upon the muceus membranes; cause of hay fever.
217. Xanthium spinosum L. Spiny Clotbur. The seeds and probably the whole plant poisonous.
218. Xanthium strumarium L. European Cocklebur. Young seedlings and seeds probably poisonous to hogs.
219. Xanthium canadense Mill. American Cocklebur. Young seedlings poisonous to hogs.
220. Eupatorium perfoliatum L. Boneset. Emetic in large doses.
221. Rudbeckia laciniata L. Tall Cone Flower. Supposed to be fatal to sheep and hogs.
222. Bidens frondosa L. Black Beggar-ticks. Produces an itching sensation to some persons.
223. Helenium autumnale L. Sneezeweed. Plant and also flowers poisonous to cattle, sheep and horses.
224. Helenium nudiflorum Nutt. Purple-head Sneezeweed. Poisonous.
225. Helenium tenuifolium Nutt. Slender-leaf Sneezeweed. Poisonous. Supposed to be fatal to horses and mules.
226. Anthemis cotula L. Mayweed. Will sometimes blister the skin. Has a disagreeable odor.
227. Artemisia absinthium L. Common Wormwood. The volatile oil of this plant is a violent, narcotic poison.
228. Arctium lappa L. Great Burdock. Produces an itching sensation to some persons.
229. Cichorium intybus L. Chicory. When fed in large quantities to dairy cattle it imparts a bitter flavor to the milk and butter.

NEWS AND NOTES.

Most of the papers and abstracts in this issue of the NATURALIST were read at the November meeting of the Ohio State Academy of Science. Others will appear in later numbers of the NATURALIST.

ERRATA.—In Prof. Griggs' "Notes on Interesting Ohio Willows" (Ohio Nat., 4:11) the following corrections should be made: p. 13, 37th line, for *distinct* read *distant*; p. 14, 13th line, for *nominal* read *normal*; p. 15, 36th line, for *hairy-like* read *hairy, like*.

During the past year the dandelion (Taraxacum taraxacum and T. erythrospermum) has been in bloom in the open every month from January to December. Other plants which are in bloom during the greater part of the year, at Columbus, are Alsine media, Lepidium virginicum, and Lamium amplexicaule.

Recently Mr. A. A. Eaton has written an interesting account of Equisetum laevigatum A. Br. (Fern Bull **11**:40). His observations agree with my own as I know this species in the west. The manuals, even the latest, say that the stems of this species are perennial, evergreen, the cones tipped with a rigid point. The aerial stems are annual and the cones do not have a point. Formerly in Kansas the plants growing on the prairie were burned off annually and the new aerial stems usually had the cones mature by the first of June. Either the description in our manuals of Braun's E. laevigatum is wrong or else we have to deal with a composite species as Eaton suggests.

Since all three forms of the prickly lettuce occur in Ohio, Lactuca saligna L. should be added to Miss Burr's Compass Plants of Ohio, Ohio Nat. **3**:333. J. H. S.

THE MOTH BOOK.—We have been interested in turning through the pages of this work, and delighted in using the plates for the determination of specimens. The author, Dr. W. J. Holland, and the publishers, Doubleday, Page & Co., deserve especial credit for producing so important a volume. As The Butterfly Book has stimulated the study of butterflies, so will The Moth Book stimulate the study of moths. The tricolor process of photography by which the plates are produced is very satisfactory for the particular group treated, the careful selection of specimens and their preparation is commendable, and the chapters on Life-history and Anatomy, and on Capture, Preparation and Preservation of Specimens are full enough for general usage. We predict that the book will be welcomed by high-school pupils, by teachers, by amateurs and by specialists.—J. S. H.

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THE TOPOGRAPHY AND GEOLOGY OF CLIFTON GORGE.

W. E. WELLS.

This gorge is located in Greene county, Ohio, about two miles from the town of Yellow Springs. It is made by the headwaters of the Little Miami river.

The beauty of the gorge is not surpassed by anything of a like nature in the State. It has been visited by thousands of pleasure-seekers from all the surrounding country, especially from the near-by cities of Dayton, Springfield and Xenia. Neither is this remarkable gorge unknown to the scientists of this and other states. In the gorge are found two quite rare plants—Ground Hemlock (Taxus canadensis), found nowhere else in the county, and Asplenium ruta-muraria, found nowhere else in the State.

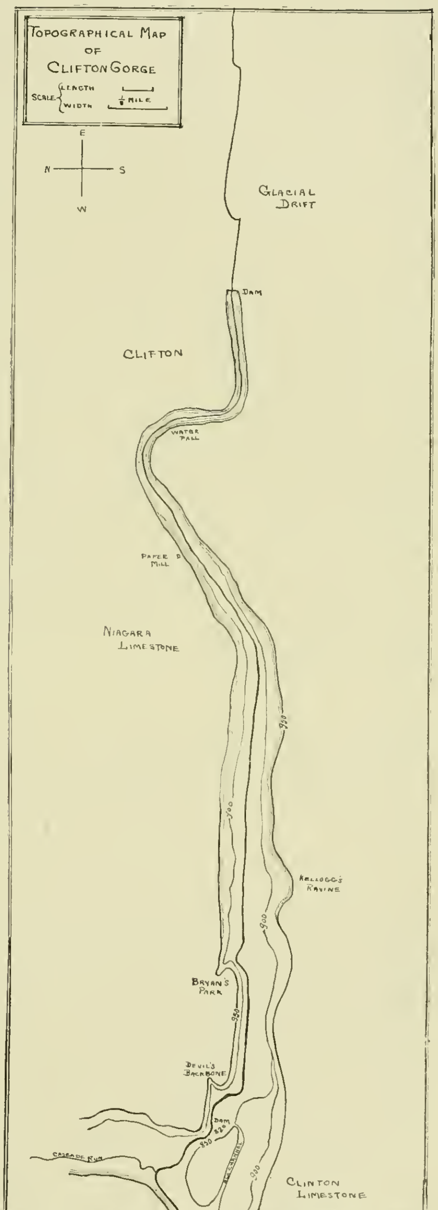
The origin of the gorge seems to be as follows: The headwaters of the Little Miami flow with an apparently gentle slope over the glacial drift, for some distance. At the town of Clifton, however, the drift thins out and the Niagara limestone comes to the surface. At the same time the slope increases, with the natural result that the river has hewn for itself a deep bed in the solid rock. This deep bed is the gorge.

At its beginning the gorge is very narrow, having an average width of about 40 feet. The average depth here is 34 feet. But as the stream proceeds the valley gradually widens. This is due to the fact that the Springfield division of the Niagara has been more easily eroded than the Cedarville division just above it; so that from time to time the latter has broken off. In proof of this we find the valley floor strewn with rock masses, most of them moss-covered, some of the largest with small trees growing on their upper surfaces. One large mass has lodged in mid-stream, and from its resemblance is called "Steamboat rock."

About three miles downstream a softer ridge (Clinton) is encountered, whereupon the valley becomes broader and the cliffs disappear for the most part. About a mile further down, the river passes through a still softer rock (Cincinnati limestones and shales). As a result the valley becomes very capacious, being one-fourth to one-half a mile wide.

FIG. 1. Looking down the Gorge towards the site of the old Woolen Mill, just above the Waterfall.

The slope of the river bed in the gorge was found to be about 35 feet to the mile. It is hardly necessary to add that this produces an abundant water power. Fifty years ago not much of this power was allowed to go to waste. In 1855 there were in the gorge alone five grist mills, one paper mill, one woolen mill, one saw mill and three distilleries. But as time went on these enterprises, one by one, were abandoned, until at the present time only two grist mills are left. The only reason that can be given for this failure to utilize so bountiful a supply of free power is that this particular locality has failed, generally, to meet the expectations of its first settlers. The town of Yellow Springs was laid out for a city of 10,000 inhabitants. It now has 1,300.



In the softer strata just under the overhanging cap rock, are some shaly seams. These act as water bearers, and as a result the gorge is well supplied with springs, some of considerable strength. They always appear at the base of the cliffs.

It is interesting to note in this connection that this same stratum furnishes the remarkable iron spring which has given the town of Yellow Springs its name.

The hard cap-rock (Cedarville) when burned makes excellent lime; and yet, in over two miles of exposure we found the remains of but two limekilns.

Not the least among the interesting things connected with a study of this gorge is the existence of an old abandoned channel. In 1876, Prof. Claypole, then a professor in Antioch College, worked out this channel very completely. The record of his work, unfortunately, is lost. All we know of his investigations is, that he dug into the channel to the depth of about 20 feet before reaching rock. At this depth the drill brought up a black, mucky soil, filled with old, dead leaves! The channel is located near the mouth of the gorge and is cut through Clinton limestone. Its length is about one-half mile, its average width 125 feet, and its present height above the river, 22 feet. This corresponds to the depth of Prof. Claypole's drilling. In fact, all the evidence goes to prove that this channel is preglacial and is now largely filled with drift. At the head of the channel a ravine has cut a deep trough, showing very nicely the character of the filling (boulder clay). The owner of the land upon which the channel is located says that at one time a large stump standing in the old channel turned over and in the course of a few months disappeared entirely. A few bluffs are to be seen at the lower end of the channel, giving additional proof of its origin.

Not long ago Prof. Bownocker worked out the history of this river, but unfortunately overlooked this old channel. He has traced, however, the old channel to within about a mile of this one. So that this discovery simply extends the course of some ancient river bed, whose course is being gradually mapped out.

A terrace with an average height of about 30 feet was found in the gorge. This would indicate, in the history of the present stream, a general upward movement of the crust, in times past.

The gorge itself is without doubt post-glacial.

NOTE: The topographical map which accompanies this sketch was made by Miss Alice Carr, Miss Gertrude Baker and Mr. R. O. Wead of the geology class of Antioch College.

Antioch College.

INDEX TO UREDINEOUS CULTURE EXPERIMENTS WITH LIST OF SPECIES AND HOSTS FOR NORTH AMERICA.

W. A. KELLERMAN.

(*Abstract.*)

Careful culture work to determine life histories of fungi or cycles of development was initiated by De Bary in 1865. It was continued by him in 1866 and in the same year also taken up by Oersted and Woronin. A few years later other foreign botanists engaged in similar work, and the list continued to the present contains such additional names as Schroeter, Rostrup, Winter, Schenk, Cornu, Plowright, Klebhan, Hartig, Dietel, Barclay, Fischer, Tubeuf, Soppit, Tranzschal, Eriksson, Pazschke, Juel, Wagner, Bubak, Jacky, Shirai, Müller and Ward.

In America Dr. Farlow was the pioneer worker, publishing his first experiments on the "Gymnosporangia or Cedar Apples of the United States" in 1880. He continued work on the same group in 1885, and it was supplemented (independently) by Halsted in 1886–7, published in the Bulletin of the Iowa Agricultural

College. More fruitful results were obtained by Thaxter in 1887 and again in 1889,—the connection between the several species of Gymnosporangium and associated Roestelia occurring in this country being satisfactorily established, which may be found in print in the Proceedings of the American Academy of Arts and Sciences, Boston; and Bulletin 134, Conn. Agr. Exp. Sta. Pammel repeated the experiment verifying connection in case of one of the species (Ia. Hort. Soc. Rep. 1893), the same also by Stewart and Carver (Proc. Ia. Acad. Sci. for 1895, Vol. 3; same in N. Y. Exp. Sta. for 1895).

No connections between Uredineous forms were then experimentally determined—except that Howell (in 1890) showed the three stages of the Clover Rust to be genetically related, and Clinton (in 1894) the two stages of the Bramble Rust—until 1899, when extended and important work was reported by Arthur and by Carleton. The latter dealt with the Cereal Rusts only, making sowings almost exclusively of Uredospores mainly from Wheat, Oats, Barley, Rye and Maize, on the same and on different host species. The interesting results were published as Bulletin No. 16, U. S. Dept. Agr. Div. Veg. Physiology and Pathology, April 23, 1899.

Arthur communicated his first results to the public in a paper read before the A. A. A. S., Botanical Section, Columbus, Ohio, August, 1889, and the same was published in the Botanical Gazette, 29 : 268–276, April, 1900. Of eleven species of Uridineae, the aecidial and teleutosporic forms were definitely connected by these cultures. In the Journal of Mycology (8 : 51–6), June, 1902, he reported cultures made in 1900 and 1901—successful inoculations in eight cases, four being repetitions of previously demonstrated connections, and the complete cycle for four being reported here for the first time. Arthur's third report (cultures in 1902) was published in the Botanical Gazette (35 : 10–23) for January, 1903. The successful cultures made number eleven previously reported and seven reported for the first time.

In 1902 cultures were undertaken by Kellerman. The first case of demonstrated connection was published in the Journal of Mycology (8 : 20), May, 1902, and appeared in the same periodical (9 : 6–13) in February, 1903. This showed seven successful inoculations, two of these not having been previously demonstrated. The second report (continuing his work during 1903), detailing more extended cultures, was given in part in the Journal of Mycology (9 : 109–10), May, 1903, and the year's work is reported in full in the Journal, December Number, 1903.

This brief historical outline shows that as yet comparatively few American mycologists have undertaken culture work to determine life cycles of our numerous species of Uredineae.

Space precludes giving here a detailed record of work by American botanists, but the paper in full is published in the Journal of Mycology, also printed *on one side of page* as a SEPARATE. The following is a summary of the alternate forms whose connection has been demonstrated :

SUMMARY OF ALTERNATE FORMS.

Aecidium albiperidium Arth.—Puccinia albiperidia Arth.

Aecidium asteratum Schw.—Puccinia caricis-asteris Arth.

Aecidium berberidis Pers.—Puccinia poculiformis (Jacq.) Wettst.

Aecidium calystegiae Desm.—Puccinia convolvuli Cast.

Aecidium caulicolum Kellerm.—Puccinia caulicola Tr. & Gall.

Aecidium cirsii-lanceolati Kellerm.—Puccinia cirsii lanceolati Schroet.

Aecidium ellisii Tr. & Gall.—Puccinia subnitens Diet.

Aecidium erigeronatum Schw.—Puccinia caricis-erigerontis Arth.

Aecidium euphorbiae Am. Auct.—Uromyces euphorbiae C. & P.

Aecidium fraxini Schw.—Puccinia fraxinata (Lk.) Arth.

Aecidium on Helianthus—Puccinia helianthi Schw.

Aecidium hibisciatum Schw.—Puccinia hibisciata (Schw.) Kellerm. (P. muhlenbergiae Arth. & Holw.)

Aecidium hydnoideum B. & C.—Puccinia hyduoidea (B. & C.) Arth.

Aecidium impatientis Schw.—Puccinia impatientis (Schw.) Arth. (P. rubigo-vera Auct. on Elymus virginicus.)

Aecidium jamesianum Pk.—Puccinia jamesiana (Pk.) Arth. (P. bartholomaei Diet.)

Aecidium on Larix decidua, *see* Caeoma on Larix decidua.

Aecidium lateripes Kellerm.—Puccinia lateripes B. & Rav.

Aecidium leucospermum B. & C.—Uromyces lespedezae-procumbentis (Schw.) Curt.

Aecidium lycopi Ger.—Puccinia angustata Pk.

Aecidium oenotherae Pk., *see* Aecidium peckii DeToni.

Aecidium pammelii Trel.—Puccinia panici Diet.

Aecidium peckii DeToni (Ae. oenotherae Pk.)—Puccinia peckii (DeToni) Kellerm. (P. caricis Auct. p. p.)

Aecidium pentstemonis Schw.—Puccinia andropogonis Schw.

Aecidium plantaginis Ces. (?) on Plantago rugelii Dec.—Uromyces aristidiae E. & E.

Aecidium pteleae B. & C.—Puccinia windsoriae Schw.

Aecidium pustulatum Curt.—Puccinia pustulata (Curt.) Arth.

Aecidium [ranunculacearum (?)] on Anemone canadensis L.—Puccinia simillima Arth.

Aecidium ranunculi Schw.—Puccinia eatoniae Arth.

Aecidium rhamni Pers.—Puccinia rhamni (Pers.) Wettst. (P. coronata Corda.)

Aecidium rubellum Pers.—Puccinia phragmitis Schum.

Aecidium sambuci Schw.—Puccinia sambuci (Schw.) Arth. (P. atkinsoniana Diet., P. bolleyana Sacc.)

Aecidium smilacis Schw.—Puccinia amphigena Diet.

Aecidium solidaginis Schw.—Puccinia caricis-solidaginis Arth.

Aecidium on Solidago—Uromyces solidagini-caricis Arth.

Aecidium on Strophostyles helvola—Uromyces phaseoli (Pers.) Wint.

Aecidium on Trifolium, *see* Uromyces trifolii (A. & S.) Wint.

Aecidium urticae Schum.—Puccinia caricis (Schum.) Reb.

Aecidium verbenicola K. & S.—Puccinia vilfae A. & H.

Caeoma (Aecidium) erigeronatum Schw., *see* Aecidium erigeronatum Schw.

Caeoma (Aecidium) hibisciatum Schw., *see* Puccinia hibisciata (Schw.) Kellerm.

Caeoma on Larix decidua—Melampsora medusae Thüm. [M. populina Am. Auct.]

Caeoma miniata Am. Auct.—Phragmidium speciosum Fr.

Caeoma nitens Schw., *see* Gymnoconia interstitialis (Schlect.) Lagh.

Caeoma ulmariae Thüm.—Triphragmium ulmariae (Schum.) Lk.

Gymnoconia interstitialis (Schlecht.) Lagh., aecidium (Caeoma nitens Schw.), and teleuto (Puccinia peckiana Howe); autoecious.

Gymnosporangium biseptatum Ell.—Roestelia botryapites Schw.

Gymnosporangium clavariaeforme (Jacq.) Rees.—Roestelia lacerata (Sow.) Fr.

Gymnosporangium clavipes Cke. & Pk.—Roestelia aurantiaca Peck.

Gymnosporangium conicum Rees.—Roestelia cornuta (Ehr.) Fr.

Gymnosporangium ellisii (Berk.) Farl.—Roestelia transformans Ellis (?).

Gymnosporangium globosum Farl.—Roestelia globosum ("lacerata z") Thaxter.

Gymnosporangium macropus Lk.—Roestelia pyrata Thaxter.

Gymnosporangium nidus-avis Thaxter—Roestelia nidus-avis Thaxter.

Melampsora medusae Thüm [M. populina Am. Auct.]—Caeoma on Larix decidua.

Melampsora populina Am. Auct., *see* Melampsora medusae Thüm.

Phragmidium speciosum Fr.—Caeoma miniata Am. Auct.

Puccinia albiperidia Arth., aecidium [albiperidium Arth.], uredo and teleuto; autoecious.

Puccinia americana Lagh., *see* Puccinia andropoginis Schw.

Puccinia amphigena Diet.—Aecidium smilacis Schw.

Puccinia andropoginis Schw. (P. americana Lagh.)—Aecidium pentstemonis Schw.

Puccinia angustata Pk.—Aecidium lycopi Ger.

Puccinia atkinsoniana Diet. *see* Puccinia sambuci (Schw.) Arth.

Puccinia bartholomaei Diet., *see* Puccinia jamesiana (Pk.) Arth.

Puccinia bolleyana Sacc., *see* Puccinia sambuci (Schw.) Arth.

Puccinia caricis (Schum.) Reb.—Aecidium urticae Schum.

Puccinia caricis Am. Auct. p. p. (P. peckii DeToni) Kellerm., *see* P. peckii (DeToni) Kellerm.

Puccinia caricis-asteris Arth.—Aecidium asteratum Schw.

Puccinia erigerontis Arth.—Aecidium erigeronatum Schw.

Puccinia caricis-solidaginis Arth.—Aecidium solidaginis Schw.

Puccinia caulicola Tr. & Gall., aecidium [caulicolum Kellerm.], uredo and teleuto; autoecious.

Puccinia cirsii-lanceolati Schroet., aecidium [cirsii-lanceolati Kellerm.], uredo and teleuto; autoecious.

Puccinia convolvuli Cast., aecidium [calystegiae Desm.], uredo and teleuto; autoecious.

Puccinia coronata Corda, *see* Puccinia rhamni (Pers.) Wettst.

Puccinia eatoniae Arth.—Aecidium ranunculi Schw.

Puccinia fraxinata (Lk.) Arth.—Aecidium fraxini Schw.

Puccinia graminis, *see* Puccinia poculiformis (Jacq.) Wettst.

Puccinia helianthi Schw., aecidium [Caeoma helianthi Schw.], uredo and teleuto; autoecious.

Puccinia hibisciata (Schw.) Kellerm. (P. muhlenbergiae Arth. & Holw.)—Aecidium hibisciatum Schw.

Puccinia hydnoidea (B. & C.) Arth.—Aecidium hydnoideum B. & C.

Puccinia impatientis (Schw.) Arth. (P. rubigo-vera Auct. on Elymus virginicus)—Aecidium impatientis Schw.

Puccinia jamesiana (Pk.) Arth. (P. bartholomaei Diet.)—Aecidium jamesianum Pk.

Puccinia lateripes B. & Rav., aecidium [lateripes Kellerm.], uredo and teleutospores; autoecious.

Puccinia muhlenbergiae Arth. & Hol., *see* Puccinia hibisciata (Schw.) Kellerm.

Puccinia panici Diet.—Aecidium pammelii Trel.

Puccinia peckiana Howe, *see* Gymnoconia interstitialis (Schlecht.) Lagh.

Puccinia peckii (DeToni) Kellerm. (P. caricis Am. Auct. p. p.)—Aecidium peckii DeToni (Ae. oenotherae Pk.).

Puccinia peridermiospora (E. & T.) Arth., *see* Puccinia fraxinata (Lk.) Arth.

Puccinia phragmitis (Schum.) Körn.—Aecidium rubellum Pers.

Puccinia poculiformis (Jacq.) Wettst.—Aecidium berberidis Pers.

Puccinia pustulata (Curt.) Arth.—Aecidium pustulatum Curt.

Puccinia rhamni (Pers.) Wettst. (P. coronata Corda)—Aecidium rhamni Pers.

Puccinia rubigo-vera Am. Auct. on Elymus virginicus, *see* Puccinia impatientis (Schw.) Arth.

Puccinia sambuci (Schw.) Arth. (P. atkinsoniana Diet., P. bolleyana Sacc.)—Aecidium sambuci (Schw.) Arth.

Puccinia simillima Arth.—Aecidium [ranunculacearum (?)] on Anemone canadensis L.

Puccinia subnitens Diet.—Aecidium ellisii Tr. & Gall.

Puccinia vilfae A. & H.—Aecidium verbenicola K. & S.

Puccinia windsoriae Schw.—Aecidium pteleae B. & C.

Roestelia aurantiaca Pk.—Gymnosporangium clavipes Cke. & Pk.

Roestelia botryapites Schw.—Gymnosporangium biseptatum Ell.

Roestelia cornuta (Ehr.) Fr.—Gymnosporangium conicum Rees.

Roestelia globosum ("lacerata z") Thaxter—Gymnosporangium globosum Farl.

Roestelia lacerata (Sow.) Fr.—Gymnosporangium clavariaeforme (Jacq.) Rees.

Roestelia nidus-avis Thax.—Gymnosporangium nidus-avis Thaxter.

Roestelia pyrata Thaxter—Gymnosporangium macropus Lk.

Roestelia transformans Ell. (?)—Gymnosporangium ellisii (Berk.) Farl.

Triphragmium ulmariae (Schum.) Lk.—Caeoma ulmariae Thüm.

Uromyces aristidae E. & E.—Aecidium plantaginis Ces. (?) on Plantago rugelii Dec.

Uromyces solidagini-caricis Arth.—Aecidium on Solidago.

Uromyces euphorbiae C. & P.—Aecidium euphorbiae Am. Auct.

Uromyces lespedezae-procumbentis (Schw.) Curt., aecidium [leucospermum B. & C.], uredo and teleuto; autoecious.

Uromyces phaseoli (Pers.) Wint., aecidium, uredo and teleuto; autoecious.

Uromyces trifolii (A. & S.) Wint., aecidium, uredo and teleuto; autoecious.

SOME MORPHOLOGICAL PECULIARITIES OF THE NYMPHAEACEAE AND HELOBIAE.*

John H. Schaffner.

Having spent some time in studies upon various species belonging to the Helobiae, the writer has naturally taken considerable interest in the recent investigations by Lyon, Cook and others on the embryogeny of the Nymphaeaceae. On account of certain peculiarities in the anatomical structure of these plants, the writer following many others had reservedly placed the Nymphaeaceae near the Helobiae; but, because of the supposed characteristic Dicotyl embryo and certain Dicotyl features which were read into the flowers, it was thought improper to take them away from their "authoritative" position. However, since the way has been considerably cleared by Lyon and Cook, at least so far as the embryo is concerned, for judging certain other characters of the group on their merits, a considerable study has been carried on for the last three years upon various species of the group.

It might perhaps be proper to state here that the writer had the pleasure of examining most of Cook's preparations on which his more important conclusions were based; even going so far as to reconstruct the early stages of the embryo which showed that in Nymphaea advena the development of the so-called cotyledon is essentially the same as what Lyon had reported for Nelumbo. It is unfortunate that Coulter and Chamberlain in their "Morphology of Angiosperms" overlooked the reference to Cook's embryo of Nymphaea advena. For the fact that the embryo of Nymphaea has such a close resemblance to Nelumbo must have a very important bearing on the subject.

As is well known, the vascular bundles of the Nymphaeaceae are essentially Monocotyl in type, showing the characteristic closed bundle. So striking is this in the bundles of the flower stem of Nelumbo that one might almost palm off a section for a corn bundle. The disposition of the xylem and vessels, the phloem, and the cap of sclerenchyma, taken together with the scattered arrangement and the absence of secondary cambium certainly represent a structure characteristic of Monocotyls (Fig. 1). The vascular bundles of Podophyllum and certain species of Piperaceae which the writer examined are considerably different and show the open type of bundle characteristic of Dicotyls. These plants have therefore no important bearing on the relationship of the Nymphaeaceae so far as the anatomy of the stem is concerned.

The many superficial characters must also be taken into consideration. The similarity of habitat, the rhizome habit, the

*Contributions from the Botanical Laboratory of Ohio State University, XVI.

striking agreement of some of the leaf forms, and the general character of the flowers at once suggest the Helobiae as near relatives; and though such characters could not be of first rank in making a final disposition of the group, they do not in the least stand in the way but rather assist in disposing of the water lilies as Monocotyls.

Since there has been a strong tendency to read Dicotyl characters into the flowers of some water lilies, the writer took the opportunity to make a study of the flower of a few representative species of Naiadales and Nymphaeaceae in order to see how well the floral plan could be made to fit into the Monocotyl scheme. It is certainly much easier to read Monocotyl characters into the flowers than Dicotyl. The mere position in which a species is placed may have much to do with its description. For instance, the perianth of Nymphaea advena is described as having six sepals and an indefinite number of stamen-like petals. These staminodes, the so-called "petals," are so evidently only very slightly modified stamens that in many cases a superficial examination will not distinguish them. The perianth is then typically trimerous with three sepals and three petals. This is of course of no special importance, for many of the true Ranales also have a trimerous perianth.

In Castalia the sepals are said to be four and the petals numerous. This is sometimes the case; but in Castalia odorata (Fig. 11) the sepals are normally three in a cycle, but sometimes by the expansion of the receptacle one of the segments of the second cycle is partly or nearly completely brought to the outside. Its relationship to the inner cycle is, however, always evident. The second cycle of three segments usually with some green on the outside, must therefore be regarded as corresponding to the second cycle in Cabomba or Nymphaea and all the rest of the petal-like segments may be staminodes. In Castalia tuberosa (Fig. 12) the dispacement by expansion is normal and there are four green segments, but the one "sepal" still clearly shows its relation to the inner cycle. This tendency of the floral organs to fall into sets of four is very prominent in some Helobiae as in the various species of Potamogeton (Fig. 9).

The transition from comparatively simple flowers to those with great numbers of parts as appears in passing from Cabomba to Nymphaea is also characteristic of the Alismaceae. The extreme numbers no doubt represent multiplication or augmentation. In Alisma the parts are few (Fig. 2), in Sagittaria rigida (Figs. 3, 4) the numbers are greater, but still small when compared with the carpellate flowers of Sagittaria latifolia, where the carpels count up to sixteen hundred, more or less (Figs. 5, 6). Staminodes are also a prominent character in various Helobiae as in Sagittaria rigida, Vallisneria, Philotria, Butomus, and Limnocharis.

Although there is much variation in the number of parts, typical specimens were selected to represent the diagrams accompanying this paper. Each diagram given represents an actual flower of the species. The descriptions following represent what to the writer appears to be the correct characterization, so far as number and arrangement of parts are concerned, of the flowers of the species studied :

Cabomba caroliniana Gr.—Flowers hypogynous, pentacyclic, actinomorphic, trimerous, with all the parts separate ; sepals 3, petals 3, stamens 6, carpels 3 more or less (Fig. 7).

Brasenia purpurea (Mx.) Casp.—Flowers hypogynous with all the parts separate ; perianth cyclic, trimerous ; androecium and gynoecium spiral, stamens 18 more or less, carpels 9 more or less (usually 6–18) (Fig. 8).

Nymphaea advena Sol.—Flowers hypogynous with the parts separate except in the gynoecium ; calyx and corolla cyclic, trimerous ; androecium and staminodes spiral ; staminodes stamen-like, 18 more or less ; stamens 250 more or less, arranged in spirals with about 14 circles of 18 stamens each ; gynoecium cyclic of 18 carpels more or less, completely united in 1 cycle forming a plurilocular ovulary (Fig. 10).

Castalia odorata (Dry.) W. & W.—Flowers with partly epigynous stamens, staminodes and perianth ; calyx cyclic of 3 sepals ; corolla and staminodes not separable, spiral ; original petals probably 3, the staminodes arranged in about 7 circles of 6 divisions each, passing gradually into fertile stamens ; stamens 100 more or less, spirally arranged in about 17 circles of 6 divisions each ; carpels 18 more or less, united in 1 cycle forming a plurilocular ovulary (Fig. 11).

Castalia tuberosa (Paine) Greene.—Flowers with numerical plan about the same as in C. odorata, but the arrangement much displaced so that there are apparently 4 sepals, and 4 petals of the second cycle. There is also a disarrangement of the staminodes (Fig. 12).

Nelumbo lutea (Willd.) Pers.—Flowers hypogynous with 2 dimerous cycles of sepals and 3 petals in the first corolla cycle ; the remaining petals or highly modified staminodes spirally arranged in about 7 circles of 3 each ; stamens 150 more or less, spirally arranged, falling into 6 circles of 24 each ; carpels 18 more or less, distinct, situated in pit-like depressions of the large top-shaped receptacle, arranged into several imperfect circles of 3s, 6s, 9s, etc., representing a primitive spiral arrangement (Fig. 13).

There has been no constancy in the progressive development of the ovule in the Helobiae ; for in the epigynous Hydrocharitales we have both orthotropous and anatropous ovules, while in the hypogynous Alismaceae as in Alisma and Sagittaria the ovule passes in its development from orthotropous, through the anatropous condition and becomes campylotropous when mature. The setting aside of the lower endosperm nucleus of the first division by a wall and its development as a large vesicular cell, as is the case in Sagittaria and Vallisneria, while not confined to the Helobiae nor apparently characteristic of all of them, is yet significant when one finds a similar peculiarity in some of the Nymphaeaceae.

The number of ovules in the carpel also shows a diverse development. In Potamogeton, Alisma, Sagittaria and Nelumbo there is usually a single ovule in each ovulary. In Butomus, Vallisneria and other genera of the Hydrocharitales the ovules are scattered on the inner surface of the ovularies. This is also one of the striking characters of Nymphaea and Castalia. In fact the peculiar way in which the ovularies of certain Nymphaeaceae agree with many of the Hydrocharitales must appear most interesting to anyone who has made the comparison. Coalescence and epigyny also figure in both the Hydrocharitales and Nymphaeaceae. Thus it will appear that what might be considered as minor or secondary characters do not detract but rather add considerably to the weight of the argument that the Nymphaeaceae have very much in common with the Helobiae.

The important investigation of Lyon shows conclusively that he was correct in claiming that the embryo of Nelumbo is essentially of the "Monocotyl" type, and, since there can be no question of the facts, it also appears that his further conclusion was unavoidable that the Nymphaeaceae should be placed near the Helobiae. As stated before, the writer had the opportunity of studying some of Cook's preparations and it became evident that the embryo of Nymphaea advena is in all essentials similar to that of Nelumbo. Later a special study was made of the young embryo of Nymphaea advena. As stated by Cook, in the young embryo of Nymphaea the "cotyledon" is at first not lobed. Later there is a rapid development at the two sides resulting in a two-lobed structure (Figs. 14, 15). Since Conrad stated that in Castalia odorata the embryo has two distinct "cotyledons" from the first, a study was also made of this species. With some difficulty very young embryos were dissected out of their embryosacs which are easily removed from the ovule. It was found that although the "Dicotyl" appearance is quite strong, the embryo must be regarded as of the same type as Nymphaea and Nelumbo. In the very young embryo there is an expansion which extends nearly around the base but is discontinuous at one side (Fig. 16). Soon this expansion develops on opposite sides as two prominent lobes in such a manner that the original connection between the two lobes is very difficult to distinguish (Fig. 17). On examining the embryo from below, however, the similarity to the Nelumbo and Nymphaea embryos becomes perfectly apparent (Figs. 18, 19). There is the same opening on one side, and on the back a connection of the two lobes, only to a less extent. Unless special care were taken in reconstructing such an embryo from serial sections, one might readily take it for a Dicotyl. It will be evident, however, from a comparison of the figures that the Castalia embryo represents only the extreme of the lobing shown in Nelumbo and Nymphaea.

There is a structure present in various Helobiae which deserves special attention in discussions on the relationship of the Nymphaeaceae. The so-called macropodous embryos of Halophila, Ruppia, Zostera and other genera appear to the writer to throw considerable light on the peculiar structure of the Nymphaea embryo. The enormous development of the basal or hypocotyledonary region of the embryo in such widely separated genera shows a strong and peculiar tendency in the group of Helobiae. In such typical forms as Sagittaria latifolia, Zannichellia palustris

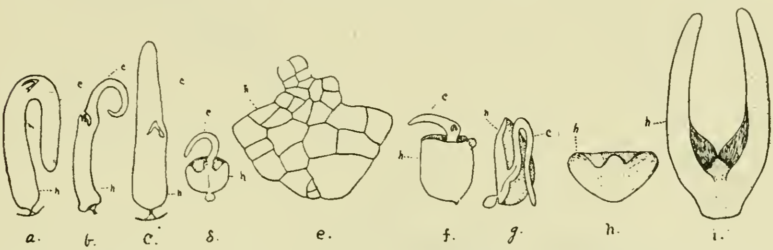


Fig. 1. Similar parts are indicated as follows: c, cotyledon, and h, the basal or lateral region developed into an expanded organ in some embryos.

a—Embryo of Sagittaria latifolia. b—Embryo of Zannichellia palustris. c—Embryo of Vallisneria spiralis. d—Longitudinal half of embryo of Halophilia ovalis, after Balfour. e—Section of young embryo of Erythronium americanum showing beginning of massive development of basal region. f—Embryo of Ruppia rostellata, after Wille. g—Longitudinal half of embryo of Zostera maritima, after Rosenberg. h—Young embryo of Nelumbo lutea, after Lyon. i—Older embryo of Nelumbo lutea, after Lyon.

and Vallisneria spiralis (Text Fig. 1, a, b, c) there is barely a hint of such a development. In some other Monocotyls, as, for instance, in Erythronium americanum, the basal region of the embryo early shows a rapid development, growing into a massive, lobed structure which functions as an absorbing organ (Text Fig. 1, e), This is no doubt the purpose of the massive expansions and lobes present in Halophila, Ruppia, Zostera, Nelumbo, Nymphaea and Castalia (Text Fig. 1, d, f, g, h, i, and Figs. 14–19). To the writer there is no more reason for calling the ridge or lobes of the Nymphaeaceae, cotyledons, than the remarkable expansion at the base of the embryo of Zostera. The basal expansion in the Castalia embryo, to the writer, cannot represent the same or homologous structure as the cotyledons of Sagittaria or Bursa. According to this view the so-called cotyledons of Nelumbo, Nymphaea and Castalia represent hypocotyledonary expansions homologous to the expansions found in Zostera and other genera of the Helobiae.

It appears to the writer that the supposition that all so-called cotyledons are homologous is probably erroneous. The type of embryo found in Sagittaria and Alisma is in fact rather exceptional among Monocotyls and must be regarded as ideal rather than typical of the class. Neither is the fact that the plumule develops as a terminal structure to be regarded as at all conclusive for it is said that the plumules in Dioscoreaceae and Commelinaceae are apical. There are also a number of fundamentally different types of Dicotyl embryos. Instead of having two general types in Angiosperms there are several types, and these approach each other at various points in widely separated orders. The division line between Monocotyls and Dicotyls is, after all, not

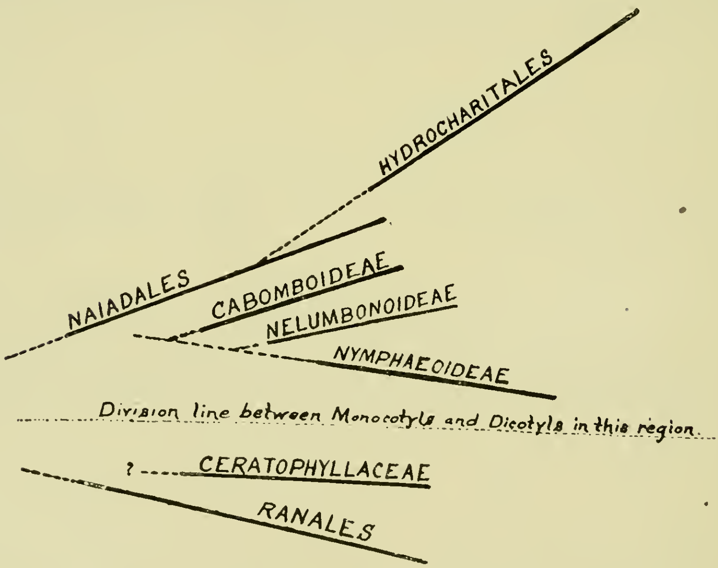


Fig. 2. Diagram of relationship between Helobiae, Nymphaeaceae and Ranales.

very distinct. Although Angiosperms are far removed from all other plants, they represent such a vigorous modern group that there has not been time for the extinction of intermediate forms. With the removal of a few connecting groups it would be more easy to recognize six or seven classes of Angiosperms instead of two.

With our increasing knowledge of the embryogeny of Angiosperms it is becoming more and more apparent that the mere difference in the character of the embryo is not sufficient to determine the position of a genus or family. All possible characters during the life cycle must be taken into account, otherwise the result will be largely artificial. As intimated above, the writer, through paleontological studies, came to the conclusion a number of years ago that Monocotyls did not come from Dicotyls nor Dicotyls from Monocotyls; that the Angiosperms do not represent two sharply defined classes, but that there are a number of lines of development from some common stock; and that on this account there are frequent independent duplications of important characters in quite distinct series of forms. According to the views expressed above the relationship of the groups under discussion may be represented as shown in the diagram (Text Fig. 2).

Since lists of the important literature have recently been given in a number of papers, it is not necessary to add an extensive bibliography here.

1. Lyon, H. L. Observations on the Embryogeny of Nelumbo. Minn. Bot. Studies **2**: 643–655. 1891.
2. Cook, M. T. Development of the Embryo-sac and Embryo of Castalia odorata and Nymphaea advena. Bull. Torr. Bot. Club **24**: 211–220. 1902.
3. Conrad, H. S. Note on the Embryo of Nymphaea. Science **15**: 316. 1902.
4. Campbell, D. H. On the Affinities of Certain Anomalous Dicotyledones. Amer. Nat. **36**: 7–12. 1902.

EXPLANATION OF PLATES V–VII.

The diagrams represent typical flowers selected from a series of variable types and show the actual number and position of the floral organs. The other figures were drawn with the aid of an Abbe camera.

PLATE V.

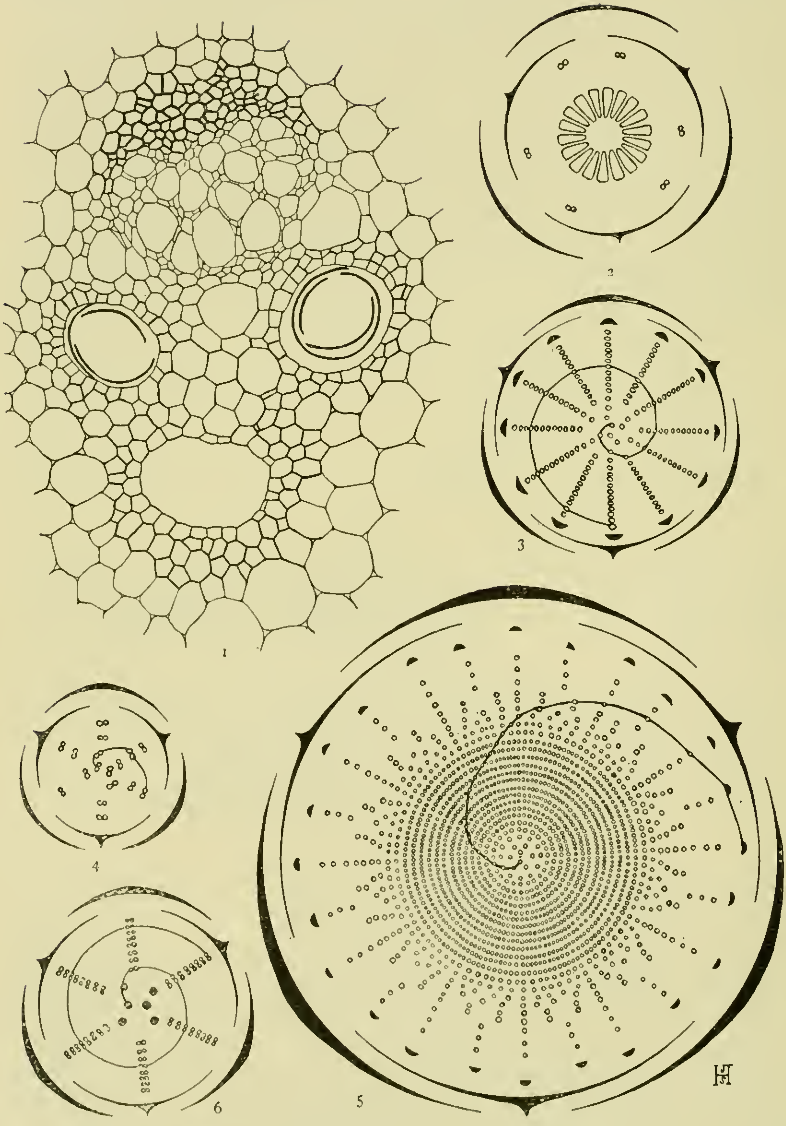
Fig. 1. Section of vascular bundle from the peduncle of Nelumbo lutea.
Fig. 2. Diagram of flower of Alisma plantago.
Fig. 3. Diagram of carpellate flower of Sagittaria rigida.
Fig. 4. Diagram of staminate flower of Sagittaria rigida.
Fig. 5. Diagram of carpellate flower of Sagittaria latifolia.
Fig. 6. Diagram of staminate flower of Sagittaria latifolia.

PLATE VI.

Fig. 7. Diagram of flower of Cabomba caroliniana.
Fig. 8. Diagram of flower of Brasenia purpurea.
Fig. 9. Diagram of flower of Potamogeton natans.
Fig. 10. Diagram of flower of Nymphaea advena.
Fig. 11. Diagram of flower of Castalia odorata.
Fig. 12. Diagram of flower of Castalia tuberosa.
Fig. 13. Diagram of flower of Nelumbo lutea.

PLATE VII.

Fig. 14. Young embryo of Nymphaea advena.
Fig. 15. The same embryo as in Fig. 14, back view.
Fig. 16. Young embryo of Castalia odorata.
Fig. 17. Older embryo of Castalia odorata, upper side.
Fig. 18. The same embryo as in Fig. 17, under side.
Fig. 19. Still further developed embryo of Castalia odorata, showing "Dicotyl" appearance.



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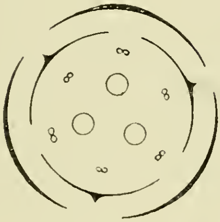

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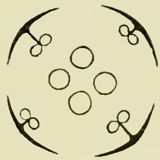

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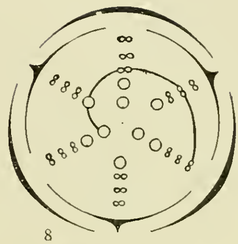

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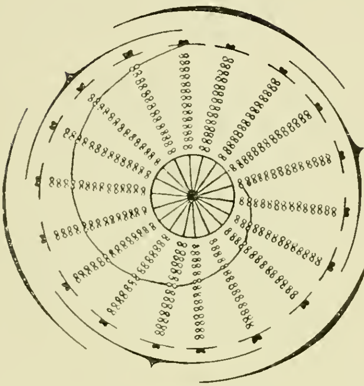

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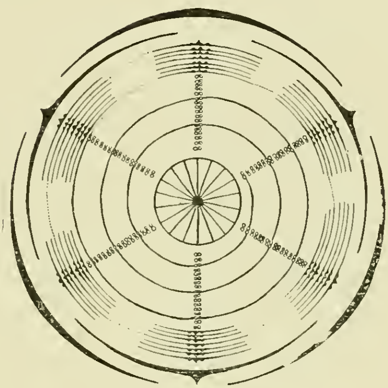

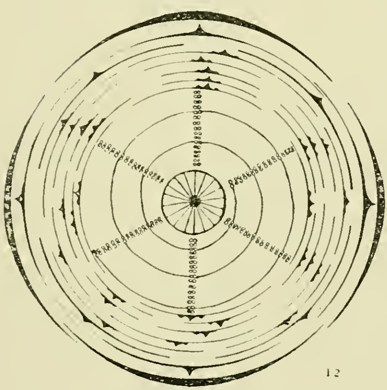

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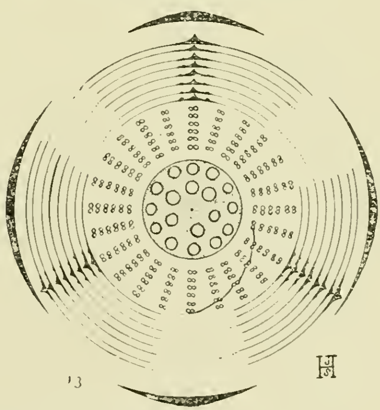

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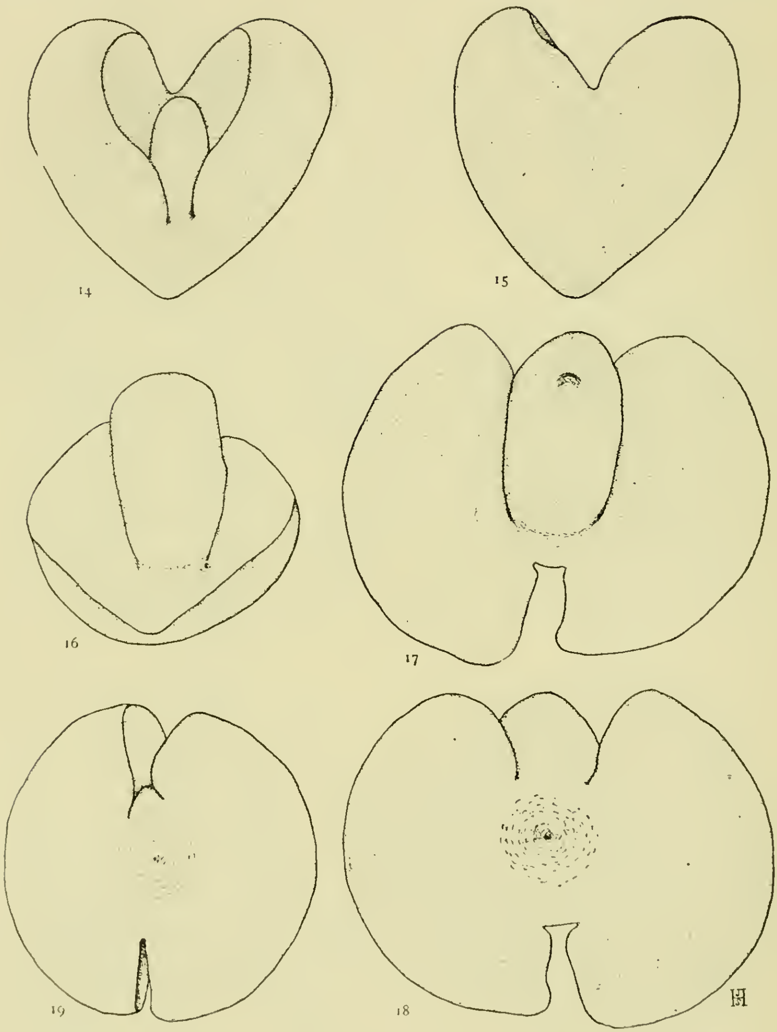
SCHAFFNER on "Nymphaeacae and Helobiae."

OHIO NATURALIST. *Plate VII.*



SCHAFFNER on "Nymphaeacae and Helobiae."

NOTE ON ALATE FORM OF PHYLLOSCELIS.*

Herbert Osborn.

The genus Phylloscelis was established in 1839 by Germar to contain the American species atra and pallescens.

One of the generic characters of this genus has been the absence of wings. Stal using this in his key (Hemip. Africana, IV, p. 151) to separate the genus from other genera of Dictyopharida.

Partly owing to lack of knowledge of wing structure the genus has been difficult to place, and some authors have included it in the Caloscelinae because of the foliaceous anterior legs, others including it in Dictyopharinae on elytral characters, etc., notwithstanding the absence of the projecting vertex.

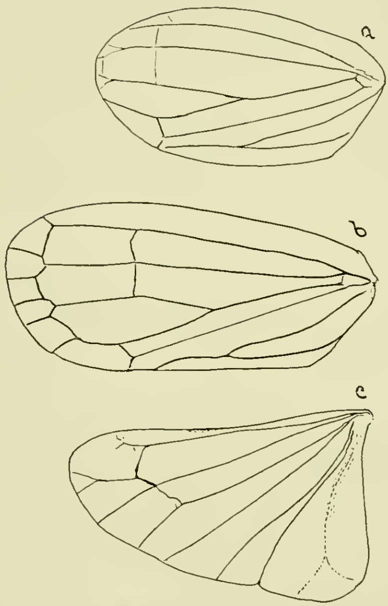


Fig. 1. *Phylloscelis atra.* *a*, elytron of apterous form; *b*, elytron of macropterous form; *c*, wing.

No one seems to have described the alate form and it was therefore with much interest that I discovered a short time ago an individual with fully developed wings in the collection of Mr. Dury, of Cincinnati. The specimen, indeed, differs so much in general appearance from the ordinary apterous individual that its relation to Phylloscelis atra was not at first suspected.

The main difference lies, however, in the larger development of the elytra and the presence of perfect wings. The elytra are elongate, oval, thick and black to apex, the venation essentially like the apterous form. The wings are nearly as long as elytra, broadly rounded, the anal area without reticulation and the venation of Dictyopharid pattern. Based on venation, therefore, it becomes possible to definitely refer the genus to the subfamily Dictyopharidae. Whether this character should have greater weight than the dilation of tibiae may be an open question. Usually, however, venational characters are counted of special value.

*Read at the November meeting of Ohio State Academy of Science.

Germar speaks of it as near Issus and closely related also to Eurybrachus, being distinguished by the absence of wings, the foliaceous anterior femora and the smaller five-keeled front and long six-spined tibiae. As these genera now stand in distinct subfamilies this reference is of little value in determining relationship.

The sequence of events in cases of reduction are indicated by the following: First, normal individuals have fully developed elytra and wings; next we find many species with fully developed elytra but aborted wings; next, individuals with reduced elytra and no wings, and finally forms with elytra absent or reduced to mere rudiments.

The conclusion seems evident that for species not using wings the first loss is from reduction of the wings probably since they are more delicate and susceptible to influences of disuse; next the elytra show reduction at the apex, usually by obliteration of the apical cells, the next most susceptible area, and finally by still further reduction in length.

In one remarkable genus, Danepterix, recently discovered in California, the wings are wanting and the elytra instead of being shortened have been narrowed to mere strap-like appendages, leaving a wide strip of abdomen exposed between their dorsal margins as well as at the sides.

THREE NEW SCALE INSECTS FROM OHIO.

J. G. Sanders.

Orthezia solidaginis, n. sp. Pl. VIII. Figs. 57–63.

Adult female: Length (including marsupium), 6mm.; width, 2.5mm. Body covered completely by white waxy secretion in four series; two inner series composed of eight pairs of lamellae extending laterally from median line with tips turned backward and upward, gradually increasing in length to the sixth, then rapidly decreasing: the ninth pair joined at tips forming a ring around anal orifice. The two lateral series are each composed of ten lamellae, all turning backward except the first on either side. The second and third lateral lamellae are subequal, the others increasing in length to the long subequal eighth and ninth, reaching midway on the marsupium; the tenth pair are very short and inconspicuous. A lamella extends downward between the antennae to the ventral surface. The marsupium is fluted on the dorsal surface, plain ventrally and gradually narrowed and elevated posteriorly.

Body, antennae and legs dark reddish-brown. Antennae 8-jointed bearing scattered hairs and with distal ends of joints enlarged; the fusoid eighth joint with a terminal spine and with distal half black. Formula - 3, 8, (4, 5, 2,) 6, (7, 1). Length of joints in μ: (1) 135, (2) 150, (3) 205, (4) 150,

(5) 150, (6) 140, (7) 135, (8) 180. Legs large and strong, rather spiny with femur and tibia of almost exactly equal length and with tarsus more than half the length of the tibia; large claw with three or four denticles and a pair of short flattened digitules. The body is thickly covered with tubules about 20μ long, and small derm-orifices. The anal ring is elliptical, bearing six hairs and a narrow chitinous band on each side of the orifice, and is thickly dotted.

Immature stage: Length, 3mm.; width, 2mm. Completely covered above by four series of waxy lamellae. The two median series consist of eleven short thick lamellae; the 11th pair being very small and the anterior pair protruding forward over the head in a bilobed manner. The first four lateral lamellae are similar to those of the adult, the 5th and 6th pairs are short, and the apparently fused 7th and 8th are again longer, giving the insect a rectangular appearance. The 9th lamellae from either side are fused, forming a single long lamella projecting posteriorly on the median line.

On the ventral surface there are 12 short, broad subequal lamellae on each side around the margin of the body, and the entire surface has an armadillo appearance on account of the short, plate-like lamellae. This stage has 7-jointed antennae. Formula: 7, 3, 2, 4, (5, 1,) 6. (1) 75, (2) 87, (3) 120, (4) 81, (5) 75, (6) 72, (7) 141. The distal half of the 8th joint is black.

Larval stage: With 6-jointed antennae and two series of large cottony lamellae on the dorsal surface.

REMARKS: The author has found only five adults, near Port Clinton, Ottawa county, Ohio, July 5, 1903. The immature forms have been collected at Port Clinton, Columbus and Georgesville.

Concerning this species, Prof. Cockerell says: "*Orthezia solidaginis* is no doubt part of what has been called '*americana*,' but since '*americana*' was never properly described, it is all right to give a name to your insect. The species one first thinks of comparing it with are *O. urticae* (which might have been introduced from Europe) and *O. graminis* (which gets as far East as Kansas). *O. solidaginis* differs superficially from both; from *urticae* by the triangular outline of the mass of dorsal lamellae (in *urticae* it is oval); from *graminis* by the very long posterior lamellae, overlapping the ovisac."

CHIONASPIS SYLVATICA, n. sp. Pl. VIII. Figs. 64, 65.

Scale of female: Length, 1.5—2mm., somewhat convex, very irregulur in shape, sometimes elongated and rounded posteriorly, and sometimes decidedly broadened and truncated posteriorly, giving it a deltoid shape; dirty-white to light-buff in color. First exuvia persistent, buff; second exuvia, brown.

Scale of male: Length, .6—1mm., white, strongly tri-carinate with parallel sides. Exuvia very small, delicate, semi-transparent, covering about one-fifth of the scale. Commonly found on the leaves of the host, causing pale spots at the point of attachment.

Female: Oval in outline, with 3rd, 4th and 5th segments anterior from the pygidium prominent. Median *lobes* fused to near the tip, diverging widely to rounded tips, then truncated obliquely toward the second lobes; serrate or crenate on lateral margins. Inner lobule of second lobes serrate, produced on inner margin to a rounded tip; outer lobule reduced, triangular, sharp-pointed, entire. Third lobe slightly produced, serrate. On the median line, a chitinous band extends anteriorly to base of median lobes, expanding to a bulb-like thickening. Chitinous bands extend obliquely toward this from outer margins. Second lobes slightly thickened on inner margins. The *gland-spines* are arranged as follows: 1, 1, 1, 1—2, 4—6; the first short and blunt. Second row of *dorsal pores* represented by 1—2 in anterior group; 3rd row by 3—4 in anterior and 4—5 in posterior group; 4th row by 3—5 in anterior and 5—7 in posterior group. Median group of *circumgenital gland-orifices*, 7—10; anterior lateral, 15—26; posterior lateral, 14—18.

REMARKS: The writer has found this scale on *Nyssa sylvatica* at four widely separated locations in southeastern Ohio—Sugar Grove, Fairfield county; Newark, Licking county; Somerset, Perry county; Quaker City, Guernsey county.

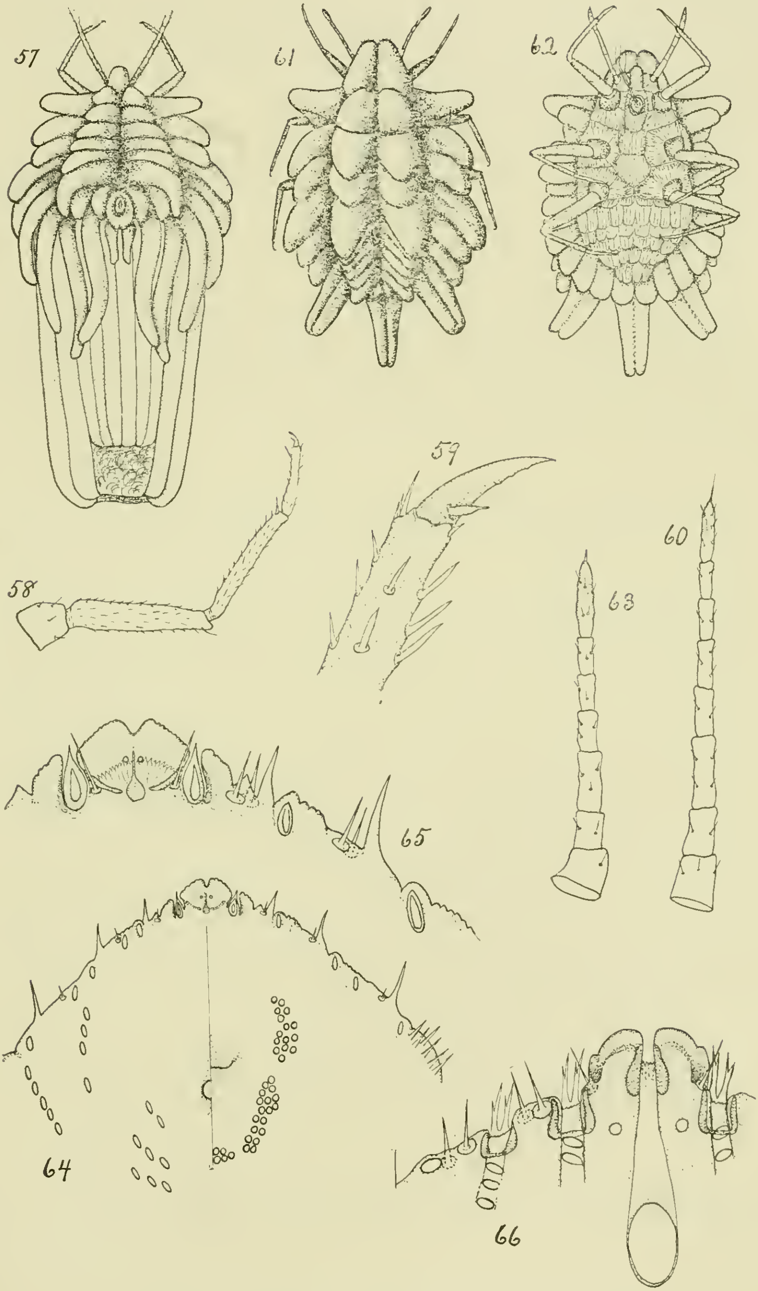
Prof. R. A. Cooley has kindly examined this species and pronounced it a valid one.

ASPIDIOTUS PICEUS, n. sp. Pl. VIII. Fig. 66.

Scale of female: 1.8—2mm. in diameter, flat, often subelliptical to oval, with subcentral exuviae; black shading to dark gray toward margin, having the appearance of pitch covered with dust. The raised, shiny black, deciduous first exuvia is surrounded by an indistinct ring-like depression. When rubbed the second orange exuvia appears. The young scales appear not unlike the young male scales of *A. perniciosus.* When removed a white patch is left.

Scale of male: Elliptical, 1mm. in length, black, with a distinct ring-like depression surrounding the lustrous black exuvia, the posterior flap shading to gray.

Female: With one pair of *lobes*, well developed, prominent, broad, notched midway on lateral margin, with outer corners well-rounded off toward inner angle. Inner margins parallel, not close, bounded by large chitinous processes, which extend somewhat reduced in density around the outer margin to a denser process at outer base of lobe. Second and third lobes rudimentary, sometimes with inner angle of second lobe slightly developed. Interlobular incisions broad and deep, bounded by elongated chitinous processes, the inner usually the larger. There are two perforations anterior to median lobes on a level with the base of chitinous processes of first incision. Between the median and second, and second and third lobes are pairs of di-pointed spine-like *plates*, two-thirds of length of median lobes. On the dorsal surface there is a spine on each of the second and third lobes, and on the ventral surface each lobe bears a spine on the lateral margin laterad of dorsal spine, also spines one-third and two-thirds of distance to penultimate segment. First row of *dorsal pores* (between first and second lobes) of 2;



SANDERS on "Three New Scale Insects from Ohio."

2nd row of about 6; 3rd row, 5—6; 4th row (near margin) of 3—4 orifices. Four or five groups of *circumgenital gland-orifices*, the median sometimes wanting; median, 0—3; anterior lateral, 15—23, averaging 18; posterior lateral, 6—14, averaging 9. Anal orifice very large, removed from margin by about three lengths of median lobes.

REMARKS: Found very abundantly on young *Liriodendron tulipifera*, at Painesville, Lake county, Ohio, July 21, 1903. This species differs from *A. osborni*, its nearest species, by the jet-black exuviae, the very large anal orifice, and the numerous circumgenital gland-orifices.

EXPLANATION OF PLATE VIII.

Figures 57–63—*Orthezia solidaginis*. Fig. 57—Adult female. Fig. 58—Cephalic leg. Fig. 59—Tarsus and claw. Fig. 60—Antenna of adult female. Fig. 61—Dorsal view of immature form. Fig. 62—Ventral view of immature form. Fig. 63—Antenna of immature form. Fig. 64—Pygidium of female of *Chionaspis sylvatica*. Fig. 65—Enlarged view of lobes. Fig. 66—Part of pygidium of female of *Aspidiotus piceus*.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, December 7, 1903.

The meeting was called to order by the President, Mr. Jennings.

Under the head of personal observations, Prof. Kellerman and J. N. Frank reported studies on the teleutospore of Puccinia muhlenbergii, and Prof. Kellerman made some remarks on a puffball. Prof. Schaffner reported that the color of the fruit of the Dandelions varies considerably. Prof. Hine reported work on a small family of Diptera. Mr. Jennings mentioned that ferns formerly called Asplenium pinnatifidum (Muhl.) Nutt. had been examined by W. N. Clute, of the "Fern Bulletin," and pronounced Asplenium ebenoides Scott. Prof. Hine reported a new "Moth Book" by Holland in which it is claimed 1,500 species are figured. Prof. Kellerman outlined the botanical papers presented at the Ohio Academy of Science and Mr. Sanders did likewise for the zoological ones. Prof. Schaffner spoke of the relation of the Ohio Academy of Science to the Biological Club and the Ohio Naturalist. Prof. Kellerman talked on collecting in the Cheat Mountains of West Virginia.

The following new members were elected: F. G. Smith, Harlan H. York, Miss Marie Gill, G. A. Pfaffman and W. G. Jenkins.

The Club adjourned to the second Monday in January.

E. D. COBERLY, *Secretary*.

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TABLE OF CONTENTS

A FURTHER CONTRIBUTION TO THE HEMIPTEROUS FAUNA OF OHIO.*

HERBERT OSBORN.

A preliminary list of the Hemiptera of Ohio was published in the proceedings of the Academy in 1900 (8th Annual Rept.), and a short supplementary list in the 9th Annual Report.

Since these publications a number of new species have been added and much additional data obtained concerning the distribution of some of the rarer forms hitherto noted.

Some of these are of sufficient interest to merit a record at this time, especially as a final report upon the group is yet impossible. It is hoped that during the next two years sufficient collections may be made in certain quarters of the State to render possible a monograph of the State fauna in this group. Several members of the Academy have kindly assisted in gathering material and I am especially indebted to Mr. Dury, Prof. Wetzstein, Mr. J. G. Sanders, Prof. Hine, Mr. O. H. Swezey and T. W. Ditto for such help. Mr. Swezey has secured a number of the Fulgoridae and Mr. Ditto most of the Aphididae included in this list.

The Coccidae have been studied exhaustively by Mr. Sanders, and he has prepared an annotated descriptive list for the State, so I have not introduced detailed records here. Prof. F. M. Webster and Mr. A. F. Burgess published a list of this family (Bull. U. S. Dept. Agriculture), and this list was republished with certain revisions and additions by Mr. Geo. B. King, *Ent. News*, XIV, page 204.

Collections at Cincinnati, the south-east portion of the State and in Ashtabula County are especially desired.

*Read at the meeting of the Ohio State Academy of Science.

With the previous lists of 321 and 60 species these additions give us a list of 528 species for the State.

CICADIDAE.

Cicada canicularis Harr. One specimen of this species which is now separated from the tibicen of Linnaeus. This specimen agrees in size with typical specimens from Maine and is I believe correctly placed here but additional specimens are much desired, The species differs from tibicen in being smaller, about 40 mm. long instead of 50 mm., and the opercles of male are broader than long.

MEMBRACIDAE.

Publilia nigridorsum Godg. Columbus.

Ceresa taurina Fh. Ashtabula.

Ceresa brevicornis Fh. Medina (Hine).

Ceresa vitulus Fab. Ironton (Hine).

Stictocephala lutea Walk. Ironton, Vinton, Hanging Rock, Sugar Grove, Newark.

FULGORIDAE.

Chlorochara conica Say. Sandusky (Swezey). Cincinnati (Dury). Columbus (Koebele).

Scolops dessicatus Uh. Cincinnati (Dury). Hitherto listed for Bellaire only.

Phylloscelis atra Germ. Alate form, Cincinnati (Dury).

Myndus radicis Osb. On roots of various plants. Columbus.

Myndus fulvus Osb. Sandusky and Castalia.

Myndus viridis Ball. ? One specimen agreeing closely with this species except in male styles and frontal markings, was collected at Sandusky by Mr. Swezey.

Myndus pictifrons Stal. Collected at Vinton by Prof. Hine.

Cixius stigmatus Say. Cincinnaii (Dury).

Oliarus humilis Say. Cedar Point, Sandusky. (Swezey) Castalia, Vinton.

Oliarus 5-lineatus Say. Cedar Point.

Kelisia axialis Van D. Quite common at Columbus September and October 1903 and collected by Mr. Koebele and the writer.

Pissonotus aphidiodes Van D. Columbus (Swezey) Koebele?

Pissonotus dorsalis Van D. Columbus (Swezey) June.

Phyllodinus Koebelei Osb. September and October 1903. (Koebele.)

Phyllodinus fuscus Osb. Columbus.

Liburnia Kilmani Van D. Columbus. Newark. (Swezey.)

Liburnia pellucida Fieb. Wooster (Webster), Ironton, Columbus, Georgesville?

Liburnia lineatipes Van D. Columbus (Swezey).

Liburnia lutulenta Van D. Abundant at Columbus, Cedar Point.

Liburnia occlusa Van D. Columbus (Swezey).

Liburnia Gillettei Van D. Newark (Swezey).

Liburnia Osborni Van D. ? Columbus.

Liburnin incerta Van D. Newark (Swezey).

CERCOPIDAE.

Tomaspis bicincta Say. Cincinnati (Dury).

JASSIDAE.

Phlepsius decorus O. & B. Severel specimens collected at Columbus by Mr. Albert Koebele.

Phlepsius majestus O. & B. A specimen seen while collecting but escaped from net. It is a very active flyer and one of the most difficult Jassids to capture.

Thamnotettix lusoria O. & B. Rather plentiful at Columbus in September and October, 1903.

Chlorotettex spatulatus O. & B. Columbus, October, 1903.

Dicraneura communis Gill. Wooster (F. M. W.).

Empoasca obtusa Walsh.

APHIDIDAE.

Phylloxera caryaeren Riley. (Ditto.)
Pemphigus rubi Thos. (Ditto.)
Pemphigus populicaulis Fh. (Ditto.)
Pemphigus populitransversus Riley.
Shizoneura corni Fab. Columbus. (Ditto).
Shizoneura Rileyi Thos. On elm. (Ditto).
Phyllaphis fagi L. Weed. (Ditto).
Lachnus longistigma Monell, on willow, Columbus.
Lachnus platanicola Riley. Columbus.
Cladobius Smithae Monell, on willow, Columbus. (Ditto.)
Cladobius bicolor Oest. Willow. Columbus. (Ditto.)
Cladobius flocculosus Weed. Columbus.
Chaitophorus negundinis Thos. (Ditto.)
Chaitophorus viminalis Monell. (Ditto).
Callipterus discolor Monell. (Ditto).
Callipterus bellus Walsh. (Ditto).
Drepanosiphum acerifolii Thos. (Ditto.)
Aphis cornifoliae Fh. Columbus. (Ditto.)
Aphis maidis Fh. On corn. (Ditto.)
Aphis pomi. Previously listed as mali.
Aphis Fitchii. Columbus. (Ditto.)
Aphis rubicola Oestl. Columbus. (Ditto.)
Aphis crataegifolii Fh. (Ditto.)
Aphis rumicis L. Columbus. (Ditto.)
Aphis prunifoliae Fh.
Aphis maculatae Oestl. (Ditto.)
Aphis marutae Oestl. Columbus. (Ditto.)
Siphocoryne salicis Monell. Columbus. (Ditto.)
Myzus rosarum Walk. (Ditto.)
Rhopalosiphum berberidis Fh. (Ditto.)
Nectarophora cucurbitae Thos. (Ditto.)
Nectarophora pisi. The pea aphis.
Nectarophora circumflexa Buckton. (Ditto.)

COCCIDAE.

Pseudococcus trifolii Forbes.
" pseudonipae Ckll.
Phenacocceus acericola King.
" Osbornii Sanders.
Ericoccus azaleae Comst.
Gossyparia spuria (Modect).
Kermes galliformis Riley.
" pubescens Bogue.
" andrei King.
" trinotatus Bogue
Asterolecanium variolosum (Ratz).
Eulecanium caryae Fitch.
" Fletcheri Ckll.
" Cockerelli Hunter.
" Fitchii Sign.
" canadense Ckll.
" Websterii King.
" tulipifera Cook.
" quercitronis Fitch.
" magnoliarum Ckll.
" querifex Fitch.
" prunastri Fonsc.
Saissetia depressum Targ.
Saissetia hemisphericum Targ.
Pulvinaria innumberabilis Rathv.
Aspidiotus ostreaformis Curtis.
" juglans Comst.
" glandiliferous Ckll.
" lataniae Sign.
" cyanophylli Sign.
Chrysomphalus aurantii Mask.
Aspidiotus comstocki Johns.
" uvae Comst.
" ulmi Johns.
" cydoniae crawii Ckll.
Chionaspis americana Johns.
" gleditsiae Sand.
" carpae Cooley.
" euonymi Comst.
" ortholobis Comst.
Hemichionaspis aspidistrae Sign.
Diaspis boisduvalii Sign.
Parlatoria zizyphus (Lucas).
Fiorinia fiorinniae (Targ.)
Comstockiella sobalis Comst.

HETEROPTERA.

Canthophorus cinctus. Cincinnati. Previously listed for Columbus.

Amnestus pusillus Uh. Cincinnati. (Dury, Coll.)

Corimelaena Gillettei V. D. Ironton.

Mineus strigipes Fab. Columbus.

Podisus maculiventris Say. Spinosus Dall. Generally distributed.

Brochymena 4-pustulata Fab.

Euschistus tristigmus Say var. Van D.

Chariesterus antennator Fab. was noted in various stages on Euphorbia nutans the past summer. Have seen specimens in Cincinnati (Dury, Coll).

Alydus 5-spinosus Say. Sandusky (H. O.). Cincinnati (Dury, Coll.).

Corizus hyalinus. Found in various stages on Euphorbia nutans in September.

Ischnorynchus didymus Zett. Vinton (Hine). Columbus.

Belonochilus numenius Say. Columbus.

Ischnodemus falicus Say. Cedar Point. Sandusky.

Geocoris limbatus Stal.

Cymodema tabida Stal. Ironton.

Cymus angustatus Stal. Columbus.

Cymus lividus Stal. Castalia.

Ligyrocoris constricta Say. Cincinnati (Dury).

Ptochiomera nodosa Say.
Microtoma carbonaria Rossi. Columbus.
Salacia pilosula Stal.
Emblethis arenarius L. Cedar Point.
Lygaeus Kalmii. Stal. Cedar Point. Sandusky.
Aradus aequalis Say. Collected at Cincinnati by Prof. Hine.

Aradus ornatus Say. Collected by Mr. Dury at Cincinnati. This is an especially interesting addition to our list as the species has been unknown since Say's description in 1831, until a few years ago when Bergroth rediscovered it. I have noted it in the Ohio Naturalist, volume IV, page 22.
Aradus Duryi Osb. Cincinnati, collected by Mr. Dury.
Aradus Duzei Bergroth. Westerville, J. G. Sanders. Cincinnati (Dury).
Brachyrhynchus lobatus Say. Cincinnati by Mr. Dury.
Neuroctenus elongatus Osb. Cincinnati (Dury).
Neuroctenus ovatus Stal. Cincinnati (Dury). Two species. Previously recorded for Mexico and North Carolina.
Coriscus propinquus Reut. Columbus.
Opsicoetus personatus L. Has been rather frequent in Columbus and Sandusky.
Pelogonus americanus Uh. Cedar point. Sandusky.
Limnoporus rufoscutellatus Lat. Cedar Point.

OHIO PLANTS WITH EXTRA-FLORAL NECTARIES AND OTHER GLANDS.*

John H. Schaffner.

The existence of glands and nectaries outside of the flower or inflorescence has been a subject of much interest to biologists. Delpino, Darwin, Trelease, and many others have given a large amount of information in regard to the occurence and nature of these organs; yet much is still obscure and any one so inclined may at least obtain considerable pleasure by making observations along this line.

Various views have been held as to the cause and use of extra-floral glands and their secretions. Delpino considered that the power to secrete nectar by any extra-floral organ has been specially gained in every case for the sake of attracting ants and wasps as a body-guard, or as defenders of the plant against enemies. Darwin while admitting that this may be the case in some plants did not think that all such glands originated in this way. He held that the saccharine matter in nectar was excreted as a waste product of chemical changes in the sap and that this product might then become useful for accomplishing cross-fertilization or for attracting a body-guard, and thus the nectary would become an object for selection. He cites the case of the leaves of certain trees where a saccharine fluid, often called honey-dew, is excreted without the aid of special glands. By some, the special use of extra-floral nectar is supposed to be to divert ants and other insects from visiting flowers which they might otherwise injure. But many plants have nectar long before and long after the flowering period. On Viburnum opulus, for example, nectar is still present and abundantly used by ants late in October. Another view has been that certain of these glands act as absorptive

*Read at the Meeting of the Ohio State Academy of Science.

cups and surfaces for the absorption of rain and dew. In Euphorbia pulcherrima, commonly cultivated in green houses, there are very large cup-shaped nectar glands, one on the involucre of each cyathium. There are also stipular glands and glands on top of the petiole at the base of the blade. Ants visit the large glands very extensively and one might be inclined to believe that in such cases the foliar glands are guides to the more abundant sweets to be found higher up when the plant is in bloom. In the case of submerged water plants, as for example in certain species of Potamogeton with glands on the leaves, the entire question of a relationship between insects and glands in general is eliminated.

Besides nectar there are various other secretions; important among which are those with a digestive function and those of a sticky nature to prevent crawling insects from passing certain parts or for holding them fast while they die and decay.

During the past summer, the writer spent some time in studying the glands which appear on the blades, petioles, stipules, and other parts of our native and cultivated plants. The mode of occurrence and the character of these organs is quite erratic. A species may have highly developed glands while its near relatives have none whatever. Even on a given individual, some leaves may have the glands while others have none and rarely is the number constant.

Very common among plants is the presence of gladular hairs or pubescence, like on Petunia violacea, Martynia louisiana, Polanisia graveolens, Silene virginica, and Cypripedium acaule. Punctate glands in the leaf blade and other parts are also abundant as in Xanthoxylum americanum, Polygonum punctatum, Amorpha fruticosa, Hypericum perforatum, and Boebera papposa. The latter has comparatively large, yellow, oval glands which are very conspicuous under a hand lens. Various plants also have glutinous leaves especially when young, but these will not be considered here.

Of plants which have glandular surfaces with digestive secretions especially concerned in capturing and absorbing other organisms as food, we have the following:

1. Sarracenia purpurea.
2. Drosera rotundifolia.
3. Drosera intermedia.
4. Utricularia cornuta.
5. Utricularia vulgaris.
6. Utricularia intermedia.
7. Utricularia minor.
8. Utricularia gibba.
9. Dipsacus sylvestris.
10. Silphium perfoliatum.

In this group probably belong such plants like Silene antirrhina with glutinous bands around the stem and Carduus undulatus, a western species, in which the outer surface of the involucral bracts are very glutinous and catch large numbers of ants which attempt to reach the flowers above, as well as small flying insects. It seems reasonable to suppose that the debris from these decaying insects may serve as food to the captor. Some of the Ohio thistles also have glandular involucral bracts.

Various plants have gland tipped teeth or serrations, as species of Salix, Populus, Prunus, and other genera. In some plants the stipules have prominent nectar glands or are reduced to nectaries. Other gland-like stipules however do not appear to secrete nectar. Among the genera which contain species with glandular or gland-like stipules, the following may be mentioned: Reseda, Linum, Euphorbia, Isnardia, and Circaea.

The more important glands of special interest are those which secrete nectar or those which have attained considerable morphological development. Although it is not easy to make a classification of extra-floral glands because of the indefiniteness of these structures, an arbitrary arrangement will be given below to indicate in a general way their origin and position. Some of the special types I have not yet found on Ohio plants as for example the pit-like nectar glands on the lower surface of the midribs of the leaves of Gossypium herbaceum and other plants. The following types are known to occur in Ohio:

1. Glands which appear on the margin at the base of the blade or on the top or the sides of the petiole and evidently representing highly specialized glandular teeth or serrations; as in Populus and Amygdalus.

2. Highly developed glands under the lobes or teeth of the blade; as in Ailanthus.

3. Special patches of tooth-like glands appearing like modified hairs or eruptions either at the upper or lower end of the petiole or at both; as in Asclepiodora and Asclepias.

4. Patches of pit-like nectaries on the upper side at the lower end of the petiole; as in Tecoma.

5. Single or few nectaries on the petiole not apparently originating from hairs, serrations, leaflets, or stipules; as in Cassia and Ricinus.

6. A series of nectaries on the rachis between the successive pairs of leaflets or divisions; as in Acuan.

7. Glands on the under side of the leaf in the axils of the veins or on the ranchis at the base of the divisions; as in Catalpa and Pteridium.

8. Glands on the rachis apparently representing modified leaflets or stipels; as in Sambucus.

9. Glands on the stipules or representing highly modified stipules; as in Vicia and Circaea.

10. Glands on the calyx or peduncle not showing any evident relation to pollination; as in Tecoma, Paeonia, and Ricinus.

11. Glands on submerged water plants; as in certain species of Potamogeton which have two glands at the base of the leaf blade.

During the past summer ants were found abundantly on the following plants, working at the nectar and crawling over the leaves and branches:

Cassia marylandica.
Cassia chamaecrista.
Acuan illinoensis.
Prunus avium.
Amygdalus persica.
Tecoma radicans.
Ricinus communis.
Viburnum opulus.

Some of the foliar glands are also visited by bees and may thus be important in the production of honey, as the large nectariferous glands on the leaves of Catalpa.

Extra-floral nectaries make an interesting object lesson well suited for advanced nature study and for elementary botany. The subject is no less important because the reason for the phenomenon is not so very evident and because the teacher is not able to give a conclusive answer so easily. In winter one may readily obtain material for study by sprouting sweet potatoes (Ipomoea batatas) in a dish with moist sphagum and sawdust. The large foliar glands of the first leaves secrete an abundance of nectar.

Below is given a partial list of the native and cultivated Ohio plants with glands, together with numbers referring to the eleven types indicated above.

1. Pteridium aquilinum, 7.
2. Potamogeton hillii, 11.
3. " obtusifolius, 11.
4. " friesii, 11.
5. " pusillus, 11.
6. Sporobolus heterolepis, 10.
7. Populus heterophylla, 1.
8. " candicans, 1.
9. " balsamifera, 1.
10. " dilatata, 1.
11. " deltoides, 1.
12. " grandidentata, 1.
13. " tremuloides, 1.
14. Salix nigra, 1.
15. " amygdaloides, 1.
16. " lucida, 1.
17. " fragilis, 1.
18. " alba, 1.
19. " babylonica, 1.
20. Crataegus coccinea, 1.
21. " rotundifolia, 1.
22. " macrantha, 1.
23. Prunus armeniaca, 1.
24. " americana, 1.
25. " pumila, 1.
26. " cerasus, 1.
27. " avium, 1.
28. " pennsylvanica, 1.
29. " mahaleb, 1.
30. " virginiana, 1.
31. " serotina, 1.
32. Amygdalus persica, 1.
33. Acuan illinoensis, 6.
34. Cassia nictitans, 5.
35. " chamaecrista, 5.
36. " marylandica, 5.
37. Vicia sativa, 9
38. " angustifolia, 9.
39. Vigna sinensis, 10.
40. Ailanthus glandulosa, 2.
41. Acalypha ostraefolia, 3(?).
42. " virginica, 3(?).
43. " gracilens, 3(?).
44. Ricinus communis, 5, 10.
45. Euporbia dentata, 9.
46. Impatiens biflora, 1.
47. " aurea, 1.
48. Circaea lutetiana, 9.
49. " alpina, 9
50. Asclepias incarnata, 3.
51. " sullivantii, 3.
52. " amplexicaulis, 3.
53. " variegata, 3.
54. " syriaca, 3.
55. Ipomoea batatas, 7.
56. Tecoma radicans, 4, 10.
57. Catalpa catalpa, 7.
58. " speciosa, 7.
59. Sambucus canadensis, 8, 9.
60. " pubens, 8; 9.
61. Viburnum opulus, 1, 9.
62. " lentago, 1.
63. Viburnum prunifolium, 1.

NOTE ON MORPHOLOGY OF CERTAIN CLASPING ORGANS IN THE PEDICULIDAE.

HERBERT OSBORN.

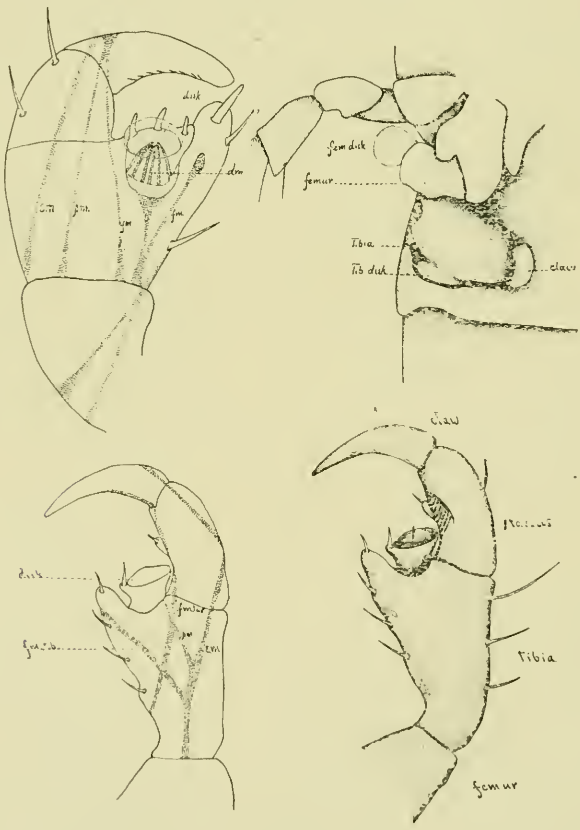
The results of Parasitism in developing special organs for adherence possess a prominent Morphological interest since these organs exhibit a high degree of specialization which contrasts markedly with the degeneration of other sets of organs. The Pediculidae present a number of instances of such structures which seem not to have been described in detail and the purpose of this note is to call attention to some of them.

In Haematopinus urius there is a protractile disk at the distal end of the tibiae, the purpose of which, as suggested in an earlier note, being to press against the hair in opposition to the tarsal claw and thus assist in the hold upon the hair. In the previous description of this structure no attempt was made to explain the apparatus or its movements, but it was mentioned that the disk played back and forth in a pit-like depression of the tibiae, and the examination of balsam mounts of this organ fails to show very clearly the basis of movement. There is a large muscle running through the tibia and forking near the middle of the tibial joint, one part going to the tibial spur, the other passing on to the tarsal joint while from the latter a fiber runs to the base of the protractile disk. This would seem able to retract the organ and combined with an elastic frame-work for the protraction would account for the movements. I have been entirely unable to discover any muscle strands which would seem to act for the protraction and believe that this may be provided for in the movements of the chitinous wall assisted partially by the flexion of the tarsal joint. The figure shows the distribution of the muscle strands as noted in the majority of specimens examined.

In Haematopinus macrocephalus there is a disk-like organ in the same position as in the preceding species, but it differs from the protractile disk in urius in having a convex surface, apparently membranous, and within the bulb of the organ may be seen a half dozen strands of muscles, the contraction of which would serve to withdraw the surface membrane. The muscle strand runs from the base of the tibiae to the cup-like depression of the disk, but not having examined this organ in living specimens the extent of the protraction, if any, is unknown. The musculature of the tibial joint is shown in the accompanying figure.

In Euhaematopinus abnormis the posterior pair of legs is very greatly modified, so much so that they cannot serve any function as ordinary organs of locomotion, but must be adapted purely for clasping, the femur and tibia each possessing expanded disks, the former upon the anterior part of the femur and so arranged that it must press against the femur of the middle legs and with them doubtless forms a clasping organ ; the latter, upon the outer face of the tibiae is adjusted to a special structure in the margin of the abdomen and which serves to crowd the inner face of the tibia against the abdominal wall. The claw is a broad, nail-like structure apparently incapable of distinct flexion. Both tibia and femur seem to provide special means of rigidly clasping the hairs of the host animal, and if we bear in mind the subterranean habits of its host, the development of such special organs may be accounted for.

Special organs for clasping occur also in the antennae and abdominal brushes of certain species, but these have been mentioned, perhaps, in sufficient length in other papers.



Lower figures : Haematopinus urius.
Upper left hand figure : H. macrocephalus.
Upper right hand figure : Euhaematopinus abnormis.

A LIST OF THE ORTHOPTERA OF OHIO.*

CHARLES S. MEAD.

A little over a year ago the writer, at the suggestion of Prof. Herbert Osborn, began to work over the Orthoptera in the Entomological collection at the Ohio State University, with a view of eventually publishing a list of those found in Ohio. During the spring and fall, collecting was done in central Ohio and during the summer in northern Ohio, mostly in the neighborhood of Sandusky. Heretofore, very little work has been done on the grasshoppers of Ohio and nothing published. Very few references are found in the literature to Orthoptera collected in this state. The Orthoptera, in general, reach their adult condition in late summer and early fall, only a few species maturing and dying before the first of August. Some of the species listed below are fairly common in parts of Ohio and others are quite scarce.

Syrbula admirabilis (Uhler). This is a southern form with its northern range about the center af Ohio. On September 23 three females were captured at Buckeye Lake.

Orphulella speciosa (Scudder). Blatchley reports having captured but a single pair in Indiana, where it is quite scarce. Morse writes of its being common in the New England states. It is fairly plentiful in the vicinity of Columbus and Sandusky.

Hippiscus rugosus (Scudder). On September 23, a coral winged form of this species was captured at Buckeye Lake. It agrees with the descriptions of "rugosus" in all particulars except the color of the wings, which are usually lemon or orange. No mention could be found in the literature of a coral winged form.

Trimerotropis maritima (Harris) This is a very abundant species on Cedar point, where three well marked color forms occur: a light, ashy red form with the mottling on the tegmina and body indistinct; a form with the dorsal portion of the tegmina cinnamon red; and a dark gray form, the last being the most common. Specimens agreeing with "maritima" and "citrina" are present and also so many intermediate forms that it is impossible to draw a line between the two. Both have been included under "maritima" in the state list.

Spharagemon wyomingiana (Thomas). Specimens of this species were quite plentiful on Cedar Point in the woods about midway between the laboratory and the steamer landing. They could be captured there nearly any time during the summer, and were found in no other locality, either on the Point or on the mainland.

*Contributions from the Department of Zoology and Entomology, Ohio State University, No. 16. Read at the meeting of the Ohio State Academy of Science.

Leptysma marginicollis Serville, has been recorded only from Florida, South Carolina and central Indiana. A single immature female was captured July 11, 1903, on Cedar Point near Black Channel.

Melanoplus viridipes Walsh-Scudder, reported hitherto only from western Indiana and Illinois. A colony of these was found in Highland county and they are fairly common in Franklin county. They are one of our spring locusts, almost never being found after the first of August.

Melanoplus blatchleyi Scudder. The range of this grasshopper is west of the Mississppi river, Marion county, Indiana, being the most easterly point from which it has been recorded. During the past summer it was captured in Franklin and Erie counties, Ohio, a single specimen being secured in each, and a careful search failed to reveal any others.

Conocephalus palustris Blatchley. This species was described from Indiana and has not been reported from any other state. Specimens are in the collection at the State University from Columbus and Castalia.

Xiphidium nemorale Scudder. This is another southern form that is found quite plentiful around Sandusky Bay.

Xiphidium strictum Scudder. The general range of this insect, as heretofore recorded, is to the west and southwest ; but it is common in central and northern Ohio.

Orchelimum volantum Mc Neill, has been recorded only from Indiana and Illinois, but two adult specimens were captured on Cedar Point in August, 1903.

Nemobius maculatus Blatchley, reported only from Indiana, was captured in several localities in Franklin county, Ohio, this fall.

Gryllus americanus Blatchley, a recently described species from Indiana, was found near Georgesville, Franklin county in May.

The rest of the species are such as one would expect in the state, from their known range in adjacent regions.

At present there are 99 species to record for Ohio, distributed among the families as follows :

Forficulidae, 2.	Acrididae, 33.
Phasmidae, 1.	Locustidae, 29.
Blattidae, 5.	Gryllidae, 19.
Tettigidae, 10.	

The following is a list of the species so far collected in Ohio. Those marked with a *, 38 in number, have been found on Cedar Point.

FORFICULIDAE.

*Forficula aculeata Scudd. Labia minor L.

PHASMIDAE.

*Diapheromera femorata Say.

BLATTIDAE.

Blatta orientalis L.
Ischnoptera uhleriana Sauss.
Periplaneta americana L.
Blatella germanica (L.).
*Ischnoptera pennsylvanica De G.

TETTIGIDAE.

Nomotettix carinatus Burm.
Tettix granulosus Kirb.
*Tettix arenosus Burm.
*Paratettix cucullatus Burm.
*Tettigidea parvipennis Morse.
Nomotettix cristatus Morse.
Tettix obscurus Hanc.
*Tettix ornatus Harris.
Tettigidea armata Morse.
Tettigidea parvipennis pennata [Morse.

ACRIDIDAE.

*Chloealtis conspersa Harris.
Orphulella speciosa (Scudd.).
Dichromorpha viridis Scudd.
Syrbula admirabilis (Uhler).
Arphia sulphurea Fab.
Chortophaga viridifasciata De G.
Camnula pellucida (Scudd.).
Hippiscus rugosus Scudd.
*Spharagemon bolli Scudd.
*Spharagemon wyomingiana (Thom).
*Leptysma marginicollis (Serv).
Schistocerca alutacea Harris.
Melanoplus luridus Dodge.
Melanoplus viridipes W-S.
*Melanoplus atlanis (Riley).
Melanoplus differentialis (Riley).
Paroxya hoosieri (Blatchley).
*Stenobothrus curtipennis Harris.
Orphulella pelidna Burm.
*Tryxalis brevicornis L.
*Mecostethus lineatus (Scudd.).
Arphia xanthoptera Burm.
*Encoptolophus sordidus Burm.
Hippiscus tuberculatus D. de B.
*Dissosteira carolina L.
*Spharagemon collare Scudd.
*Trimerotropis maritima Harris.
Schistocerca americana Drury.
Melanoplus gracilis Brunner.
Melanoplus scudderi Uhler.
*Melanoplus femur-rubrum (De G.)
Melanoplus blatchleyi Scudd.
*Melanoplus bivittatus Brunner.

LOCUSTIDAE.

Scudderia curvicauda Stal.
Scudderia texensis Sauss-P.
Amblycorypha rotundifolia Scudd.
Microcentrum laurifolium L.
Conocephalus palustris Blatch.
Conocephalus nebrasensis Brunner.
*Xiphidium brevipenne Scudd.
*Xiphidium nigropleura Brunner.
Xiphidium fasciatum De G.
*Orchelimum nigripes Scudd.
*Orchelimum delicatum Brunner.
Atlanticus dorsalis Burm.
Ceutophilus maculatus (Say).
Ceutophilus uhleri Scudd.
Ceutophilus sp.
*Scudderia furcata Brunner.
*Amblycorypha oblongifolia De G.
Microcentrum retinerve Brunner.
Cyrtophyllus concavus Harris.
*Conocephalus ensiger Harris.
*Xiphidium attenuatum Scudd.
Xiphidium strictum Scudd.
Xiphidium nemorale Scudd.
*Orchelimum vulgare Harris.
*Orchelimum campestre Blatchley.
*Orchelimum volantum Mc Neill.
Atlanticus pachymerus Burm.
Ceutophilus blatchleyi Scudd.
Ceutophilus terrestris Scudd.

GRYLLIDAE.

Gryllotalpa borealis Burm.
*Gryllus abbreviatus Serv.
Gryllus domesticus L.
Nemobius canus Scudd.
*Nemobius carolinus Scudd.
Oecanthus angustipennis Fitch.
*Oecanthus 4-punctatus Beut.
Oecanthus latipennis Riley.
*Anaxipha exigua Say.
Tridactilus apicalis Say.
Gryllus americanus Blalchley.
*Nemobius fasciatus (De G.).
Nemobius exiguus Scudd.
Nemobius maculatus Blatchley.
Oecanthus bipunctatus De G.
Oecanthus niveus De G.
*Oecanthus fasciatus Fitch.
Phylloscirtus pulchellus Uhler.

[Ohio State University.]

ADDITIONAL RECORDS OF OHIO BIRDS.

LYNDS JONES.

Rev. W. F. Henninger, of Tiffin, reports the following additional records from the collection of the Wynous Point Shooting Club near Sandusky:

Chen hyperborea nivalis, shot in the fall of 1886.

Olor buccinator, shot in the fall of 1877.

Anser albifrons gambeli, shot in the fall of 1877.

Oidemia deglandi, a female, shot in the fall of 1881.

A hybrid between Anas obscura (rubripes?) and Anas bochas, killed in the fall of 1878, by Judge E. B. Sadler.

Aythya americana, a pure albino, female, captured in the fall of 1881.

Fulica americana, a partial albino, captured in the fall of 1881, by C. J. Clark.

Gallinago delicata, a partial albino, captured in the fall of 1881, by C. J. Clark.

Falco peregrinus anatum, a male captured in the fall of 1882, by Col. E. A. Scoville.

All of the Ohio ducks were represented in this collection, among them the rare Gadwall, in several specimens.

Mr. A. Hall, of Lakewood, informs me that the specimen of Dendroica kirtlandi reported as captured May 3, 1878, by W. and J. Hall was captured by himself instead.

Mr Hall furnishes me with the following additional records: Himantopus mexicanus, Black-necked Stilt, one shot at Berea, October 24, 1881. Mimus polyglottos, Mockingbird, January 5, 1904, singing. He states that this is the sixth specimen which he has reported near Cleveland. It seems probable that the theory of escaped cage birds for these records will have to be abandoned.

I am pleased to report the presence of Pinicola enucleator leucura, Canadian Pine Grosbeak, in some numbers practically all along the Lake front. Also the record of two Acanthis linaria, Redpoll, on December 29, 1903. These two northern species are decidedly unusual in northern Ohio.

On December 4, 1903, a single Hermit Thrush was found near Brownhelm, Lorain county, and on January 1, 1904, a single Vesper Sparrow, at Kishman's Switch on the lake shore.

Mr. R. J. Tozer informs me that there is a large Crow roost in Lake View Cemetery, Cleveland, where hundreds of Crows remained all winter long. In Lorain county there have been many more Crows present during the present winter than ever before.

[Oberlin, Ohio.]

BOOKS RECEIVED.

Two volumes have recently come to hand from the pen of W. S. Blatchley, State Geologist of Indiana.

"Gleanings from Nature" is published by the Nature Publishing Company of Indianapolis and is dedicated to the 800,000 boys and girls of the state of Indiana. The author writes in a popular way from personal observations on birds, snakes, fishes, flowers, insects, weeds, swamps and caves and treats them in an interesting and instructive manner, giving the information the youth especially is always desirous of knowing. Since we have read the book and compared the plants and animals mentioned with the flora and fauna of Ohio we find that almost without exception the forms treated are common to the two states, therefore, although it is written with special reference to the natural history of Indiana, it is almost as valuable for Ohio and doubtless for a number of other states.

"The Orthoptera of Indiana" is a reprint from the 27th Annual Report of the Department of Geology and Natural Resources of the state of Indiana.

The glossary and chapter on anatomy are features which add greatly to its usefulness as by this means the characters used in the keys and descriptions are made plain. One hundred and forty-eight species are given as occurring in Indiana, with full descriptions, and keys for determining each species. We find this work very appropriate for determining our Ohio Orthoptera and already we have recognized nearly a hundred of the forms given in it for Indiana. Students of the group cannot afford to be without a copy and students in general Entomology will find it valuable.

J. S. H.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, February 1, 1904.

The meeting was called to order by the President, Mr. Sanders, and the minutes of the previous meeting read and approved.

The paper of the evening was given by Professor Minnie A. Stoner of the Domestic Science Department. She outlined the work in Domestic Science as given by the University, both in the long and short courses and made mention of several improvements contemplated, especially along the line of research work. She also gave a short history of Domestic Science courses in the United States and told in brief of the work which is going forward in the various public and private institutions of this country in which such departments are established.

Professor Kellerman gave his ideas upon industrial courses in various schools, and Domestic Science courses in particular thinking that they should to be expanded.

Mr. Sanders gave a short biographical sketch of Linnaeus after which Dr. Kellerman, Professor Osborn and Professor Schaffner discussed the work of Linnaeus as a systematist.

Under current literature, Professor Osborn presented a recent publication from the Biological laboratory of the University of Illinois on the Plankton in the Illinois river. Professor Kellerman reported that no flowers of any kind had been observed in bloom during January of this year.

Mr. Morse announced the lecture by Dr. David Star Jordan at the First Congregational Church on February 16th, under the auspices of the Philosophical Club.

The Club adjourned to the first Monday evening in March.

E. D. COBERLY, *Secretary.*

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GALLS AND INSECTS PRODUCING THEM.*

Melville Thurston Cook.

Part VI. Flower and Fruit Galls.

Galls affecting flowers and fruits are not so abundant as those affecting leaves, but in many cases the insect which produces flower or fruit galls also produces leaf galls. No sharp line of distinction can be drawn between flower and fruit galls, since the gall may form and mature without indication of fruit or may form in the flower and mature as the fruit develops. Thus far I have collected five species of flower and fruit galls representing three orders of insects.

1. GALLS OF THE ACARINA.

Phytoptus sp.—on Euphorbia corallata L. (Figures 70; 71a, b; 72a, b). This mite produces galls on both leaf and flower. The structure of the gall is the same in both cases and is identical with Phytoptus galls, previously described in Part I, (Figures 8–11). All my specimens of this gall were well advanced. The structure of the leaf of E. corallata (Fig. 70) is typical. When attacked by the Phytoptus the leaf becomes very much modified by thickenings, ridges and convolutions (Figures 71a, b). The palisade cells divide so that it is impossible to distinguish them from the mesophyll, and the intercellular spaces are obliterated as the result of the rapid cell division. The new cells are small and very rich in protoplasm, but gradually become filled with tannin as the gall approaches maturity. The tannin first forms in the outer and most exposed cells of the gall while the inner layers of cells retain their protoplasm very late. The Phytoptus restricts its attacks to these inner and more protected parts. From a study of these galls it is apparent that the Phytoptus is not working on

*Contributions from the Department of Zoology and Entomology, Ohio State University, under the direction of Prof. Herbert Osborn, No. 17.

all parts of the gall at the same time, but gradually moves outward over the surface of the leaf, thus increasing the size of the gall and drawing its food supply from the newer part thus formed.

When the attack is made upon the flower we have a mass of distorted tissue which is structurally the same as that produced in the leaf gall (Figures 72a, b). The floral envelopes are the first to suffer from the attack, the ovary with its contents is the next greatest sufferer, while the stamens are frequently unaffected. It is evident that the attack upon the flower must be made very early in order to cause complete destruction. Very frequently the floral envelopes will be very much deformed and the ovary and the stamens very slightly affected. In other cases the ovary will be very much enlarged and its chambers practically obliterated. It is evident that the attack upon the ovary must be made very early to produce a great deformity. The partial immunity of the stamens is probably due to their being very nearly mature before the opening of the bud.

2. GALLS OF CECIDOMYIA.

Cecidomyia anthophila O. S.—on Solidago canadense L. (Figs. 73a, b), makes the attack early and completely prevents the opening of the bud. The gall is in the form of a hollow cone. The transformation is so complete that the location is the only evidence that the gall is produced from a flower bud. A section of the gall shows the nutrient layers of the cells next to the larval chambers, large parenchyma cells near the outer epidermis, and a number of rather weak fibro-vascular bundles.

Cecidomyia sp.—on Ratibida pinnata Barnhart (Figs. 74a, b, c). The entire bud is transformed into a gall with the larva in a chamber in what was originally the ovary. All the floral parts have become modified and united to form the gall. A section of the gall (Fig. 74c) shows that the cells are more uniform in size than in the preceding galls and that the fibro-vascular bundles are practically obliterated.

Cecidomyia sp.—on Prunus virginiana L. (Figs. 75a, b). My specimens of this gall were mature. I am unable to say at what time the gall originates, but it reaches its maturity with the fruit. The gall is somewhat larger than the fruit, but otherwise resembles it closely. The larva makes its exit through an opening at one side of the stem. The larval chamber is very large, thus giving the gall a bladder-like character. The cuticle is well developed and the parenchyma cells below it are very large, while the cells next to the larval chamber are much smaller. Weak fibro-vascular bundles are also present. The wall of the gall (Fig. 75b) is much thicker than the wall of the fruit at this time (Fig. 75a), and parenchyma cells are much larger. The characteristic stone (sclerenchyma) of the fruit is never developed in the gall.

3. GALLS OF LEPIDOPTERA.

I gathered a number of Lepidopterous galls on Rudbeckia laciniata L. which I was unable to determine. These galls occur on both leaf and flower and are very large and fleshy. In fact they were so fleshy and juicy that it was very difficult to secure sections. The parenchyma cells were very large, and small fibro-vascular bundles were numerous. The larval chambers were numerous and each contained a single larva or pupa. In my specimens the larvae were far advanced, many of them in the pupa stage, but the cells next to the chambers were very rich in food supply.

PART VII. ROOT GALLS.

Amphibolips radicola Ashm. (Figs. 76a, b).—on Quercus alba L. was the only root gall that I collected. The galls were borne just under the surface of the ground at about the point of transition from stem to root. They were produced in great numbers and so closely packed together as to assume the shape of figs. Those nearest the surface of the ground and therefore slightly exposed to the light were of a rich, red color, while those deeper in the ground were almost white, slightly tinged with yellow. Each gall contained from one to five larval chambers. The younger galls showed four zones well defined (Fig. 76a). The inner or nutritive zone was thick and the cells contained abundance of protoplasm. The protective zone was thin and the cells fibrous in character rather than sclerenchymatous. The parenchyma zone was thick and composed of large parenchyma cells. The epidermal zone was relatively thick and the cells firm. As the insects approach maturity the nutritive and protective zones are entirely destroyed (Fig. 76b). The insect eventually makes its escape through an opening in the side of the gall.

PART VIII. HISTOLOGY OF GALLS.

Many of the histological characters of galls have been referred to in the preceding parts. This part has been introduced at this time for the purpose of adding a few additional facts which were not clear at the time of the writing of the preceding parts.

A. Internal Structures.

I. GALLS OF ACARINA.

These galls have been sufficiently discussed and need very little attention at this time. In general these galls may be thrown into three groups: (1) Those galls in which there is very little distortion, but a modification of the epidermis, as in the case of the Phytoptus on the beech; (2) Convolutions of the parts as in the case of P. ulmi (Fig. 8), P. abnormis (Figs. 9, 44), P. quadripes (Figs. 10, 43), and P. acericola (Figs. 11, 45). These convolutions result in the formation of a more or less well defined cavity, and trichomes are developed in great abundance in the younger stages; (3) Thickening of the parts which become covered with an abundant growth of trichomes as in the case of E. anomalum (Figs. 47, 48).

The Phytoptus galls show two fairly well-defined zones, the outer made up of rather large cells and the inner of much smaller cells, which are very rich in protoplasm and which supply nourishment for the young animal (Fig. 77). As the galls approach maturity the protoplasm disappears, first from the outermost cells and lastly from the cells on the inner surface. As the protoplasm disappears the tannin accumulates in great abundance (Fig. 78).

2. GALLS OF THE APHIDIDAE.

Many of the Aphididae galls produce trichomes which soon disappear. At first all the cells contain protoplasm and divide rapidly, but as the galls approach maturity the tannin increases in abundance.

Schizoneura americana Riley (Fig. 12), Colopha ulmicola Fitch (Fig. 13), and Hormaphis hamamelis Fitch (Fig. 15) have been considered in Part I.

In Pemphigus populi-transversus (Figs. 55, 56) and P. p.-caulis (Figs. 57, 58) the thickness of the walls of the galls is much greater than any other members of this family and the cells are more uniform in character. These galls are especially well supplied with fibro-vasular bundles and are very dense.

In P. vagabundus (Fig. 112) we have a gall in which many of the cells are elongated similar to C. ulmicola and H. hamamelis. Its close structural resemblance to C. ulmicola and H. hamamelis and unlikeness to P. p.-transversus and P. p.-caulis is due to the fact that P. vagabundus, C. ulmicola, and H. hamamelis are formed on the blades of the leaves, while P. p.-transversus and P. p.-caulis are formed on the petioles which are made up largely of fibro-vascular tissue. My specimens of these galls were mature, and I am therefore unable to say anything concerning their early stages.

In the Phylloxera galls all the cells are at first rich in protoplasm and the tannin does not form in abundance until very late. The two zones are fairly prominent. In P. c.-caulus Fitch on H. ovata, a gall which forms on both blade and petiole of the leaf and also on young stems large intercellular spaces are formed near the surface.

3. GALLS OF PSYLLIDAE.

Pachypsylla c.-mamma Riley has been described in Part V (Figs. 59, 60).

4. GALLS OF CECIDOMYIA.

These galls have been described in Part I (Figs. 22, 23, 24), in Part V (Figs. 61, 62, 63), in Part VI (Figs. 73, 74, 75), and in the Appendix (Figs. 114–119). In these galls the two zones are usually fairly well defined, but the galls of this genus are so different in character that it is difficult to give a definite description. The time for the formation of the tannin is variable, but it is usually produced late and in great abundance.

5. GALLS OF THE CYNIPIDAE.

All these galls are very similar. The majority show the four zones and in most cases these zones are well defined. The outer zone is the epidermal which will be described later (Figs. 84–91). The second is the parenchyma zone; the third is the protective zone made up largely of sclerenchyma, and the fourth or innermost is the nutritive zone. In many cases the second and third zones become partially or entirely separated. This separation, however, is not between the second and third zones as previously stated by me in Parts I and V, and by Fockeu, but rather a separation of the tissues of the second or parenchyma zone, the greater part of this zone clinging to the epidermal zone and a few cells remaining attached to the protective zone.

Diastrophus siminis Bassett (Figs. 66–69) has been described in Part V. The four zones are distinct and each shows the character previously referred to.

Diastrophus nebulosus O. S., described in the Appendix (Figs. 129a, b), is a stem gall in which the zones are well defined, the protective zone being especially well developed. Each zone shows the characters previously referred to.

In Amphibolips confluentus Harris (Figs. 121a, b, c) the first and second zones are well developed, but the distinction between the third and fourth is not so pronounced.

In Amphibolips inanis O. S. (Fig. 28) the four zones are well defined. In the young gall (Fig. 79) the cells of the nutritive zones are very rich in protoplasm and there is very little or no distinction between the nutritive and the protective zone, but as the galls approach maturity the cells of the protective zone become very thick and are soon converted into sclerenchyma (Fig. 80).

In Callirhytis papillatus O. S. we have the four zones well defined (Fig. 30). As the gall approaches maturity the cells of the nutritive zone lose their protoplasmic contents and become very much shriveled, the protective zone is made up usually of only two or three layers of cells. Next to the protective zone are two or three layers of cells which are in reality a part of the parenchyma zone. The large intercellular spaces formed in this zone are bridged by long unicellular threads, but no fibro-vascular bundles (Fig. 81)

Dryophanta palustris O. S. galls show the four zones well defined (Figs. 29, 65). When mature the contents of the cells of the nutritive zone has been entirely used by the insect. The protective zone consists of only two or three layers of sclerenchyma cells, to which are attached a few cells of the parenchyma zone (Fig. 82).

Andricus petiolicola Bassett (Fig. 124) produce a very hard petiole or mid-rib gall which shows the four zones well defined. There is no separation between the second and third zones. The nutritive zone is at first very prominent, but it is reduced as the gall approaches maturity. The protective zone developes its sclerenchyma character rather late (Fig. 83) and gradually merges into the two adjacent zones.

B. Epidermal Structures.

The epidermal cells vary in the size and in the thickness of the cell walls. The galls may be smooth, pubescent or covered with spiny structures. The amount of pubescence depends somewhat on the natural pubesence of the host plant. Galls on such smooth plants as Populus deltoides Marsh show very few and very small trichomes, while galls on plants that are naturally pubescent are likely to be pubescent. These trichomes vary in shape and general character and are very prominent when the gall is young. As the gall approaches maturity the trichomes usually disappear. When these trichomes drop off their place of former attachment is marked by a small mass of small cells, usually containing tannin and from which imperfect rows of cells seem to radiate (Figs. 84–90).

1. GALLS OF CYNIPIDAE.

Dryophanta palustris O. S. is very pubescent when young (Fig. 84a). In the mature gall the cells are much larger, the trichomes have disappeared and their point of attachment is made visible by the accumulation of tannin (Fig. 84b).

All my specimens of Amphibolips inanis O. S. were fully developed, but the points where the trichomes had evidently been attached were very prominent (Fig. 85). These points are the large, black spots so prominent on these large bladdery galls.

In Diastrophus siminis Bassett the trichomes are very large (Fig. 86) and drop off very readily.

In Diastrophus potentillae Bassett the trichomes are very numerous and each is at the apex of a very small elevation (Fig. 87). Examination of the epidermis of Acraspis erinacei Walsh show that its spines were due to similar but much more prominent elevations.

2. GALLS OF THE APHIDIDAE.

Galls belonging to this family are usually less pubescent than those belonging to the Cynipidae. The trichomes are usually much shorter and frequently less numerous. Each trichome is usually made up of a single cell (Fig. 88). The place where these trichomes were attached is marked by an accumulation of tannin, the same as in the Cynipidous galls (Figs. 89, 90).

Examination of the galls of the Phylloxera spinosa Shimer show that the spines were due to the same cause as in the Cynipidous galls (Fig. 87).

Galls of Pemphigus p.-transversus Riley (Fig. 91) and P. p.-caulis Fitch were perfectly smooth, but the cell walls were much thicker than in any other galls studied.

CONCLUSION.

1. The inner layer of cells (i. e., those next to the larva) are always supplied with nutriment until the insect is mature.

2. The development of the other layers of cells is for the protection of the larvae. These protective devices reach their highest development in the Cynipidous galls.

3. In the very young galls there is usually little or no distinction between the nutritive and protective zones. The time of the differentiation of the protective zones varies in different species.

4. The fibro-vascular bundles are most prominent in galls on the petiole and mid-rib.

5. Most galls are covered with trichomes which disappear as the galls approach maturity. The number of trichomes is variable in proportion to the pubescence of the host plant.

6. Spines are due to elevations composed almost entirely of epidermal cells.

PART IX. OVIPOSITORS AND MOUTHPARTS.

One of the most prominent questions concerning the formation of galls which presents itself to the students of entomology and botany and even to the most casual observer, is the exciting factor in gall production. Is the stimulus from the ovipositor or mouth-parts? Is it mechanical or chemical? The author believing that the logical method of solving this problem was to first make a careful study of the morphology and development of galls has published the preceding parts of this paper. The author does not claim to have found a complete solution of the problem, but is hopeful that some of the facts stated in this series of papers may lead to more thorough and satisfactory studies of the problem. The problem presents many difficulties; the parasites and inquilines which are usually present are frequently difficult to distinguish from the real gall-maker; this is especially true when the study is confined to the larvae. In the following studies the author is reasonably certain that the determinations are correct.

OVIPOSITORS.

Gall-making insects deposit their eggs by two methods, either on the surface of the plant or within the tissues. Those insects which deposit their eggs on the surface usually have mouthparts developed for sucking, while those which deposit their eggs within the tissues usually have mouthparts developed for biting. Those which deposit their eggs on the surface of the plant are the Acarina, the Hemiptera, and the Diptera. Those which deposit their eggs within the tissues are the Hymenoptera and the Lepidoptera. In this paper we have made a careful study of the ovipositors of Cecidomyia gleditsiae, of Nematus sp———, Dryophanta palustris, Amphibolips radicola, Andricus cornigerous, A. seminator, and Rhodites radicum. A number of others were examined, but because of the uncertainty as to determination are not figured.

The Cecidomyia ovipositor (Fig. 92) is not suited to puncturing tissues. The gall is never formed until after the hatching of the larva. In this case it is evident that the stimulus, whether mechanical or chemical, is produced by the larva.

Insects belonging to the genus Nematus deposit their eggs either on the surface of the plant or in slits made by the ovipositor (Figs. 93a, b). It is said that the galls are formed from these wounds before the larva escapes from the egg, and in these cases it is claimed that the irritating cause is a drop of fluid secreted by the parent insect. Westwood claims that the egg increasing in size is a result of imbibing sap from the wound in the plant. It is well known that the eggs of some insects increase in size as a result of the growth of the embryo within the egg. I have so far been unable to make any satisfactory observations upon the Nematus galls, but it is probable that the eggs increase in size from the growth of the embryos and not as a result of the absorption of plant sap. It is also possible that the gall may be the result of the mechanical irritation of the ovipositor or the enlargement of the egg or both. The wound caused by the ovipositor of the Nematus is very much more severe than the wounds caused by the ovipositors of the Cynipidous insects.

Adler, after a careful observation on Nematus Vallisnierii, says: "This fly, which is armed with a finely serrated terebra, cuts into the tender leaves of the end of the shoot of the Salix amygdalina, and inserts her egg into the open wound, frequently placing several in the same leaf. At the same time the glandular secretion flows into the wounded leaf. A few hours after this injury the leaf surface presents an altered appearance, and new cell formation begins freely, leading to a thickening of the surrounding leaf surface. After the lapse of about fourteen days the green and red-shaped gall is fully grown. If it be now opened the egg can still be seen lying within the cavity. The embryonic development is as yet unfinished and three weeks elapse before the larva emerges from the egg to find around it the material prepared for its nutriment. In this case the wound caused by the fly is the immediate exciting cause of cell activity, and leads to gall formation."

M. W. Beyerinck, in a paper regarding the growth of the gall of Nematus caprea on Salix amygdalina holds a similar view. I have not seen this paper, but an abstract* of it says: "The production of the gall is undoubtedly due to the matter secreted by the poison gland, which is, consequently, homologous with the poison of Hymenoptera aculeata; when the insect does not deposit an egg in the wound which it makes, the quantity of albuminous matter poured into the vesicle is always less than when an egg is deposited; by careful observation it is possible to assure oneself that the size of the gall is always proportional to the size of the wound and the quantity of albuminoid matter introduced. By an experiment in which a deposited egg was punctured by a fine needle, it was shown that the gall is due to the parent and not to the egg; but, of course, in such a case the gall remains small; neither the egg nor the larva are necessary for its production, though their presence exercises a certain influence on the regularity of their development."

The ovipositors of the Cynipidae vary in length and in the amount of coiling within the abdomen. All present the same general characters. So far I have been unable to detect any relationship between the length and character of the ovipositors and the location and complexity of the galls (Figs. 94 to 98). Adler claims that the egg is always deposited in or near the Cambium layer of the plant. I am inclined to accept this statement, but have made no special effort to verify it. If Adler's observations are correct the length of the ovipositor would be associated not with the depth of the Cambium from the surface of that part of the mature plant affected, but with the location of the Cambium at the time of oviposition and with the difficulties which the insect would experience in forcing the ovipositor to the desired point.

Oviposition usually occurs before the buds are open, and the eggs may be placed in three positions (1) in the stem, as in the case of Rhodites radicum O. S., R. globulus Beut., Andricus cornigerous O. S.; (2) in the apex of the incipient stem as in Andricus clavula Bassett, and Holcaspis globulus Fitch; or (3) in the leaves of the bud as in Rhodites bicolor Harris, Amphibolips confluentus Harris, A. inanis O. S., A. ilicifoliae Bassett, Neuroterus irregularis O. S., A. seminator, Callirhytis tumifica

*Jour. Roy. Micr. Soc., 1887, p. 746.

O. S., Holcaspis centricola O. S., Dryophanta palustris O. S., and Callirhytis papillatus O. S. In these cases it is evident that the force necessary to penetrate the bud may be as great or even greater than the force necessary to penetrate a stem. Adler's observations demonstrate that great force is used to penetrate the buds and reach the desired point for depositing the eggs.

Beyerinck has demonstrated that the fluid ejected by the ovipositor of the Cynipidae is very different from the fluid ejected from other Hymenopterous insects; that it is without taste or smell and does not irritate when injected under the skin. Adler has demonstrated that this fluid cannot be considered as the stimulus to gall production. It is probable that it may serve to attach the eggs, or as an antiseptic, or as a seal for the wound.

Since the gall does not form until after the hatching of the larva it is evident that oviposition does not furnish the stimulus unless it may be that there is cell division but no swelling of the plant tissues previous to the hatching of the larva. The author has made no observations upon this point. Adler, in discussing this question, says, in regard to Trigonaspis: "This fly pricks the leaf in May, but months pass before any trace of gall formation can be seen. It has tolerably strong ovipositor with which it cuts into the veins of the leaf, and in this way a distinct mark is left wherever an egg has been inserted. Guided by these marks it is easy to find the egg, but it is not until September that the larva leaves the egg, and then gall formation begins."

MOUTHPARTS.

Since oviposition does not give an explanation of the stimulus causing the formation of the gall it is necessary for us to turn our attention to the mouthparts.

For convenience the insects may now be divided into two groups, those with mouthparts for sucking, which make their attacks upon the outside, and those with mouthparts for biting, which make their attacks from the inside. Under the former are included the Acarina, the Hemiptera and the Diptera; under the latter are included the Lepidoptera and the Hymenoptera.

I. HEMIPTERA.

The Hemipterous insects which produce galls may be placed in the following order, with reference to the complexity of their galls, beginning with the lowest: Schizoneura, Colopha, Hormaphis, Phylloxera, Pemphigus and Pachypsylla. Mouthparts of the following were carefully examined: Schizoneura americana Riley, Colopha ulmicola Fitch (Fig. 99), Hormaphis hamamelis Fitch, Phylloxera carya-fallax Riley, P. c.-globuli Walsh, P. c.-spinosa Shimer, P. vastatrix Planchon, Pemphigus populi-transversus Riley, P. p.-caulis Fitch, P. vagabundus Walsh, Pachypsylla celtidis mamma Riley (Figs. 100a, b), and P. c.-gemma Riley.

The study of these mouthparts gave no new anatomical facts. The different genera showed considerable variation as to length of beak and setae. In general it may be said that the setae tend to increase in the distance they may be protruded beyond the tip of the beak as the galls approach complexity. This, however, cannot be considered an exact rule, since the S. americana, C. ulmicola and H. hamamelis have setae of practically the same length, although the gall produced by S. americana is much simpler than the galls produced by either C. ulmicola and H. hamamelis (Part I, Figs. 12, 13 and 15). It was impossible to make exact measurements of the distance the setae protruded beyond the tip of the beak, since it was impossible to tell whether the setae were fully extended or partially retracted. The above conclusions were reached after the examination of a large number of specimens.

So far as I have been able to determine the insects do not remain attached to any one point for a great length of time. The P. c.-mamma (Figs. 100a, b) has a gall of the greatest complexity, and the insect has setae which protrude farther beyond the point of the beak than any other examined ; a large number of these galls were opened and the position of the insect noted. The insect was never found attached and apparently had no definite point of attack.

The preceding observations emphasize Conclusions 6 and 8 of Part I and a statement in the first of Part V. That is, the modification of the plant tissue to form the gall is purely mechanical, being a continuous effort on the part of the plant to heal the wound produced by the repeated puncturing of the cells by the insect. When a branch is cut from a tree a growth is produced which tends to cover the wound. In this case a single wound and a single stimulus which is purely mechanical but which produces rapid growth for the purpose of covering the wound. In the case of Aphididae and the Psyllidae galls the wounds are more slight but repeated rapidly, the stimulus is mechanical and the growth rapid, tending to cover the injury.

It is possible that the setae of the various genera may stimulate different tissues and thus cause galls of varying complexity, but upon this question I am not ready to give a definite statement.

2. DIPTERA.

The Cecidomyid galls occur upon a greater variety of hosts than any other group of galls, and as previously stated in Part V, show by far the greatest variation in structural characters and the smallest number of typical characters.

The mouthparts of a number of larvae were examined (Figs. 101, 102), and all were practically the same; salivary or other gland structures could not be demonstrated.

I am inclined to believe that the Cecidomyid galls are due to purely mechanical stimuli and that the great variations are due to the different tissues upon which the larvae feed.

Mr. W. A. Cannon,* in discussing a Cecidomyid gall on the Monterey pine, says that the "larvae take their food only by absorption through the surface of the body," also that "there is no indication that the hypertrophy is either caused or affected by any substance deposited with the eggs."

3. HYMENOPTERA.

We now come to the galls of greatest complexity and also to those with which we have the greatest difficulty. These galls are so very generally infested with parasites and inquilines that it is difficult to decide which larva is the true gall producer.

A careful study of these shows that the insects have a very strong pair of mandibles (Figs. 103 to 108), each working upon two pivotal points. Some of these mandibles appear to have an opening at the tip (Figs. 104, 105), and some showed what appeared to be sacs or glands at the base (Figs. 104, 106b). In one case at least (Fig. 104) these glandular sacs appeared to be connected with the opening. The question that naturally presents itself is, are these openings for the purpose of pouring out a fluid or are they suctorial as in the case of Chrysopa and other families? In only two species was it possible to demonstrate these structures. Some light is thrown upon this by Part VIII, in which it was shown that the cell walls of the inner or nutritive zones were not destroyed, but that the contents of the cells were removed, causing them to shrivel.

The teeth of the mandibles are never on the same plane and the mandibles become more and more chitinous as the larvae approach maturity. The strength of the mandibles appears to depend upon the density of the tissue through which the insect works its way to the outside In A. inanis (104) and A. confluentus (Fig. 105) the strength of the mandibles is practically the same and the character of the galls very similar. In D. siminis (Figs. 106a, b) the mandibles are stronger and the tissues of the gall correspondingly denser. C. petiolicola (Fig. 103) is by far the strongest of those studied, and the tissues through which the insect must work its way the densest of the leaf galls (Fig. 124).

A study was made of the larvae from galls of C. papillatus. This is a small, rather dense leaf gall. Larvae of two species

*Cannon, W. A. "The Gall of the Monterey Pine." *The American Naturalist*, Vol. XXXIV, No. 406 (Oct., 1900), p. 801.

were found (Figs. 107, 108). A careful study of the mouthparts lead me to consider No. 107 as a true gallmaker and No. 108 as a parasite. The mouthparts of the one which I consider a true gallmaker were as strong as those of C. petiolicola (Fig. 103). The mandibles of the parasite (108) were equally strong and showed what appeared to be rudimentary gland structures.

Holcaspis globulus Fitch was the only bud (i. e., incipient stem gall, Part III, Fig. 34) gall examined. In the young larvae the mouthparts are weak, but as the larvae approach maturity the mandibles become very strong (Fig. 109) and well fitted to cut the opening for the escape of the insect. However, the mouthparts were not so strong as in the case of C. petiolicola, but the gall of H. globulus is not so dense as the gall of C. petiolicola.

The mouthparts of Nematus pomum Walsh (Fig. 110) were very similar to those of the Cynipidae. I am not inclined to consider the apparently glandular-like structure observed in a few species of any great importance. They may be suctorial or they may be degenerate organs. I consider the stimulus as purely mechanical. The character of the gall may depend upon the location, which would result in difference in tension in different parts of the plant on which the gall may be located and also upon the laws of natural selection, which will be considered in the latter part of this paper.

It would be interesting to know the exact time that cell division begins in the formation of a gall, but it is very difficult to make satisfactory observations upon this point. Adler has made successful observations upon this stage in Neuroterus laviusculus and Biorhiza aptera. He says: "The moment the larva has broken through the egg covering and has for the first time wounded the surrounding cells with its delicate mandibles, a rapid growth begins. This goes on so quickly that while the posterior part of the larva is still within the covering a wall of like growth of cells has already arisen in front. This rapid cell increase can be easily explained because the irritation set up by the emerging larva is exerted upon highly formative cells which collectively possess every condition of growth. The cells which are primarily around the larva cannot be distinguished from the parenchymatous cells from which they proceed."

4. LEPIDOPTERA.

A careful study was made of the mouthparts of the Gelechia solidaginis Fitch (Fig. 111) and upon an undetermined species found upon Rudbeckia laciniata (Part VI). The mandibles are larger and much stronger than in any of the Hymenopterous gallmakers which I examined. The gall is also much stronger than any of the Hymenopterous galls whose larvae were studied. No glandular structures were observed.

CONCLUSION.

1. The fluid secreted by the ovipositor is not an irritant, and therefore cannot be the stimulus for gall production.

2. Since the gall does not form, excepting the Nematus galls, until the appearance of the larvae, it is improbable if oviposition is a stimulus for gall production ; and in those insects in which the egg is not deposited within the tissues of the plant it is impossible.

3. Glandular structures were observed in only a few of the Hymenopterous larvae and these were of doubtful character.

4. Since it has so far been impossible to demonstrate the presence of a chemical stimulus except in Nematus, we must consider that the stimulus is usually mechanical. As previously stated (Part I, Conclusion 3) the morphological characters of the gall depend upon the genus of the insect producing it rather than upon the plant upon which it is produced. The early history of all galls except the Cecidomyid is practically the same (Part V, Con. 2). The shape and external character of the gall probably depends upon the following: (1) The plant upon which the attack is made; (2) Upon the part upon which the attack is made; (3) Upon the tissues affected; (4) Upon possible results of natural selection.

SUMMARY OF PARTS.

Next in importance to the problem of a stimulus giving rise to a gall is the explanation of specific external characters. This question is not easily answered and at the present time any explanation must be largely theoretical.

The gall-producing insects are found in six orders, as follows: 1. Arachnida (mites); 2. Hemiptera (Aphidae and Psyllidae); 3. Diptera (Cecidomyidae and Trypetidae); 4. Hymenoptera (Cynipidae and Tenthrenidae); 5. Lepidoptera, and 6, Coleoptera. The gall-producing habit must have originated independently in each of these orders and in some orders (Diptera and Hymenoptera) it must have originated independently in each of the two families represented.

The formation of the gall is due to two primary factors; a stimulus, usually mechanical, given by the insect, and nourishment furnished by the plant.

Conclusions reached as results of previous studies and bearing on this subject are as follows:

1. "Galls may be classified into two general groups, viz.: those produced by mouthparts and those produced by oviposition. Those produced by oviposition may be considered the more highly developed." (Part I, Con. 1.)

2. "The gall does not form until the appearance of the larvae. Therefore all galls are produced by mouthparts." (Part VIII, Con. 1.) The Nematus galls are an exception.

3. "The morphological character of the gall depends upon the genus of the insect producing it rather than upon the plant on which it is produced." (Part I, Con. 3.)

4. "Within each family we find certain morphological resemblances." (Part I, Con. 4.)

5. "The families show parallel lines of development from a low form of gall structure up to a high form." (Part I, Con. 5.)

6. "The presence of at least two zones, of which the inner may be considered nutritive." (Part I, Con. 7.)

7. "The formation of the gall is probably an effort on the part of the plant to protect itself from an injury which is not sufficient to cause death. Both Adler and Fockeu consider that after the first stages of formation the gall becomes an independent organism growing upon the host plant. This is probably true in the highly developed galls of Aphididae, Cecidomyia, and Cynipidae, but the writer is doubtful if this is true in the less complex galls of Acarina, Aphididae and Cecidomyia." (Part I, Con. 8 and Part V, Con. 6.)

8. "In the formation of all leaf galls except the Cecidomyia galls the normal cell structure of the leaf is first modified by the formation of a large number of small, compact, irregularly shaped cells. In the galls of Acarina and Aphididae this is followed by a development of trichomes, especially in the former. In all galls the mesophyll is subject to the greatest modification. Many small fibro-vascular bundles are formed in this modified mesophyll." (Part V, Con. 2.)

9. "Trichomes are far more common in galls produced by mouthparts than in those produced by oviposition." (Part V, Con. 9, and see Summary 2.)

10. "Variation in galls is due to their being produced by insects of different orders, to their working upon different parts of the plant and upon different tissues of these parts." (Part III, Con., and Part IV, Con. 1.)

I. ARACHNIDA.

The Arachnida galls are of four types: (1) A modification in the epidermis of the leaf as in the Phytoptus galls on maple and elm; (2) A fold in the plant tissue causing a cavity filled with trichomes, among which the parasites live, as in the case of many Phytoptidi (Figs. 8, 9, 10, 11, 43, 44, 45, Parts I and V); (3) A swelling with an exposed surface covered with trichomes, among which the parasites live, as in the case of Erineum anomalum (Part V, Figs. 47, 48); (4) The witchbroom formation, as in the case of the Phytoptus sp——, and Sphaerotheca phytoptophila Kell. and Sw. on Celtis occidentalis.

The author has studied only the second and third types. The difference between these two may be accounted for by the fact that the Phytoptus attacks the blade while the Erineum attacks the petiole, mid-rib or larger vein. The part affected undergoes a curvature in each case in the direction of the least resistance.

2. HEMIPTERA.

The method of attack by the Hemiptera is practically the same as in Arachnida, i. e., by sucking mouthparts. The galls present a complete serial line of development, the lowest form being a simple curling of the leaf as in the case of Schizoneura americana, the next higher, a simple folding of the leaf, as in the case of Colopha ulmicola, the next higher is a more complex structure, such as the Phylloxera galls and H. hamamelis, the next higher, the slightly more complex, as in the case of the Pemphigus galls (Figs. 12 to 21, and 49 to 58). The galls of the Pachypsylla (Figs. 59, 60) are the most highly developed of the entire series.

Although in this case we have a complete series, it is difficult to understand how this development has been produced. It may be that the different forms are due to the attack being made upon different tissues in each case, or to the degree in which the tissues are injured. Upon this point we have no direct proof. However, there is very little doubt that the stimulus is entirely mechanical.

3. DIPTERA.

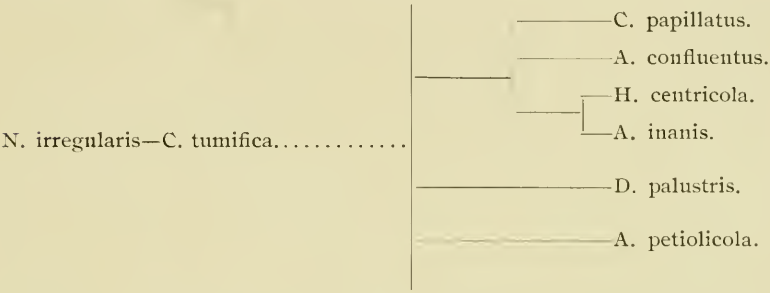
As previously stated, the Cecidomyid galls are far more varied in location and in morphological structure than any other group of galls and show less number of characters peculiar to themselves alone. There is not sufficient data to draw even theoretical conclusions concerning the influencing causes in their development.

4. HYMENOPTERA.

As previously stated, the Cynipidous galls are the most highly developed and show a greater number of morphological structures peculiar to themselves than any other group (Part I, Con. 2; Part V, Con 3).

Since the gall does not begin to develop until after the hatching of the larvae, oviposition cannot be an important factor except in so far as it is necessary to have the egg placed in certain tissues.

Examination of the mouthparts show few, small and insignificant gland-like structures the character of which is doubtful. It is therefore probable that the stimulus is purely mechanical except in the Nematus. But how are we to account for the great number of specific external characters? Let us first review the structural characters of the leaf galls, since these galls show the most uniform line of development. Considering Neuroterous irregularis the gall of greatest simplicity, we can formulate the following diagram :



In N. irregularis the zones are not so well developed as in C. tumifica. In C. tumifica the zones are perfect, but in contact. In C. papillatus the protective and parenchyma zones are separated, but connected by long parenchyma cells. In H. centricola and A. inanis the protective and parenchyma zones are connected by fibro-vascular bundles. In A. confluentus they are connected both by fibro-vascular bundles and by parenchyma cells (Fig. 121). In D. palustris the parenchyma and protective zones are not connected. In A. petiolicola the zones are in contact, but the tissues are very dense, due to location in the petiole of midrib of the leaf.

If galls become independent structures they are undoubtedly subject to the same laws of natural selection as any other group of organisms, or if they be considered as parts of the plant they must also be subject to the same laws of natural selection as any other part of the plant on which they live. How, then, have these laws affected the gall? It may be a protective coloration against birds and rodents, and other insects, but this cannot be very important since many species of galls are very conspicuous. Furthermore, animals make but very little use of galls for food. So far I have observed other animals using galls for food but once and then birds were tearing open the large galls of Pemphigus vagabundus and eating the insects. The tannin which develops in such abundance in all galls as they approach maturity is probably a great protection against insectivorous animals.

The greatest insect enemy with which the gall insect has to contend is the great number of parasites. The size, shape and character of the epidermal covering of the gall may be a protection against this numerous enemy. The thickness of the gall and the density of the tissues, especially the protective zone, is an important protective device. The large intercellular chambers in the parenchyma zone place the larvae at a great distance from the surface of the gall without increasing the amount of work necessary for the mature insects to accomplish before reaching the outside ; this is undoubtedly a great protection against parasites, since it increases the difficulties for the parasite in reaching the larvae with the ovipositor, The development of these protective devices is probably the result of natural selection. Since the character of the gall depends upon the insect, many variations in the gall may also depend on variations in the stimuli given by the insect. If these variations in character of epidermis, in thickness of parenchyma zone, in the formation of large intercellular spaces, in thickness and density of protective zone, are advantageous to the insect in protecting it from the numerous parasites, these characters may be perpetuated in succeeding generations and the gall may increase in complexity. Natural selection is a reasonable explanation.

It should be remembered that the plant is making an effort to resist a parasite from which it cannot escape. The gall-maker derives its nourishment without destroying its host and at the same time strives to protect itself as far as possible from the great number of parasitic enemies. The food supply first becomes a part of the gall and upon this supply which, in the case of the Cynipidae, is stored in the nutritive zone, it feeds.

Any irritation, such as the cutting or puncturing of plant tissues, may and usually does cause excessive growth. It is probable that the primitive galls were of a type similar to the simplest of the Phytoptus galls, i. e., a peculiar growth of the epidermal cells. The next step in the evolution of the gall may be represented by a type similar to Schizoneura americana, in which case the stimulus is greater, resulting in a curling of the leaf. The next step may be represented by a type similar to the more complex Phytoptus galls, H. hamamelis, C. ulmicola, the Phylloxera, the Pemphigus and the most complex of the Pachypsylla galls in which we find a series of more or less complex folds in the leaf up to the increase in amount and differentiation of the tissue as in the case of P. p.-mamma.

In the Cynipidous galls we have the greatest complexity, but also a factor somewhat different from that in the forms to which we have referred, i. e., the placing of the egg below the surface and in those tissues upon which the larva is expected to feed. It is impossible to say whether this habit of placing the egg below the surface was acquired before or after the gall-making habit, but it must be a great advantage to the insect. These galls, as previously demonstrated, show the more complex serial line of development of any of the galls, but even the simplest of these is more complex than the most complex gall produced by any other order of insect. This very complex development is due to an early acquirement of the gall-making habit or to more rapid evolutionary development as a result of the deposition of the egg below the surface.

The greater part of the work connected with Part IX of this series was conducted at the Lake Laboratory of the Ohio State University at Sandusky, Ohio, and I am very much indebted to the Director, Professor Herbert Osborn, for valuable assistance. I also wish to express my thanks to the many friends who have collected material and otherwise aided in these studies.

This series of papers will be presented to the Faculty of the College of Arts, Philosophy and Science, of the Ohio State University, as the thesis requirement for the degree of Doctor of Philosophy, June, 1904.

LITERATURE.

Continuous with the bibliography published with Parts I and II.

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EXPLANATION OF PLATES IX–XII.

The drawings were made with a Bausch & Lomb microscope. For Figs. 70–76 and Figs. 84–91 and Fig. 93b, a Number 2 ocular and 1/6 objective. For Figs. 77–83, a Number 2 ocular and 1/12 immersion objective. With Figs. 92–98 and Figs. 106a, 110 and 111, a 3/4 ocular and 2/3 objective. For Fig. 93 a Number 2 ocular and 2/3 objective. The reduction is not so great as in the preceding parts and therefore the figures are proportionately slightly larger. The diagrams were not made upon a definite scale. The numbering of the drawings is continuous with the preceding parts.

Abbreviations:
- e. epidermis.
- ep.—epidermal zone.
- pa.—parenchyma zone.
- p.—protective zone.
- nu.—nutritive zone.
- f. v. b.—fibro-vascular bundles.
- l. c.—larval chambers.
- sc.—sclerenchyma.

FLOWER AND FRUIT GALLS.

70. Section of leaf of Euphorbia corollata.

71a. Diagram of section of Phytoptus sp—— gall on leaf of E. corollata.

71b. Section of 71a.

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72b. Section of upper part of flower of E. corollata affected by Phytoptus sp——.
73a. Diagram of cross section of Cecidomyid bud gall on Solidago canadense.
73b. Section of same.
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74b. Diagram of longitudinal section of Cecidomyid gall on Ratibida pinnata.
74c. Section of 74b.
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75b. Section of Cecidomyid gall develop.d in fruit of P. virginiana.

ROOT GALL.

76a. Section of young gall of Amphibolips radicola.
76b. Section of mature gall of A. radicola.

HISTOLOGY.

77. Section of young gall of Phytoptus quadripes.
78. Section of young gall of Phytoptus abnormis.
79. Section of nutritive zone of young gall of Amphibolips inanis.
80. Section of mature gall of A. inanis.
81. Section of mature gall of Callirhytis papillatus. (Nutritive, protective and part of parenchyma zones.)
82. Section of mature gall of Dryophanta palustris. (Nutritive, protective and part of parenchyma zones.)
83. Section of mature gall of Andricus petiolicola.

SURFACE SECTIONS OF

84. Dryophanta palustris. (Very young gall.)
84b. Dryophanta palustris. (Mature gall.)
85. Amphibolips inanis.
86. Diastrophus siminis.
87. Diastrophus potentilla.
88. Pachypsylla c.-mamma
89. Colopha ulmicola.
90. Phylloxera c.-globuli.
91. Pemphigus p.-transversus.

OVIPOSITORS OF

92. Cecidomyia gleditsiae.
93a. Nematus salicis-ovum.
93b. Nematus salicis-ovum.
94. Dryophanta palustris.
95. Amphibolips radicola.
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MOUTHPARTS OF

99. Colopha ulmicola.
100a. Pachypsylla c.-mamma, with setae extended.
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101. Cecidomyia gleditsiae.
102. Cecidomyia pellex.
103. Andricus petiolicola.
104. Amphibolips inanis.
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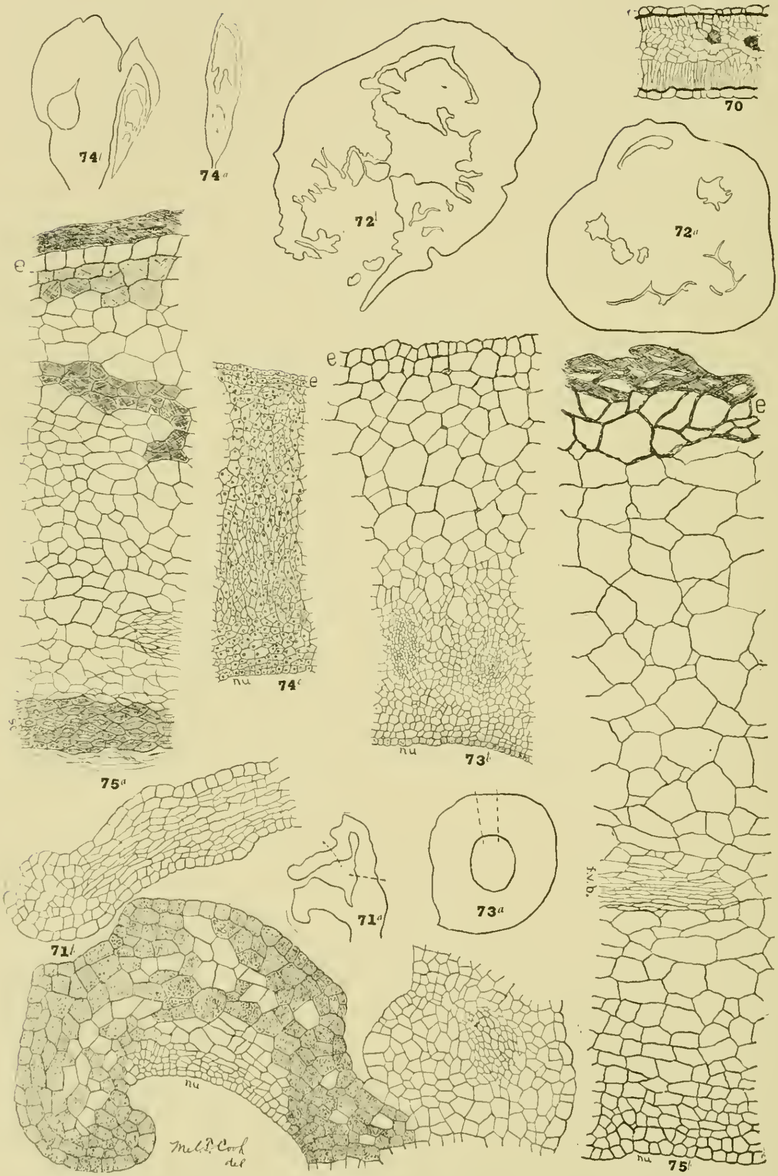
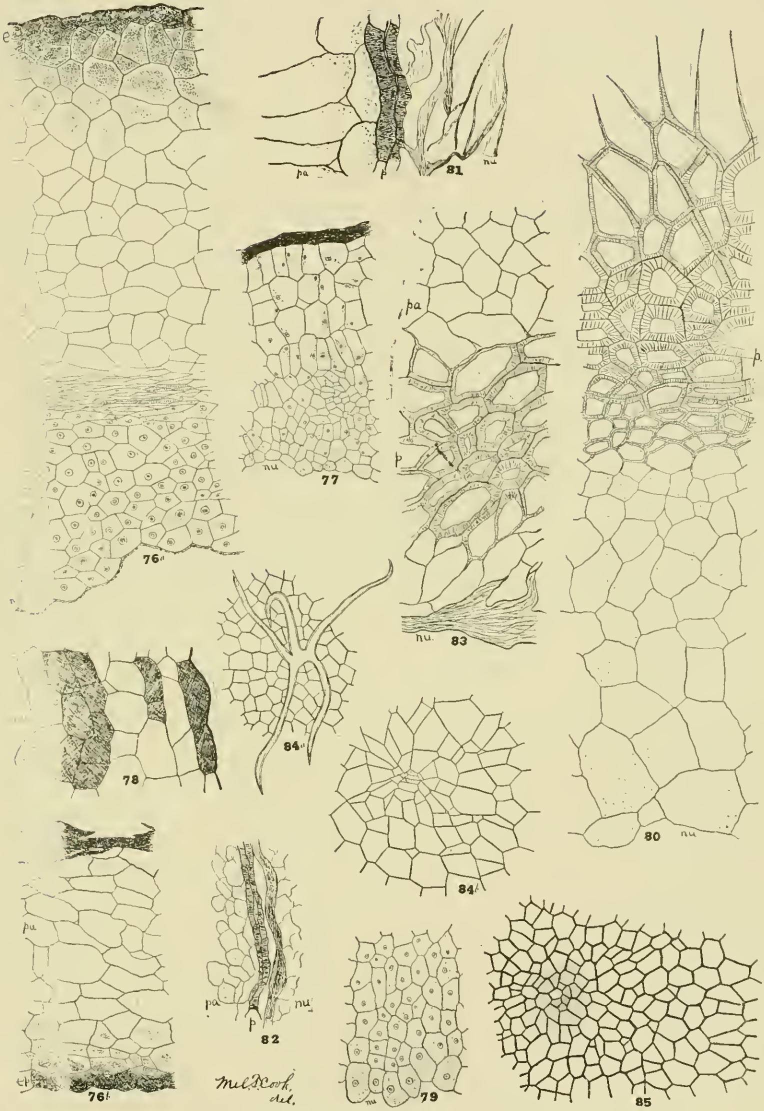
106a. Diastrophus siminis.
106b. Diastrophus siminis.
107. Callirhytis papillatus.
108. Parasite from gall of C. papillatus.
109. Holcaspis globulus.
110. Nematus pomum.
111. Gelechia gallae-solidaginis.

OHIO NATURALIST. *Plate IX.*



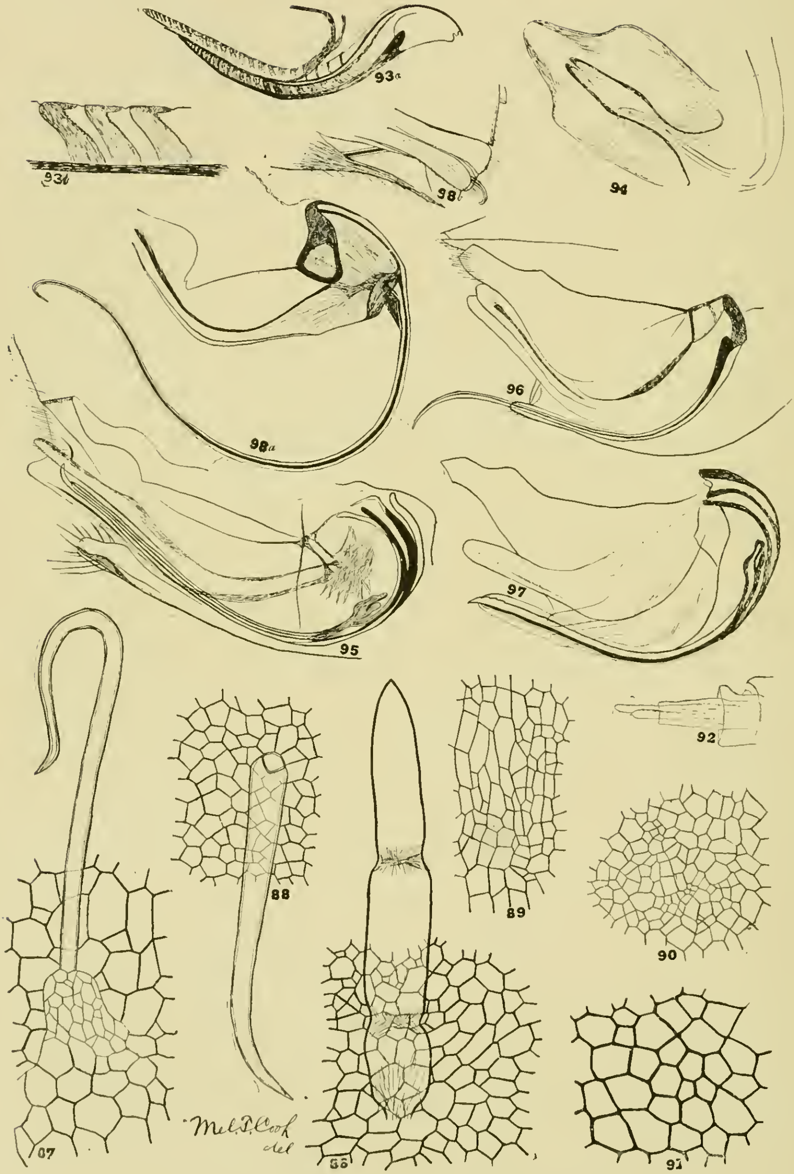
COOK on "Galls and Insects Producing Them."

OHIO NATURALIST. *Plate X.*



COOK on "Galls and Insects Producing Them."

OHIO NATURALIST. *Plate XI.*



COOK on "Galls and Insects Producing Them."

OHIO NATURALIST. *Plate XII.*

COOK on "Galls and Insects Producing Them."

APPENDIX I.

GALLS AND INSECTS PRODUCING THEM.

Melville Thurston Cook.

Part I. Morphology of Leaf Galls.

1. GALLS OF THE APHIDIDAE.

The gall of Pemphigus vagabundus Walsh (Fig. 112) is evidently formed as a result of the distortion of a large number of bud leaves. My specimens of these galls were mature, so I was unable to follow its development. Small fibro-vascular bundles were numerous and tannin was formed in great abundance. The structure was so modified that the leaf characters were lost; the cells were uniform in character, but were slightly smaller near both the exterior and interior surfaces.

The galls of Pemphigus rhois Fitch (Fig. 113) are large, bladdery and evidently the pocketing of a single leaflet of the host plant, Rhus glabra or R. typhina. My specimens of these galls were fully mature, and I was therefore unable to follow the line of development. The leaf structure was modified into the characteristic Aphididae gall structure. Fibro-vascular bundles were numerous and near the inner surface of the gall. Opposite each bundle was a large cavity filled with some substance which I was unable to determine.

2. GALLS OF CECIDOMYIDAE.

The galls of Cecidomyia pellex O. S. (Figs. 114a, b) are formed by a thickening of the petiole, giving it the appearance of a long fleshy bean pod with a slit along the upper side. This gall shows three well defined zones; an inner nutritive zone of small cells, a parenchyma zone of larger cells and the epidermal zone. The fibro-vascular bundles are numerous and are located between the nutritive and protective zones and arranged around the larval cavity and opening, the largest one just below the larval chamber and corresponding to the mid-rib of the leaflet.

Cecidomyia impatientis O. S. (Fig, 115) is a fleshy gall occurring on the leaves of Impatiens fulva. Some of my specimens had the appearance of deformed flower buds, but upon this point I was unable to decide. This gall showed two well defined zones; a zone of small cells lining the larval chamber and making up about one half the thickness of the gall, and an outer zone of large cells. Small fibro-vascular bundles were formed between the zones.

The galls of Cecidomyia holotricha O. S. on Hicoria ovata (Figs. 116a, b, c) are small and very firm. My specimens were mature, but the cells lining the larval chamber were well supplied with protoplasm, and numerous short trichomes were developed from the dorsal surface and extended into the chamber. Tannin was very abundant.

The gall of Cecidomyia tubicola O. S. on Hicoria ovata (Figs. 117a, b, c) is very similar to C. holotricha, except that the amount of tannin is not so great. The upper wall of the gall is much thicker than either the side or lower wall. The point of attachment is not so large, but the gall is protected by a growth producing a cup-shaped cavity in which the gall is developed (Fig. 117a). The inner layers of cells are very rich in protoplasm. The cells are elongated in the long axis of the gall and fibrovascular bundles are more numerous than in C. holotricha, but are very small. The cup-shaped structure (117c) in which the gall is formed is composed of elongated cells. The palisade cells in that part of the leaf opposite the gall are unaffected.

Cecidomyia viticola O. S. (Fig. 118) has the same general character as C, tubicola, but is much longer.

Sciara ocellaris O. S. is one of the simplest of the Cecidomyidae galls. The larva does not penetrate the tissues of the leaf, but confines its attack to the outside, causing an indentation on one surface of the leaf and a corresponding elevation on the opposite surface (Fig. 119a) and also causing a very slight thickening. The structure (Fig, 119c) when compared with that of the normal leaf (Fig. 119b) shows the palisade transformed into ordinary mesophyll and the intercellular spaces entirely obliterated. It therefore corresponds in structure to the simple leaf-curl galls produced by some of the Aphididae (e. g., Schizoneura Americana Riley, Part 1, Fig. 12).

3. GALLS OF THE CYNIPIDAE.

My specimens of Rhodites bicolor Harris (Fig. 120) were well developed when collected. I was therefore unable to determine the early structural characters. The structure in these galls evidently does not show the four well defined zones so characteristic of this family. The inner cells are well supplied with nourishment for the large number of larvae.

The galls of Amphibolips confluentus Harris are very large and have a single larval chamber in the center. The nutritive and protective zones (Fig. 121a) can be distinguished, but are not so well defined as in the closely related species, A, inanis (Part I, Figs. 28a, b). The parenchyma and epidermal zones (Fig, 121b) are well defined and the space in the parenchyma is filled with a cottony-like substance which upon close examination is composed of fibro-vascular bundles (as in A. inanis, Figs. 28a, b, and H. centricola, Figs. 27a, b, c) and of long, unicellular threads (Fig. 121c), as in C. papillatus (Figs. 30a, b, c and 81).

My specimens of Amphibolips illicifoliae Bassett were too far advanced to admit of sectioning, but a careful examination indicated that the zones were well defined and that the space in the parenchyma zone is bridged by means of fibro-vascular bundles as in A. inanis and H. centricola.

The galls of Amphibolips prunus Walsh (Fig. 122) are very firm and all the zones are well defined except the protective zone, which is entirely absent. The parenchyma zone is very thick and probably compensates for the lack of a protective zone. There are very few small fibro-vascular bundles.

Galls of Amphibolips sculpta Bassett (Fig. 123) were more succulent than other specimens which I have examined. My specimens were mature, but the four zones were well defined. The nutritive zone was almost obliterated, due to the age of the gall. The protective zone was thin and the cell walls not very thick. The parenchyma zone was very thick and composed of large, succulent cells and was probably very important in furnishing nutriment to the larva. Near the outer surface were numerous small fibro-vascular bundles. The epidermal zone was very prominent and composed of small cells.

Andricus petiolicola Bassett is one of the firmest of the leaf galls. It is formed either on the petiole or mid-rib and is composed of very small, firm cells (Fig. 124). The four zones are well defined, but the protective zone is very thin and the cell walls but very little thicker than in the neighboring cells The parenchyma zone is very thick, composed of very small cells with no intercellular spaces, but with many layers of long fibrous cells.

The galls of Acraspis erinacei Walsh (Fig. 125) are very conspicuous. The galls are always developed on the mid-rib of the leaf, but contain no fibro vascular bundles. The nutritive zone is thick and very rich in protoplasm. The protective zone is also thick and gradually merges into the parenchyma zone, which is also thick. The epidermal zone is very irregular and is covered with numerous unicellular trichomes.

The galls of Biorhiza forticornis Walsh are fig-shaped and the larval chamber instead of being suspended in the center of the gall, as is many others, is placed at the apex (Fig. 126a) and the space between the protective and parenchyma zones, or rather in the parenchyma zone, extends less than half way round the larval chamber. My specimens were mature and I was unable to make a careful study of the nutritive and protective zones. However, the nutritive zone appeared to be relatively thicker, while the protective zone was thin and merged gradually into the parenchyma zone (Fig. 126b). The parenchyma zone was thick and composed of large cells (Fig. 126c). Considerably more of this zone remained attached to the protective zone than is the case with most galls where this separation occurs. The cavity formed by the separation of the cells in this zone is bridged by numerous unicellular threads as in C. papillatus (Figs. 30a, b, c). In the outer part of the parenchyma zone, but near the cavity, are formed the fibro-vascular bundles. The epidermal zone is well defined and the trichomes on the surface are uni-cellular (Fig. 126c).

4. GALLS OF TENTHREDINIDAE.

The galls of Nematus pomum Walsh were the only leaf galls of this family that I secured and they were mature. There was no indication of a zonal structure, but the cells were very uniform in size and structure throughout the entire gall (Fig. 127). Many of the cells contained tannin and intercellular spaces were large and evenly distributed.

PART II. LATERAL BUD GALLS.

Mature specimens of Holcaspis globulus Fitch show the four well defined zones (Fig. 128). The inner nutritive zone is thick, composed of small cells and well supplied with nutriment for the larva. The protective zone is thin and composed of very small cells with thin walls. It gradually merges into the nutritive zone on the one side and the parenchyma zone on the other side. The parenchyma zone is very thick, the cell walls medium in size and the fibro-vascular bundles small and numerous. Further observations upon this gall emphasize the statement previously made that it is the enlargement of an incipient stem.

Further observations upon the gall of Andricus seminator Harris confirm the statement previously made that it is a compound gall produced by the insect depositing an egg in each element of the bud.

PART III. STEM GALLS.

The gall of Diastrophus nebulosus O. S. (Fig. 129a, b) is a very large swelling on the canes of Rubus villosus and is about two or three inches in length. It contains a large number of larval chambers each containing a single larva (Fig. 129a). The four zones are especially well defined. The nutritive and protective zones are composed of a few layers of cells while the parenchyma zone is very thick, composed of smaller cells and more dense than the corresponding zone in most galls of this family.

Andricus cornigerus O. S. (Fig. 130) produces one of the hardest of the stem galls. My specimens of this were gathered in the winter and were fully mature. The horn-like protuberance is a closed tube extending to near the center of the gall. This tube is composed of sclerenchyma tissue and evidently corresponds to the protective zone. Near the base of the tube is a thin partition forming the larval chamber. When mature the insect destroys this partition, travels to the end of the tube which projects beyond the body of the gall, and there makes an opening through either the end or the side of the tube and thus makes its escape. Examination of young specimens would probably show the four zones as well defined as in Diastrophus nebulosus.

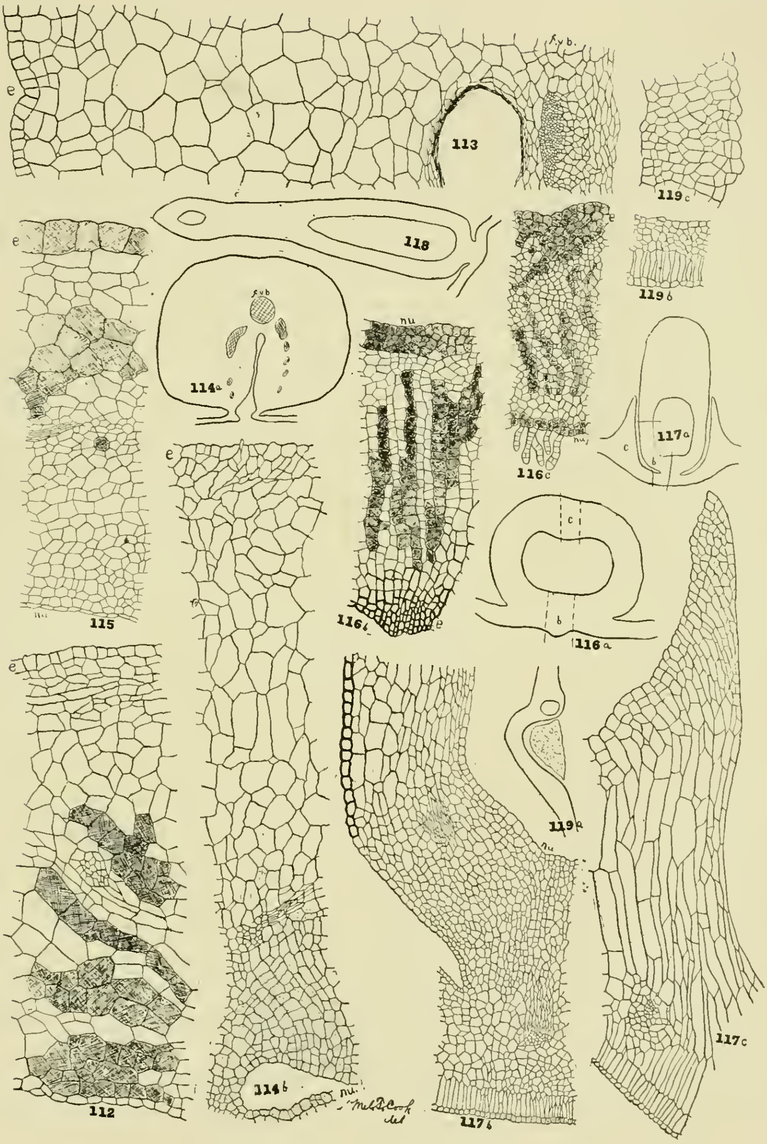
Part IV. Development of Galls.

Examination of very young specimens of Andricus seminator Harris shows three well defined zones (Figs. 131a, b), the protective zone being undeveloped. The fibro-vascular bundles were very numerous and distributed just beneath the epidermal zone. I have examined a large number of these galls of various ages and have been unable to find any trace of a protective zone. Tannin develops in the outer cells very early and probably helps to form a protection for the larva.

PLATES XIII–XV.

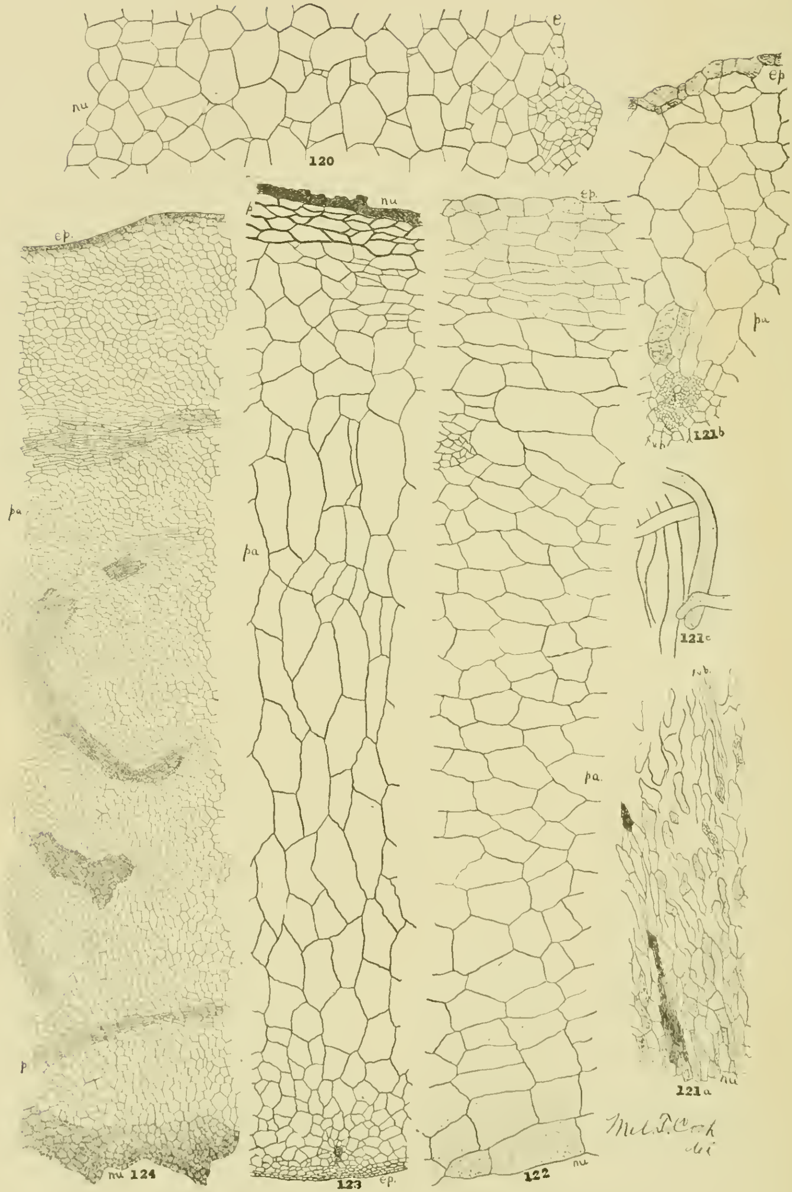
112. Section of gall of Pemphigus vagabundus.
113. Section of gall of Pemphigus rhois.
114a. Diagram of gall of Cecidomyia pellex.
114b. Section of gall of Cecidomyia pellex.
115. Section of gall of Cecidomyia impatientis.
116a. Diagram of the gall of Cecidomyia holotricha.
116b. Section of the gall of Cecidomyia holotricha.
116c. Section of the gall of Cecidomyia holotricha.
117a. Diagram of the gall of Cecidomyia tubicola.
117b. Section of the gall of Cecidomyia tubicola.
117c. Section of the gall of Cecidomyia tubicola.
118. Diagram of the gall of Cecidomyia viticola.
119a. Diagram of the gall of Sciara ocellaris.
119b. Section of normal leaf of Maple.
119c. Section of gall of Sciara ocellaris.
120. Section of gall of Rhodites bicolor.
121a. Section of gall of Amphibolips confluentus. (Epidermal and parenchyma zones.)
121b. Section of the gall of Amphibolips confluentus. Nutritive and protective zones.)
121c. Section of gall of Amphibolips confluentus. (Elongated cells in the cavity of the parenchyma zone.)
122. Section of gall of Amphibolips prunus.
123. Section of gall of Amphibolips sculpta.
124. Section of gall of Andricus petiolicola.
125. Section of gall of Acraspis erinacei.
126a. Diagram of gall of Biorhiza forticornis.
126b. Section of gall of Biorhiza forticornis. (Nutritive and protective zones.)
126c. Section of the gall of Biorhiza forticornis. (Section of protective and epidermal zones.)
127. Section of the gall of Nematus pomum.
128. Section of the gall of Holcaspis globulus.
129a. Diagram of gall of Diastrophus nebulosus.
129b. Section of gall of Diastrophus nebulosus
130. Diagram of gall of Andricus cornigerus
131a. Diagram of cross section of gall of Andricus seminator.
131b. Section of young gall of Andricus seminator.

OHIO NATURALIST. *Plate XIII.*



COOK on "Galls and Insects Producing Them."

OHIO NATURALIST. *Plate XIV.*



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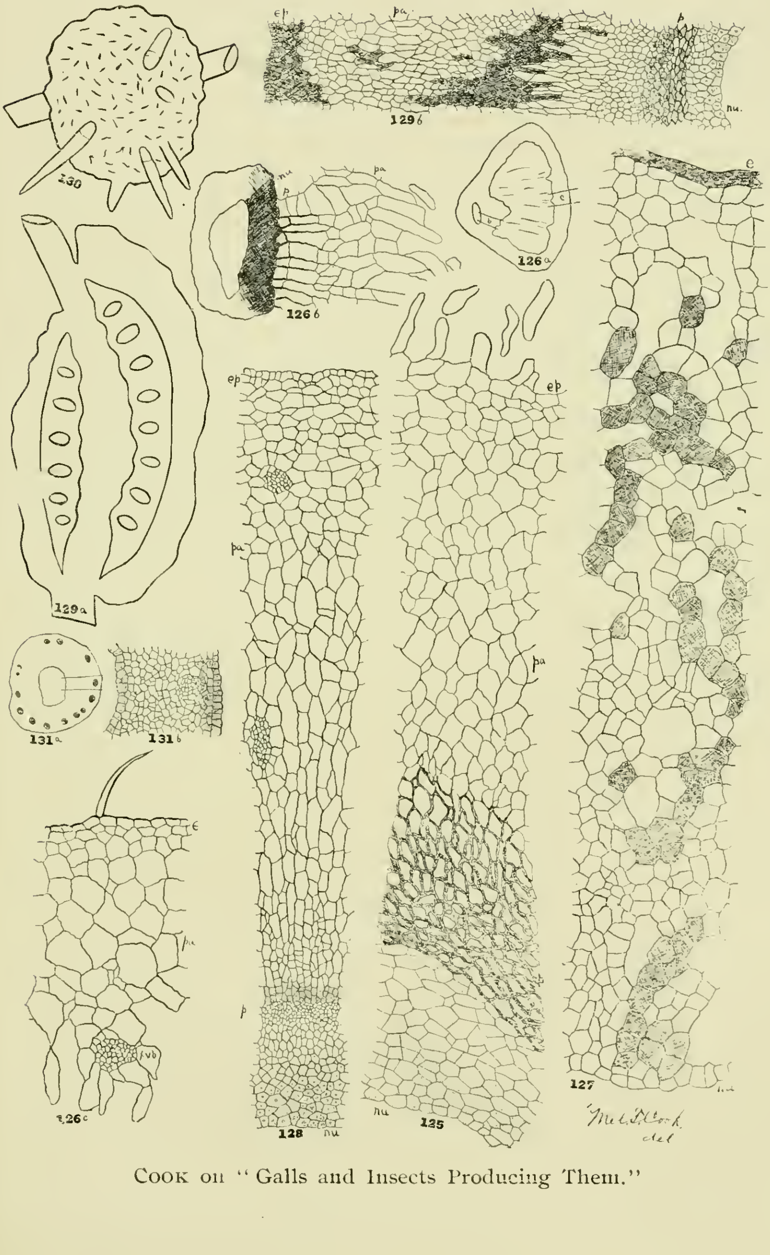

COOK on "Galls and Insects Producing Them."

NEWS AND NOTES.

Color Key to North American Birds.—This is a recent addition to the ornithological literature of North America from the pen of the well known author, Frank M. Chapman, of the American Museum of Natural History, with over 800 illustrations in color, by Chester A. Reed, whose drawings and photographs have added so much to the value and attractiveness of the "Bird Magazine." The work is wholly devoid of technicalities, so one that is not a specialist as well as one that is may use and enjoy it together. It comes nearer answering the question, "How can I learn to know the birds," to the satisfaction of all, than any other work published. The authorship is sufficient proof of its accurateness which is much in its favor, especially at the present time when so many questionable books on natural history subjects are appearing. The author states in the introduction that an attempt has been made so to group, figure and describe our birds that any species may be named which has been definitely seen. The birds are kept in their systematic orders, a natural arrangement readily comprehended, but further than this, accepted classifications have been abandoned and the birds have been grouped according to color and markings. This in a word gives the plan of the book, and any one who desires to know the birds afield, will find it a most desirable aid. Doubleday, Page & Company of New York City are the publishers.—J. S. H.

Errata—In February, '04, Naturalist, p. 98, line 27, read "formerly labled Asplenium" for "formerly called Asplenium."

In Bulletin of the United States Fish Commission for 1902, pages 369-394, Miss Julia W. Snow of Smith College gives the results of her work on "The Plankton Algae of Lake Erie." This is an important contribution to the flora of the lake and represents an inviting field of study which seems to be much neglected by American botanists. Two hundred and eleven species with a considerable additional number of varieties are listed, thirteen of which are described as new. Four good plates are given to illustrate the new species.—J. H. S.

Wytsman's Genera Insectorum in the Lloyd Library, Cincinnati, Ohio.—C. G. Lloyd is subscribing for this great illustrated work, and has already received a number of the parts, which have been placed in the great Lloyd Botanical Library in Cincinnati, O. This library is open free to students who wish to consult any of the books on Botany and Entomology. Through the courtesy of Mr. Holden, the librarian, I have examined this magnificent work.—Charles Dury, Avondale, Cincinnati, Ohio.

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TABLE OF CONTENTS

CHANGES IN THE DRAINAGE NEAR LANCASTER.

JESSE E. HYDE.

The drainage changes in the headwaters of the Hocking River, caused by the ice of the Glacial epoch, have been partially worked out by Prof. Tight[1] and Mr. Leverett.[2] Their investigations relate to the changes in the river itself, to those tributaries lying to the east and to Clear Creek on the west. To the writer's knowledge, those changes which occurred in the region just west of the Hocking and between it and Clear Creek have not, as yet, been worked out. However, a brief review of the entire region may not be lacking in interest nor out of place. The writer wishes here to express his indebtedness to Prof. J. A. Bownocker for suggestions and criticisms in the preparation of this paper.

The Hocking River rises on the upland in the southeastern part of Bloom township, Fairfield county, flows eastward and enters its valley proper in the southern part of Greenfield township near Hooker. At Hooker its valley has a breadth of about two miles, but it is not very deep or well defined. At Lancaster it is more than a mile wide, but the rock hills on either side rise more abruptly and to a greater height, making the valley more conspicuous. Continuing down the stream, it narrows until at Sugar Grove it is not more than one-half mile wide, and just above Logan it is only a few hundred yards in width and very gorge-like in character. At Sugar Grove the drift in the valley, as shown by gas borings, is about 100 feet deep, at Lancaster 200 feet and at Carroll, eight miles above Lancaster, 260 feet. The elevation of Carroll above sea level is 835 feet, that of Lancaster 831 feet and Sugar Grove 769 feet.[3] This makes the rock floor

1. Bull. Denison University, No. IX, p. 33.
2. Glacial Formations and Drainage Features of the Erie and Ohio Basins, pp. 169-172.
3. Geol. Sur. of Ohio, Vol. 6, p. 802.

of the valley about 100 feet lower at Carroll than at Sugar Grove; that is, the rock floor slopes to the north in a direction opposite to that in which the present stream flows. This fact coupled with the shape of the valley makes it certain that prior to the Glacial epoch an old divide was located somewhere south of Sugar Grove. The exact site of this col has been variously placed by different writers; Prof. Tight has very recently located it about half way between Logan and Nelsonville.[4] Before the ice invasion a stream headed on the northern side of this divide, flowed northward through the valley now occupied by the Hocking, and northwest of Carroll connected with the preglacial outlet of the upper Muskingum which crossed the northern part of Fairfield county. After the ice blocked this outlet, the water forced over the old divide at the head of the stream and in time it was cut to the present level.

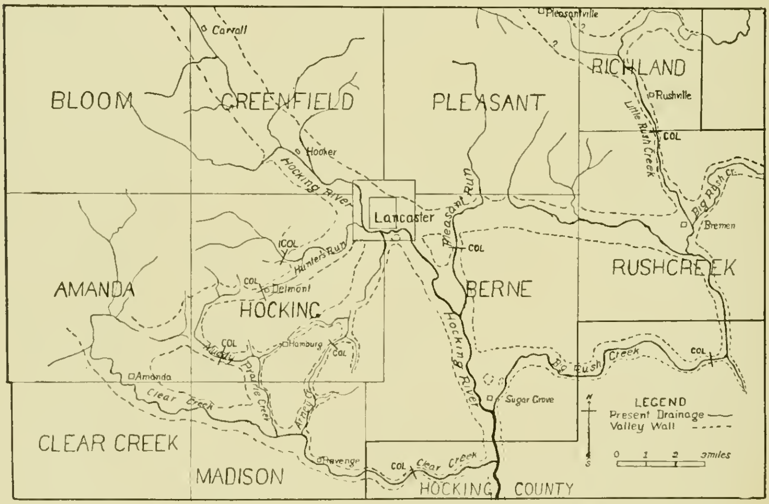

Fig. 1. Map showing drainage changes in the headwaters of the Hocking River.

Big Rush Creek is a large tributary entering the Hocking from the east at Sugar Grove. It rises near New Lexington, Perry county, flows westwardly into Fairfield county, the valley widening gradually until at Bremen it is three-quarters of a mile wide. At Bremen it turns abruptly to the south and narrows until a point in Hocking county one mile below the county line is reached. Here it is narrowest, being only 200 yards in width between the rock walls on either side, and the drift is only 20 feet deep. It

4. Professional Paper. No. 13, U. S. Geol. Survey. Drainage Modifications in Southeastern Ohio. p. 35.

there turns to the west, the valley widening until above Sugar Grove it is about half a mile wide. From Bremen to Lancaster there extends an old valley in places one mile broad and filled with drift to a depth of over 200 feet. Before the ice epoch this abandoned valley was the outlet for the waters of Big Rush Creek, a small tributary heading at the narrow point just below

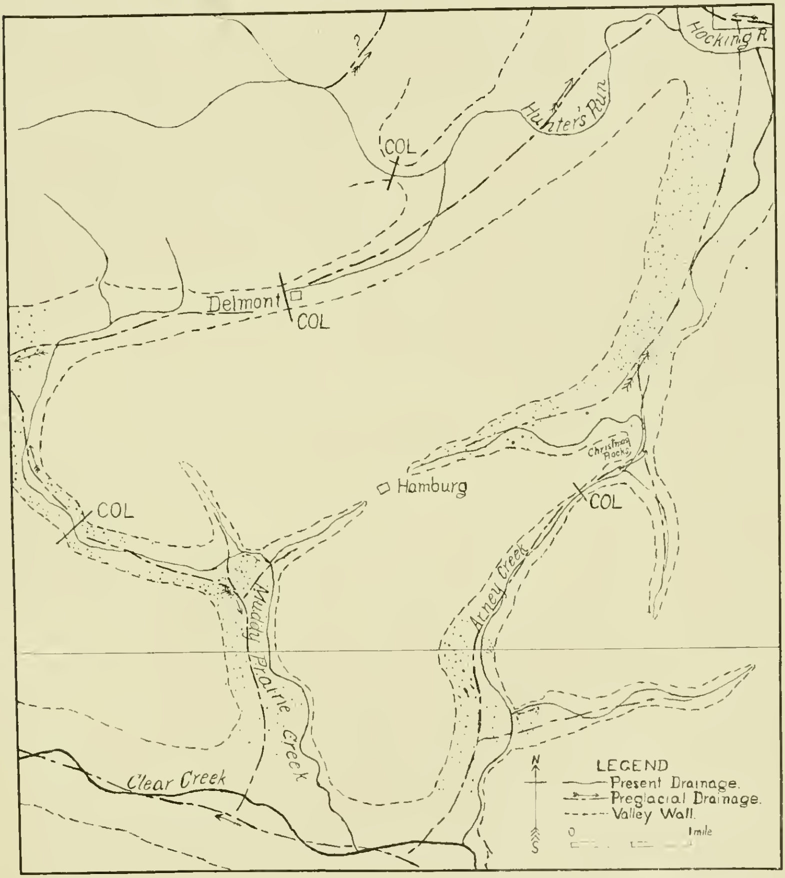

Fig. 2. Map showing changes on Arney and Muddy Prairie Creeks.

the Hocking county line where there was a low divide and flowing north to Big Rush Creek, while a second headed on the other side of the divide and flowed westward to the Hocking. The ice blocked up the old outlet at Lancaster, turning the water over this low col and cutting the present outlet.

There is one point in connection with this abandoned valley that Prof. Tight merely notices but does not connect with the glacial history of the region. Near the western end, Pleasant Run enters the abandoned portion of the valley from the north, flows diagonally across it toward the southwest and enters a narrow valley about one mile long, the southern end of which opens into the Hocking valley. This narrow valley is about 300 yards wide at its narrowest point and is bordered by very steep rock walls 150 to 200 feet high. The floor is a level plain, in every way a continuation of the floor of the larger valley. There are no well borings which might show the depth of drift. It is not in a position for an oxbow of either the Hocking or the stream which formerly occupied the abandoned valley. It is possible that there may have been a low col in this narrow valley over which the waters from the east poured after their outlet at Lancaster had been blocked by ice but before the present outlet had been cut. Subsequent advance of ice might have blocked this outlet and the present drainage have been developed.

Little Rush Creek rises in Perry county near New Reading and flows westward into Fairfield county, entering Big Rush Creek at Bremen. In its upper course its valley is broad and two and one-half miles northeast of Rushville a depth of 160 feet was reached with no rock. A short distance above Rushville it begins to narrow. At the station a depth of 40 feet was penetrated without encountering rock, but a few hundred yards below, the valley becomes extremely gorge-like and the stream flows on rock, everything indicating the site of a col. This region was probably drained to the northwest into the preglacial outlet of the Muskingum, although the channel is now difficult to trace. A low, broad depression extends from a short distance above Rushville through to this old valley.

Clear Creek enters Hocking from the west about three miles below Sugar Grove. Its headwaters are in a rolling, drift-covered region not far from the headwaters of the Hocking, but its valley first becomes well defined near Amanda, where it is more than a mile wide and is bordered by rock hills. It narrows gradually, however, and near Revenge becomes very gorge-like although there is a flood-plain several hundred feet wide. About four miles above its juncture with Hocking, it narrows perceptibly until the flood-plain is not more than 100 yards in width, the hills being very abrupt and about 200 feet or more in height. Below this point the valley widens somewhat but not much. This narrow point is an old col. The preglacial outlet of Clear Creek is buried beneath drift deposits but was probably northwest from Amanda into the Scioto.

A valley extends from Lancaster southwest to Amanda, connecting the Clear Creek and Hocking valleys. At Lancaster it is about one mile wide but it narrows until, at Delmont five miles distant and 250 feet above Lancaster, it is about 300 yards in width, the hills are 150 to 200 feet high and rise rather abruptly on either side. It then widens until it enters Clear Creek where its width is again about one mile. From a short distance west of Delmont the drainage is to the eastward, emptying into the Hocking at Lancaster. Between Delmont and Lancaster the valley is filled to a considerable depth with heavy and irregular deposits of drift into which the streams have cut deep trenches. From Delmont a small stream also drains to the westward into Muddy Prairie Creek of which more will be said later. The divide at Delmont between the two is very low and scarcely noticeable on passing over it on the railroad. Delmont is probably the site of an old col. The depth of drift over this col is unknown, but less than half a mile to the west, at the schoolhouse and also at a point a short distance east of the schoolhouse at an elevation about the same as that of Delmont, wells were sunk to a depth of about 180 feet and no rock was encountered. These wells are not situated in the center of the valley but near the north wall. It is possible that, after the blocking by the ice front of the old outlet of Clear Creek toward the northwest, and prior to the cutting down of the old col near the present mouth of Clear Creek, the waters of this region had an outlet over a low col at Delmont, and might have eroded it to a considerable depth. The ice, advancing farther, might have blocked this outlet and caused the cutting down of the col on the lower part of Clear Creek.

Muddy Prairie Creek, as has been mentioned, rises in the valley at Delmont on the western side of a low drift divide. It flows southwestward, in places cutting deeply into the drift filling. About two miles southeast of Delmont it leaves this broad valley and enters a narrow one between high hills, in spite of the fact that the drift divide between it and Clear Creek is only a few feet high ; it is so low, in fact, that when it was proposed to drain Muddy Prairie, a large peat swamp formerly existing in the stream near this point, the engineers advised cutting through this divide to Clear Creek. The valley which it follows into the hills is only a few hundred feet in width, and an observer standing in the broad valley which the stream has just left and facing the entrance into the hills would not even suspect that it was anything but a very short tributary coming in at this point. It is bordered by terraces of roughly stratified drift 60 to 100 feet or even more above the present floor. The soil on the flood-plain is peaty and the stream very sluggish, in places cutting only a few inches below the surface. There are no wells from which the depth of drift beneath the valley floor could be obtained. The stream continues in this way with no noticeable variation in the width of its valley for a distance of a mile, when it widens somewhat and becomes more rapid, but half a mile beyond is suddenly contracted to a width of 40 or 50 yards only and flows on a rock floor between rock walls. After emerging from this gorge, it turns to the south into a broad valley in which it continues to Clear Creek. One would naturally suppose that this was the site of an old col, but if the observer takes the trouble to climb the hill to the west of this narrow channel, he will find that it is of drift and stands directly across the valley, forcing the stream against the east wall to such an extent that it has cut a channel in the rock at that point. This drift dam is 75 to 100 feet or more in height and composed of roughly stratified gravel, a well sunk on its summit about the middle of the valley having gone to a depth of 100 feet with no rock. Below this dam the valley widens out but drift deposits have forced the stream at almost all points to the eastern wall.

Fig. 3. Old col on Arney Creek at "Jacob's Ladder."

There can be little doubt that the headwaters of this stream formerly drained into Clear Creek by the valley extending to Amanda, and that the ice has forced it over a col into the present system. The col was probably very low and possibly did not rise far, if at all, above the present floor. It is difficult to locate, but from the direction of tributary streams and the general contour of the valley, it would seem that it was probably less than a mile below the point where Muddy Prairie Creek enters the hills.

Arney Creek rises on the eastern side of a low divide at Hamburg and flows northeast toward Lancaster. For a distance of two miles the valley widens normally, when it has a width of half a mile or more; then the stream turns to the south, the valley growing narrower, and just below Christmas rocks turns sharply to the west. The valley now becomes a gorge and a mile below the last turn there is no flood-plain and the walls rise abruptly to a height of 300 feet, the north wall, known in the region as Jacob's Ladder, presenting a vertical rock cliff in the upper 100 feet, from the top of which a splendid wiew can be obtained of the surrounding country and the gorge below. Figs. 3 and 4, taken at the turn near Christmas rocks and from positions only 200 yards apart, contrast the character of the valley at the gorge and above it. Below this constriction the valley widens and continues to Clear Creek, three miles distant.

Fig. 4. Valley of Arney Creek above the col, looking towards Lancaster.

Returning to the point where the stream turns toward the south and its valley first begins to narrow, a broad valley continues in a northeast direction and joins the Hocking valley at Lancaster, where it is fully a mile wide, but Arney Creek is barred from this outlet by a drift dam 20 to 75 feet high extending across the valley in a northeast-southwest direction with a well defined, rather abrupt front. This is of till as is shown in a nearby railroad cutting, and is one of the ridges of the terminal moraine of the Late Wisconsin ice epoch. Half a mile to the south of this deposit is a second, not very well defined, broad, low ridge of similar material which probably represents the outermost limit of that ice sheet at this point. Between the dam and

Lancaster the valley is filled with irregular drift deposits in which a small, northward flowing stream and its tributaries have cut deep trenches with narrow flood-plains.

Prior to the advance of the ice there was a divide at Jacob's Ladder, one stream flowing to Clear Creek, another toward Lancaster. The ice advanced as far as the drift dam and stood at this point for some time, blocking the outlet and forcing the stream over the col at Jacob's Ladder. This, in time, was cut to the present level. While in this position, the ice deposited the debris in the mouth of the valley which prevented the return of the stream to the old channel after the advent of a milder climate and the retreat of the ice.

Below the col, as mentioned before, the valley again broadens, and at the point where it enters Clear Creek is about half a mile wide. In the immediate vicinity of the col there is no drift, but about one mile below drift terraces occur on both sides, the one on the west being more prominent. From this point to the mouth of the valley the stream has been forced by the ice to the east wall and flows in a narrow flood-plain, in at least one place passing over a rock bottom where it has been forced over a shelf. The valley west of the narrow flood-plain is occupied by drift deposits 50 to 100 feet above the stream.

About one and one-half miles below the col a tributary enters from the east. Its valley where it joins Arney Creek is about 300 yards in width, but it has been so blocked up at this point that the stream has been forced to cut a channel in the rock of the north wall. This channel is 100 feet deep, 200 yards long and barely wide enough for the small streamlet and a narrow wagon road. The sides are of rock and very steep. Much of the dam remains in the form of drift on the northern side of the valley just south of the rock channel, but at the southern side whatever blocked the old outlet has been removed, and there is an opening 100 yards wide where the dam is only a few feet above the present level of the tributary. At no point is the dam as high as the deepest part of the rock gorge. It is probable that ice which melted afterward aided greatly in blocking the old channel. It is possible that this dam is the extreme outer limit of the Late Wisconsin ice sheet at this point, as drift deposits to the west are abundant and uninterrupted while to the east they are unknown to the writer.

Hunter's Run, in the lower part of its course occupies the eastern end of the valley extending from Lancaster to Amanda which has been mentioned. About three miles southwest of Lancaster, as it enters this valley it passes through a narrow constriction between two high sandstone hills. Above this point the valley is not so well defined. There are rock hills on the south, but looking toward the north from these hills, one is impressed by the low, rolling country which sinks gradually to the level of the Hocking valley several miles distant. It seems quite probable that the drainage above the constriction was formerly carried to the northward into Hocking, but the region was not studied closely and the course of the old outlet is undetermined.

LIST OF THE MOSSES OF CUYAHOGA AND OTHER COUNTIES OF NORTHERN OHIO.

Edo Claassen.

This list is the result of the author's moss-collecting excursions during the last eight years; it may, consequently, be expected to fairly represent the moss-flora of Cuyahoga county, as also the greater part of that of the surrounding counties. Many species were found many times in the same county, others but once in the same county or even in all the counties together, and while many may be new to the flora of the respective counties, several are new to the State, as, for instance, *Dicranella curvata*, *Hypnum ochraceum* and *Mnium Drummondii*. Although almost all the species could be and were collected in the fruiting condition, there were several that were never seen with sporophytes, as, for instance, *Eurynchium Boscii*, *Hylocomium splendens*, *Hypnum Schreberi* and *Myurella Careyana*. It may be added, that all the species enumerated below are represented in the author's herbarium, often in several or many packages from the same county, and that the list-names of the mosses are those accepted in Lesquereux & James' Manual and in Barnes' Keys.

[The letters following the species names stand for the counties, as follows: C—Cuyahoga; E—Erie; G—Geauga; L—Lake; M—Medina; O—Ottawa; P—Portage; S—Summit.]

I. SPHAGNALES.

Sphagnum cuspidatum Ehrh., G.
cymbifolium Ehrh., C., G., P., S.

II. BRYALES.

1. Cleistocarpi.

Ephemerum serratum Hampe, C.
Pleuridium alternifolium Brid., C.

2. Stegocarpi.

a. *Acrocarpi.*

Atrichum angustatum Br. & Sch., C.
undulatum Beauv., C.

Presented at the November meeting of the Ohio State Academy of Science.

Aulacomnium heterostichum Br. & Sch., C., L., S.
palustre Schwaegr., C., G., L., P.
Barbula mucronifolia Br. & Sch., C.
ruralis Hedw., E.
unguiculata Hedw., C., L.
Bartramia pomiformis Hedw., C , L.
Bryum argenteum L , C., L.
bimum Schreb., C., E., P.
caespiticium L., C., L.
intermedium Brid., C., O.
roseum Schreb., C., L., O., S.
Ceratodon purpureus Brid., C., E., G., S.
Desmatodon arenaceus Sull. & Lesq., C., L., O.
Dicranella curvata Schimp., C.
heteromalla Schimp., C.
rufescens Schimp., C.
varia Schimp., C.
Dicranum flagellare Hedw., C., L.
fulvum Hook., C , L.
scoparium Hedw., C., L.
Didymodon rubellus Br. & Sch., C.
Diphyscium foliosum Mohr, C.
Discelium nudum Brid., C.
Ditrichum pallidum (Hampe), C.
tortile (Schrad.), C.
Drummondia clavellata Hook., C.
Fissidens adiantoides Hedw., C., O.
incurvus Schwaegr., C.
obtusifolius Wils., C.
subbasilaris Hedw., C.
tauifolius Hedw., C., L., O.
Fontinalis antipyretica gigantea Sull., C., E.
Funaria hygrometrica Sibth., C., L., P.
Grimmia apocarpa Hedw., C., O
Gymnostomum calcareum Nees & Hornsch, C.
curvirostrum Hedw., C., L.
rupestre Schwaegr., C.
Hedwigia ciliata Ehrh., C., G., L., S.
Leptobryum pyriforme Schimp., C., L., O., S.
Leucobryum glaucum Schimp., C.
Mnium affine Bland, C., L.
cuspidatum Hedw., C., P., S.
Drummondii Br. & Sch., C.
punctatum Hedw., C.
rostratum Schwaegr., C.
serratum Laich., C., L.

Orthotrichum anomalum Hedw., O.
strangulatum Beauv., C., G., M.
Philonotis fontana Brid., C., G., L.
Physcomitrium immersum Sull., C., G.
turbinatum Muell., C.
Pogonatum brevicaule Beauv., C., L.
Polytrichum commune L., C., G., L., P.
juniperinum Willd., C., P.
ohioense Ren. & Card., G., L., P., S.
Schistostega osmundacea Web. & Mohr, G.
Tetraphis pellucida Hedw., C., P., S.
Timmia megapolitana Hedw., C., S.
Ulota crispa Brid., C.
Hutchinsiae Schimp., C.
Webera albicans Schimp., C.
elongata Schwaegr., L.
nutans Hedw., C., P., S.
Weisia viridula Brid., C.

b. *Pleurocarpi.*

Amblystegium adnatum Hedw., C.
compactum C. Muell., C., G.
confervoides (Br.) Br. & Sch., C.
irriguum (Wils.) Br. & Sch., C., S.
" spinifolium Schimp., C.
minutissimum (S. & L.) Jaeg. & Sauerb., C.
noterophilum (Sull.) Holzinger, C.
riparium (Hedw.) Br. & Sch., C., P., S.
" fluitans (L. & J.) R. & C., C.
serpens (Hedw.) Br. & Sch., C., L., M. P.
varium (Hedw.) Lindb., C., L., M., P.
Anacamptodon splachnoides Brid., C.
Anomodon attenuatus Hueben., C., M.
obtusifolius Br. & Sch., C.
rostratus Schimp., C., S.
Brachythecium acuminatum Br. & Sch., C.
laetum Br. & Sch., C.
plumosum Br. & Sch., C
rutabulum Br. & Sch., C.
salebrosum Br. & Sch., C., M.
velutinum Br. & Sch., C. M.
Climacium americanum Brid., C., E., G., L., S.
Cylindrothecium cladorrhizans Schimp., C., L., M., P.
Eurynchium Boscii (Schwaegr.) Schimp., C.
hians (Hedw.) Br. & Sch., C., L.
piliferum (Schreb.) Br. & Sch., C., L.
strigosum (Hoffm.) Br. & Sch., C., E., L., S.

Homalothecium subcapillatum Sull., C.
Hylocomium brevirostrum Br. & Sch., C., L.
splendens Br. & Sch., C.
triguetrum Br. & Sch., C.
Hypnum chrysophyllum Brid., C., O.
crista-castrensis L., C.
cupressiforme L., C., G., L., M.
" uncinatulum Br. & Sch., C.
curvifolium Hedw., C., G.
Haldanianum Grev., C., L.
hispidulum Brid., C., L.
imponens Hedw., C., P., S.
molluscum Hedw., C., L.
ochraceum Turn., C.
pratense Koch, C.
rugosum L., C., S.
Schreberi Willd., C., G., L.
uncinatum Hedw., C.
Leskea obscura Hedw., C.
polycarpa Ehrh., C., E., G.
Leucodon julaceus Sulliv., C., E., O.
Myurella Careyana Sulliv., C.
Neckera pennata Hedw., C.
Plagiothecium denticulatum Br. & Sch., C., L.
Sullivantiae Schimp., C., L., S.
sylvaticum Br. & Sch., C., G., L., P., S.
Platygyrium repens Br. & Sch., C., L.
Pylaisia intricata Br. & Sch., C., E., G., L.
velutina Br. & Sch., C.
Raphidostegium demissum (Wils.) ——, C.
microcarpum (Muell.) ——, C.
Rhynchostegium rusciforme Br. & Sch., C., G., S.
serrulatum (Hedw.) Schimp., C., L.
Thelia asprella Sulliv., C., E., L.
hirtella Sulliv., C., G.
Thuidium Blandovii Br. & Sch., G., L.
delicatulum Br. & Sch , C.
microphyllum (Sw.) Best, C.
minutulum Br. & Sch., C., L.
paludosum (Sull.) Rau. & Herv., C., G., M., P.
recognitum Lindb., C., E., L., S.

[Cleveland, O.]

THE BREEDING HABITS OF THE MYRIOPOD, FONTARIA INDIANAE.

MAX MORSE.

There are in Ohio, three species of the genus Fontaria and further work will probably discover one or two others. The species under consideration is limited in its range in the State to the northern third, or perhaps it descends no farther southward than the latitude of Bucyrus. The species *indianae* Bollman, is about two inches in length. The ground color is yellowish brown above while the ventral parts are uniform light yellow. Dorsally, the posterior edges of the segments are bounded by lighter yellow, similar to that of the ventral parts. The head is uniform brown. These considerations will distinguish the genus from any other in the State. The present species is distinguishable from the other species by the fact that in the male the genital hooks are curved inward, i. e., toward one another. The form is the narrowest of those of the species found in the State, the pleura of the segments not being bent outward as in the other species, but rather bent downward to quite a degree.

The observations on which the present paper is based were all made near Sandusky, Ohio, and mainly on Cedar Point, during the summers of 1900, 1901, 1902 and 1903. The animals began to leave their winter quarters about the first of May or, in some years, earlier when the temperature had been higher for several weeks. Often after leaving the fallen leaves, etc., under which they pass the winter, they were forced to again bury themselves owing to cold periods. As soon as summer sets in in earnest, the myriopods are quite common. They are to be seen running here and there over the sand in the daylight hours, but from the tracks left in the sand it is evident that they are active during the night. This is rendered certain by finding adults running about during the night when, by means of a lantern, the sand is illuminated, and also by finding a labyrinth of tracks on the sand which, during the late afternoon and evening, has been swept smooth by a storm, thus obliterating the tracks made during the day. It is very probable that their activities during the night are directed towards foraging for food.

Up until the middle of July, while the species is common everywhere, yet only isolated individuals are seen. After that date, however, they apparently congregate and are found associated together. An examination showed that these collections were not of either one sex, but were made up of individuals of both sexes. Soon, however, the sexes pair off and are found in the tall grass that borders the south beach of Cedar Point which is washed

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by Sandusky Bay. Here they lay their eggs immediately, except when the weather becomes cold, as during the summer of 1903. For weeks during that summer, there were strong winds from the west and northwest that drove a heavy surf against the beach mentioned. Moreover, the major portion of the season during which oviposition generally takes place, remained cold and cloudy. The result was that the myriopods did not lay their eggs until late. During the latter part of July and the first of August, adults were not to be seen, as during hot summers like that of 1902, running about in groups on the sand, but were found huddled together in numbers under the dead marsh grass and debris that covered the bay beach above the wash of the waves.

For a short while in the second week in August, some were found pairing in the grass farther towards the middle of the Point, and a little later, several nests were discovered. The nests are built in loose sand, preferably that when mixed with a little loam and always soil that is somewhat damp. The nests are dug by the female while the male is mounted. She uses her anterior appendages to dig the hole, passing the dirt upward to the opening of the hole by means of the remaining appendages. She removes the dirt until she has made a cavity a little greater than the width of her body and about two inches in depth. When the greatest depth has been reached that she is to make the hole, she widens out a cave-like terminus which reaches a diameter of about half an inch. She is now ready to deposit the eggs. To understand this process, it is necessary to keep in mind that the external generative opening of the female is on the second body segment. Hence the female is enabled to deposit the eggs without withdrawing from the hole. The eggs are fastened to the walls of the enlargement at the base of the tubular nest, and after she has lined the cavity, she keeps on depositing eggs until she has made four or five layers of eggs. Sometimes the whole of the enlargement is filled, but generally there is a lumen in the center of the mass of eggs.

There is no evidence furnished by the present observations for the statement made by some authors[1] that the female guards the nest after she has deposited her eggs. Of the many cases watched, none of the females nor males remained in the vicinity of the nest after the egg-laying had been completed. The mouth of the nest was in each case left uncovered, but usually, by chance, the opening became stopped up either by rain or wind or some other factor.

Young specimens were found during the whole of the summer amongst the adults. These immature individuals ranged in length from three-quarters of an inch to full size. In color they differed

1. Korschelt and Heider, Embryology of Invert. Vol. III, p. 218.

decidedly from the adults, being clay colored, the bands on the posterior borders of the terga in the adults being represented by paler markings in these immature specimens. By successive moultings, they increased in size and after several weeks became colored like the adults when kept in the open air or in sunlight. Experiments on the young at different stages failed to bring out the adult colors until the normal length had been attained. The eggs lie over winter and the larvae emerge in the following spring as minute white bodies which grow quickly into the young described above.

DECIDUOUS LEAVES.

John H. Schaffner.

Plants have alternating periods of rest and activity. In our latitude these periods usually correspond to the alternating conditions of day and night and to the seasons of the year. The active growing period usually occurs in the summer or the rainy season and the inactive one corresponds to the cold or dry season. Where the seasons are so marked as in Ohio one takes it as quite natural that there should be a resting period in the winter. But many plants pass into a period of rest even if growing in an environment perennially favorable. Thus it is very common for complete defoliation to take place in many plants of the tropics. It is said that there are nearly two hundred species in Ceylon which become leafless at different times of the year. The statement is made that there is not a month when all the trees are in full leaf. It is evident, therefore, that in many cases the period of rest and the deciduous habit are independent of climatic conditions no difference how the character was originally acquired. In our own plants the influence of cold is no doubt predominant. The injuries of winter are not only due to the direct effect of cold upon the protoplasm, but also to the loss of water. With the approach of autumn, the chilled roots are unable to supply the necessary amount of water for the transpiration going on above; consequently there is a great advantage in reducing the transpiration surface by shedding the leaves. Thus we might say that the casting of the leaves is an adjustment to a more limited water supply. Plants may of course go into a period of rest without shedding their leaves, as in our common Conifers. In most cases, however, there is a great change in the body of the plant or some of its parts to prepare for the severe conditions. The annuals die completely and the only resting period is in the seed. The biennials usually grow but little after the cold becomes severe. The greater number of geophilous plants die to the ground. The woody plants and a few herbs have mostly learned to endure the winter by specially developed stems, the leaf which represents the active transpiring and food manufacturing organ being usually shed.

The methods by which the leaves are separated from the stem are various. Some plants like the Hemlock shed them after they are several years old. Others like the Pines get rid of the foliage leaves by pruning off dwarf branches of a certain age. Some like the Bald Cypress and Tamarix drop the dwarf branches and smaller twigs with the leaves at the end of each growing season; so the plant has no leaves in the winter. But the common way is for the leaves alone to be separated from the branches. A cleavage plane is formed usually at the base of the petiole and the leaf then falls away. The separation layer is gradually developed between the vascular bundles and epidermis, and finally, when the cleavage is nearly complete the merest puff of wind will break the woody strands and carry the leaf away.

The casting of the leaf, however, is not a sudden process but preparatory changes are going on in its tissues for some time before it is detached. In many cases anthocyan and other coloring matters are developed to protect the chlorophyll and protoplasm while the food material is being transferred to the stem.

After the cleavage plane is formed a heavy frost will help to break away the fragile woody strands which still hold the leaf in place. This is very apparent in such trees like the White Mulberry, which may put off its entire leaf dress in a single day after a frosty autumn night. There is much difference in the time of casting the leaf. The Ohio Buckeye, Juneberry, Walnuts, and Hickories are among the first to shed their leaves. The Cottonwood and Chestnut Oak shed their leaves very gradually; and some of the Oaks are among the last of the trees to be bare. The Shingle Oak drops few leaves before late in the winter, although they dry off, and it is not completely denuded until about the first of April.

It is interesting to note the several ways in which the cleavage planes are produced. In plants with simple leaves a separation layer is more commonly formed at the base of the petiole very close to the stem, as in the Elm, Maple, Oak, and Catalpa. In some, however, two cleavage planes are produced, one at the base of the petiole and the other at the outer end just at the base of the blade. This is strikingly shown in Ampelopsis tricuspidata and A. cordata. The blade drops off some time before the petiole, so that in certain years a vine of A. tricuspidata may shed nearly all of its blades before the petioles begin to fall making a rather unique appearance. The same adaptation is present in the various species of Grape. There is probably considerable advantage to the plant in such an arrangement, for the food in the large petiole, which is in much less danger of freezing than the blade, may thus have a longer time to be withdrawn into the stem. In the Catalpa, for instance, the blades often freeze and dry up in the fall while the petioles are still green and active. It would evidently be better if the useless blade were cut off by a cleavage plane so as not to hinder the work of the petiole.

In compound leaves the leaflets are usually shed singly. The leaflets of such palmate leaves as in the Virginia Creeper and the various Buckeyes are cut off some time before the petiole. Pinnately compound leaves have various peculiarities. In such forms as Rhus glabra the leaflets are separated by cleavage planes but no transverse cleavage joints are formed in the main rachis which persists for some time. In other forms, like in Fraxinus quadrangulata and Staphylea, not only are the leaflets cut off by cleavage planes but there is a series of cleavage joints formed in the rachis at the insertion of each pair of leaflets and thus the main rachis of the leaf drops off piece by piece. Decompound leaves often form an elaborate system of separation layers. A good example of this is shown in the leaf of the Honey Locust. First the numerous leaflets drop off, the main rachis and the side branchlets remaining on the tree for some time. Next the side branchlets begin to fall, and finally the whole rachis is separated. One may well ask the meaning of such an elaborate system of cleavage planes when one amputation at the base of the petiole would be sufficient. There is no doubt but that the green rachis and petiole may continue, to a limited extent at least, the process of photosynthesis; and as stated above, by means of a gradual cutting away of the large leaf surface the more exposed parts are removed first and there is a better opportunity for the withdrawal of the food present into the stem.

A very interesting condition is present in the Green Briers. The leaf of Smilax hispida has two tendrils near the base of the petiole and these, of course, hold the plant to its support. Evidently if the leaf were shed in the usual way the whole vine would fall to the gouna in the winter. There is a more or less perfect brittle layer formed in the petiole just a little beyond the two tendrils where the leaf finally breaks off, leaving the petiole base with the tendrils intact. Most of the leaves hang on until after December 1, though usually frozen before this time. The development of a brittle layer in the petiole of this plant seems to be quite a modern adaptation. Smilax glauca, S. rotundafolia, and S. bona-nox show the same peculiarity. The genus Rubus represents another group of plants which shed their leaves by a break in the petiole, leaving the base on the stem. In this case there are no tendrils and the only apparent advantage to the plant is the protection of the bud or tender part in the axil of the leaf. The adaptation, however, may have no other significance than one of the possible ways in which the plant was able to get rid of its leaves. Among the species which show this peculiarity well are Rubus odoratus, R. strigosus, R. occidentalis, R. nigrobaccus, and R. invisus. In the common Mock Orange, Philadelphus coronarius, the cleavage plane is formed a little above the base of the petiole which remains as a protection to the axillary bud.

There are certain plants which have the habit of covering their axillary buds with the base of the petiole. The Sycamore, Platanus occidentalis, presents a very perfect example of this adaptation. The reason for such a peculiarity is not easy to see. It may be for protection, or again as in Rhus glabra it may prevent the development of too many lateral buds into branches. But there may be no special advantage whatever. It may be a mere incident to the adjustment of the leaf to the surrounding tissues. Other plants which cover their lateral buds are Cladrastis lutea, Rhus hirta, R. copallina, Acer negundo, Ptelea trifoliata, Gleditsia triacanthos, Robinia pseudacacia, R. viscosa, and R. hispida. In Gleditsia and Robinia there are a number of superposed buds only part of which may be covered.

The undersigned wishes to make a census by counties of the pteridophytes of Ohio. To further this aim, the cooperation of every science teacher and fern student is asked. Specimens with full and exact data are desired and will be identified or referred to some competent authority. Unless otherwise provided for all duplicate specimens will be sent to state herbarium, O. S. U. Address June 15th to August 10th, University of Wooster, O.

Lewis S. Hopkins, *Troy, Ohio.*

Date of Pnblication of May Number, May 1, 1904.

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THE EMBRYO-SAC AND EMBRYO OF NELUMBO.*

HARLAN H. YORK.

Since the publication of Lyon's studies on Nelumbo and Cook's work on Castalia and Nymphaea, the systematic position of the Nymphyaeaceae has again become a prominent question. Owing to the variety of opinions held in regard to the classification of this group, it was thought desirable to continue the study of the life history of Nelumbo lutea, although this plant has been described more or less completely a number of times.

Material was collected during July and August, 1902, in Sandusky Bay, near the Ohio State University Lake Laboratory, at Sandusky, Ohio. Flemming's stronger and weaker solutions and chromo-acetic solution were used as killing and fixing agents. On examining the ovules, it was found that in most cases the tissues had not been properly penetrated by these fluids. In the summer of 1903 more material was collected, near the place already mentioned, which was killed and fixed in Kleinenberg's picro-acetic and picro-sulphuric solutions and was found to be preserved in good condition. The ovules were passed through the alcohols, imbedded in paraffin, and serial sections were cut 10–12 mic. thick. For staining several reagents were used : Delafield's heamotoxylin, Heidenhain's iron alum haemotoxylin, analin safranin and gentian violet. All of these stains were successful, the last named stain giving the best results. Considerable difficulty was experienced, in that a great many ovules had failed to develop embryo-sacs and others had not been fertilized. Quite a large number of slides were prepared and most of the points mentioned were observed a number of times.

This work was commenced under the direction of Prof. Mel. T. Cook in the De Pauw University Botanical Laboratory and

*Contributions from the Botanical Laboratory of Ohio State University. XVII.

completed under Prof. John H. Schaffner in the Botanical Laboratory of Ohio State University, to both of whom I wish to express my sincere thanks.

In Nelumbo, the carpels are situated in deep pits of the top-shaped receptacle. The stigma and the narrow canal which traverses the short style are covered with glandular cells which secrete a mucilagenous fluid at the time of pollination (Fig. 8). The ovule is suspended from the summit of the ovulary (Fig. 1). Some time before the integuments begin to develop, the growth of the ovule is more rapid at one side (Fig. 1) and anatrophy is well marked when the incipient seed-coats make their appearance. A single hypodermal archesporial cell can be easily distinguished from the adjacent cells by its larger size and more granular cell contents (Fig. 2). Very early in its development, it divides by a transverse wall into an upper cell, the primary parietal cell and a lower cell, the megasporocyte (Fig. 3). By a series of divisions of the primary parietal cell, a large parietal tissue of twelve cells, arranged in three tiers of four cells each, is formed (Fig. 5).

The megasporocyte expands almost equally in all directions. The divisions of the megasporocyte were not followed, but four megaspores are formed. The lowest one becomes the functional megaspore while the others degenerate (Fig. 6). By the further division of the parietal tissue and the epidermis at the tip of the nucellus, the functional megaspore becomes deeply placed in the ovule (Fig. 7.) The nucleus of the functional megaspore now divides into two (Fig. 9), four (Fig. 10), and eight nuclei respectively, producing the eight-celled embryo-sac (Fig. 11). Frequently great irregularities in the development of the embryo-sac were present. In many cases two or more imperfect sacs were observed. Usually there was one complete sac with one or more imperfectly developed sacs. By the appearance of the preparations, it seems that the extra sacs are derived from sister megaspores, rather than from independent megasporocytes (Fig. 15.)

The embryo-sac developes very rapidly and is usually straight. It enlarges principally in the direction of its longer axis, destroying the parietal cells above and encroaching on the ovular tissue below. The antipodals are small (Fig. 11) and usually disappear before the conjugation of the polar nuclei. In only a few instances could any trace of them be found after the polar nuclei had conjugated. The synergids are small. They become slightly enlarged from their original condition, and are elongated transversely to the longer axis of the sac. They degenerate about the time of fertilization or soon after (Fig. 12). The egg becomes quite large and usually is placed considerably to one side of the sac (Fig. 13).

The polar nuclei begin to conjugate about the time the flower opens and the fusion is not complete until after fertilization. In approaching each other, the lower polar nucleus travels much farther than the upper one and the fusion usually occurs near the egg or even in contact with it (Fig. 13). Quite a number of examples of a triple fusion were found. In many of the preparations in which the pollen tube had appeared, two of the nuclei were about the same size while the third one was smaller (Fig. 14). Several other examples were found where there were three conjugating nuclei, almost equal in size and similar in appearance even before the pollen tube had appeared. It seems that in the first instance where fertilization had occurred, the small nucleus of the three conjugating nuclei represents the second male cell and that there is here a true case of what has been called double fertilization ; while in the second instance the conjugating nuclei were embryo-sac nuclei, since the pollen tube had not yet entered the sac.

Soon after the eight-celled sac is formed it begins to grow very rapidly in the direction of the longitudinal axis of the ovule. The cells of the tissue below the antipodal region of the sac become greatly enlarged and between them are large intercellular spaces. Usually there is a single row of cells very rich in cytoplasm, which becomes very prominent in the preparations because of its deep stain. This row extends downward from the base of the sac toward the lower end of the ovule (Fig. 14). The cells surrounding this axial row become much larger in size and then disintegrate, leaving a large space filled with thin cytoplasm (Fig. 18). The cytoplasm of the embryo-sac extends down to the axial row of cells (Fig. 14). These central cells are present some time after the adjacent cells have disappeared, and since they are rich in cytoplasm, it seems that they serve as a conducting passage for food from the lower ovular tissue to the cytoplasm above, which in turn carries the food to the egg apparatus. After fertilization the axial row begins to degenerate and then disappears entirely, leaving a cavity reaching far back into the tissue of the ovule (Fig. 21) Sometimes the nuclei of the axial row of cells become active and divide (Fig. 20), and are afterwards found massed together in the lower part of the cavity after their walls have disappeared (Fig. 21). The cavity formed by the disintegration of the cells below the antipodal region enlarges greatly while the embryo is developing and into it the two basal lobes of the embryo are rapidly extended, their outer surface lying in contact with the walls of the cavity.

The first division of the definitive nucleus occurs about the time of the formation of the two-celled embryo and a very delicate wall is formed between the two daughter nuclei which divides the embryo-sac into two chambers. A division of one of the two endosperm nuclei thus formed takes place and a second wall is formed across the sac so that there are then three superposed compartments (Fig. 24). It seems that all three of the daughter nuclei continue to divide until the whole sac is filled with endosperm extending far down into the space formed by the dissolution of the tissue of the ovule below the base of the embryo-sac (Fig. 27). The development of the endosperm, after the three-celled stage, begins at the upper end, but there is no large vesicular cell developed at the lower end of the sac, as Cook reported for Castalia odorata. At first the endosperm cells are quite large, but as the division continues the cells become much smaller, walls continue to be formed between the dividing nuclei until the endosperm is fully developed, no free cell formation taking place, so far as observed, at any stage of the process.

The history of the embryo as followed is the same as reported by Lyon. After fertilization, the oospore continues to occupy the same position as the oosphere and it enlarges somewhat before it divides (Fig. 13). Although no two-celled embryo was observed, it is evident that the first division of the oospore is by the formation of a transverse wall. Then by the formation of a longitudinal wall in each of the two cells, a quadrant is formed (Fig. 23). Although this is the typical course of development, very frequently the divisions are different. The lower cell often divides by a transverse wall, thus forming a tier of three cells in the proembryo (Fig. 22). By the formation of longitudinal walls in the quadrant, the embryo passes into the octant stage. In case of a more irregular development, the three cells of the embryo arranged in a row, divided by longitudinal walls, making a six-celled embryo (Fig. 25). Whether the early development is typical or irregular, a series of divisions follows by which a spherical embryo of several hundred cells is formed (Figs. 26–29.)

No suspensor cell is present; so the young embryo lies against the nucellus at the micropylar end and is almost surrounded by endosperm tissue (Fig. 27). When the spherical embryo has reached its maximum growth, it becomes flattened at the outer end by the development of a collar-like ridge extending about two-thirds of the way around (Figs. 30, 31 and 32). This is followed by the outgrowth of a small protuberance from the flattened side about parallel with the apex of the ovule. After the formation of the crescent-shaped ridge, the development continues at the opposite side, giving rise to the two "cotyledonary" lobes of the embryo (Fig. 33). The two lobes grow downward very rapidly outside the endosperm, the tissue of the ovule rapidly disappearing before them. In the meanwhile, the endosperm has formed a sac-like mass of tissue around the embryo and extends down into the cavity of the embryo-sac to the disorganizing tissue below. In the meantime the growth of the plumule has been very slow, being a dome-shaped projection of tissue occupying a central position between the lobes but to one side of the axis of the embryo (Fig. 33.) Both the cotyledonary ridge and the incipient stem tip come from the outer end of the embryo and probably represent terminal structures, but the stem tip represents the more central mass of cells. On account of the spherical condition of the embryo it is practically impossible to trace the origin of any set of cells which appear at the outer end of the more mature embryo, and the cotyledonary ridge may be lateral.

After the cotyledonary lobes have become greatly enlarged the incipient plumule continues its development. It grows downward, forcing its way into the center of the mass of endosperm which lies between the two cotyledonary lobes. The first leaf and stem tip develop side by side from the terminal mass of cells in the protruberance. The leaf arises on the side opposite the cotyledonary ridge (Fig. 34). The second leaf arises on the side of the plumule opposite the first and develops more slowly than the first leaf. The comparative growth and manner of development may be seen from Figs. 35–40. The radicle has its origin at the base of the plumule. It is a vestigial organ and does not develop on the sprouting of the seed. It can only be seen at a late stage of development and is enclosed by an outgrowth from the surrounding tissue (Fig. 40).

The homology between the development of the embryo of Nelumbo and other monocotyledonous embryos is very striking in many respects. In its early development the embryo of Nelumbo is very similar to those of Aglaonema, Diffenbachia, and Lysichiton. In these forms the oospore does not cut off a suspensor cell but builds up a spherical embryo as is formed in Nelumbo. In the forms described by Campbell, the egg may segment, first, by two transverse divisions before any vertical division, or a regular quadrant may be formed, which is likewise true in Nelumbo. The development of the "cotyledonary" ridge shows a striking resemblance to the hypocotyledonary expansion of various Helobiae. The mature embryo may thus be compared with those of Halophila, Ruppia, Zostera, and Phyllospadix. In these forms there is a broad expansion of tissue below the plumule. In Halophila, Ruppia, and Zosteria, the hypocotyledonary lobe is continuous, while in Phyllospadix the structure is somewhat lobed if one may judge from the published figures and descriptions. The plumule with the so-called cotyledon is attached near the center. It is probable that the broad two-lobed expansion of tissue in the Nelumbo embryo commonly known as the cotyledons, is a true hypocotyledonary body as in the forms just mentioned. It bears a rather close resemblance to the hypocotyledonary expansion of Phyllospadix. If such a comparison is correct, the first leaf of Nelumbo is homologous with the so-called cotyledon in Ruppia and Phyllospadix, and the plumule and cotyledon of these forms may arise as terminal structures side by side, as do the plumule and "first leaf" of Nelumbo and the similar structures of the Araceae mentioned above. A careful study of all the Helobiae with "macropodous" embryos, as well as other monocotyledonous types, will probably be necessary before a definite conclusion can be reached.

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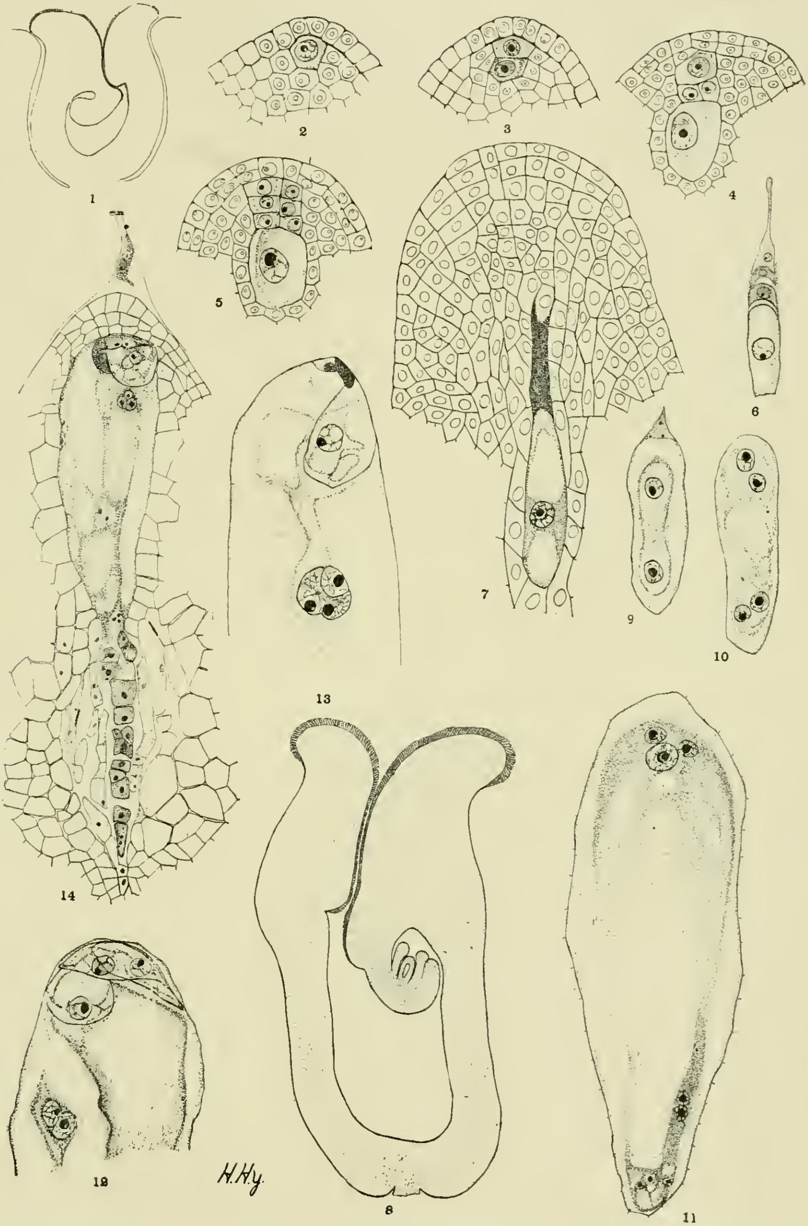
EXPLANATION OF PLATES.

The figures were drawn with the aid of an Abbe camera and the following combination of oculars and objectives: Figs. 2–7, 9–13, 20, 22, 23, 25 and 26, Bausch & Lomb $\frac{1}{12}$ obj., Leitz oc. 4; Figs. 15, 28–32 and 34, Leitz $\frac{1}{7}$ obj. and oc. 4; Figs. 14, 16-19 and 33, Leitz $\frac{1}{7}$ obj. and oc. 2; Figs. 21, 24 and 27, Bausch & Lomb $\frac{1}{12}$ obj. and oc. 2.

PLATE XVI.

Fig. 1. Young carpel before the integuments appear on the ovule.
Fig. 2. Nucellus with archesporial cell.
Fig. 3. The megasporocyte and primary parietal cells.
Fig. 4. Megasporocyte and three parietal cell.
Fig. 5. Megasporocyte and twelve parietal cells, six of which show in one plane.
Fig. 6. The four megaspores, the lowest enlarging as the functional megaspore.
Fig. 7. The nucellus with cap of tissue developed from the epidermis.
Fig. 8. Carpel with two celled embryo-sac in the ovule, showing the stylar canal lined with glandular cells.
Fig. 9. Two-celled embryo-sac with remains of the three potential megaspores.
Fig. 10. Four-celled embryo-sac.
Fig. 11. Eight-celled embryo-sac, showing conjugation of the polar nuclei and disorganization of the antipodals.
Fig. 12, Upper end of embryo-sac, showing the oosphere, synergids and conjugating polar nuclei.
Fig. 13. Upper end of embryo-sac, showing tripple fusion, the egg, remains of pollen tube, and synergid.

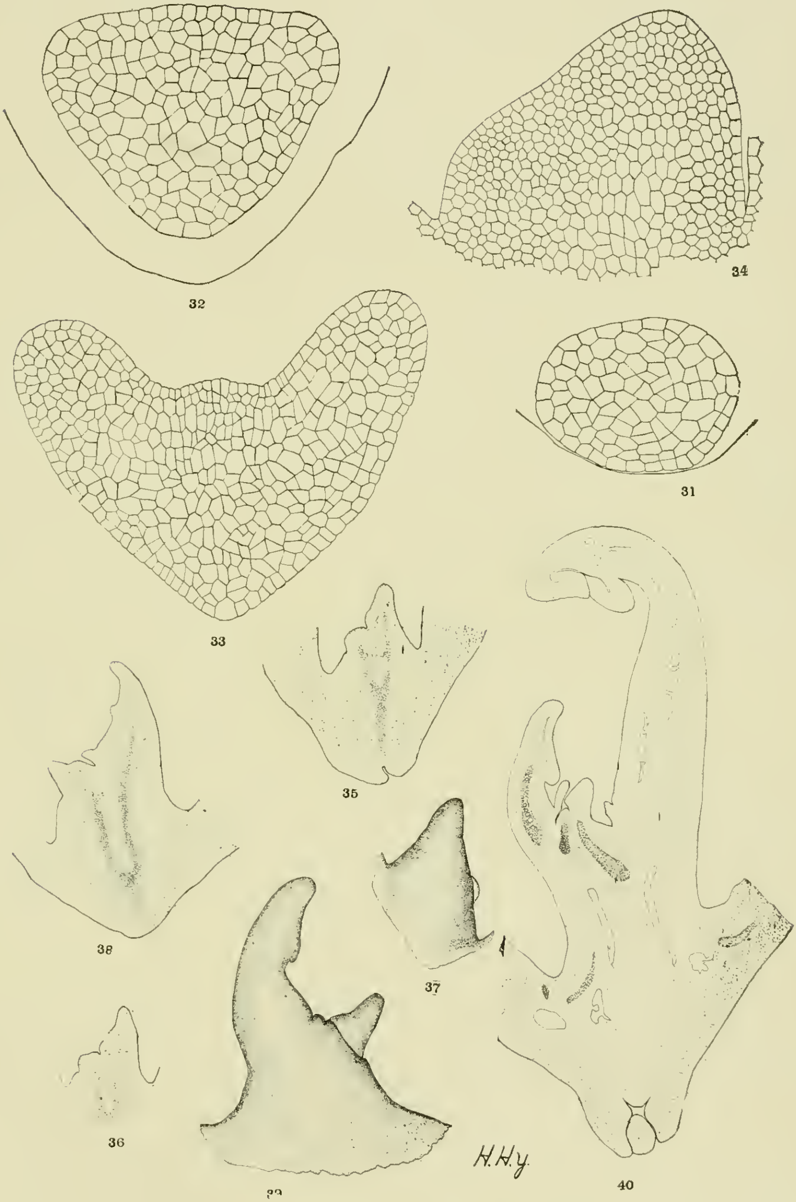
OHIO NATURALIST. *Plate XVI.*



YORK on "Nelumbo."

OHIO NATURALIST. *Plate XVII.*

YORK on "Nelumbo."



YORK on "Nelumbo."

Fig. 14. Embryo-sac with fusion of the gametes and triple fusion below. Below the sac appears the beginning of the cavity formed by the breaking down of the ovular tissue, with axial row of glandular cells.

PLATE XVII.

Fig. 15. Abnormal embryo-sac, showing three separate nuclear fusions.

Fig. 16. Early stage in development of the axial row of cells.

Fig. 17. Axial row of cells further developed.

Fig. 18. Perfectly developed axial row, surrounded by a cavity formed by the breaking down of the cells of the surrounding tissue.

Fig. 19. The cavity below the sac, with irregularly developed axial row.

Fig. 20. Basal cavity below the embryo-sac, with irregularly developed axial row.

Fig. 21. Basal cavity with groups of nuclei massed together.

Fig. 22. Three-celled embryo.

Fig. 23. Four-celled embryo and pollen tube.

Fig. 24. Four-celled embryo with pollen tube and early formation of endosperm.

Fig. 25. Six-celled embryo with remains of pollen tube and one synergid.

Fig. 26. Section of young spherical embryo.

Fig. 27. Endosperm and embryo somewhat flattened by being in contact with the wall of the ovule.

Fig. 28. Section of embryo, showing difference in staining between the basal and outer parts.

Fig. 29. Section of spherical embryo.

Fig. 30. Section of embryo, showing the flattening due to the development of the incipient "cotyledonary" ridge.

PLATE XVIII.

Fig. 31. Section of the flattened embryo further developed.

Fig. 32. Section of embryo, showing the two sides of the cotyledonary ridge.

Fig. 33. Section of embryo, showing the beginning of the dome-shaped protuberance between the cotyledonary lobes.

Fig. 34. Section of the dome-shaped protuberance, or the incipient plumule, showing terminal origin, side by side, of first leaf and stem tip.

Fig. 35. Outline section of embryo, showing incipient plumule.

Fig. 36. Outline section of embryo, showing the plumule further advanced.

Fig. 37. Surface view of the incipient plumule a little older than in Fig. 36.

Fig. 38. Outline section of plumule, showing the beginning of the development of the leaf blade.

Fig. 39. Surface view of a still older plumule than Fig. 38.

Fig. 40. Outline of section of embryo, showing the position of the first three leaves.

FORMAL OPENING OF THE LAKE LABORATORY BUILDING.

HERBERT OSBORN.

The formal opening of the new building for the Lake Laboratory on Cedar Point near Sandusky, occurred July 2nd, 1903. A number of invited guests were present in addition to the students and investigators enrolled for the summer. After a time spent in the inspection of the building and its appointments, all assembled in the main lecture hall and listened to a program including addresses by Prof. C. J. Herrick, Denison University, President of the Ohio State Academy of Science and Secretary of the Section of Zoology, American Association for the Advancement of Science;

THE LAKE LABORATORY BUILDING. (Photo by Herbert Osborn.)

Hon. John T. Mack, of Sandusky, member of the Board of Trustees; Prof. J. V. Denney, Dean of the College of Arts, and Herbert Osborn, Director of the Laboratory. Letters were read from a number of leading scientific workers of the country expressing regrets at inability to be present and congratulations on the successful establishment of the laboratory.

Mr. Mack spoke especially for the Trustees and for the citizens of Sandusky, who have taken an active interest in the progress of the laboratory. Prof. Denney dwelt upon the relation of the laboratory to general education and to the university and college life of the State. Both of these addresses were especially happy and appropriate, but being delivered without manuscript are, unfortunately, not available for publication. The others were published in the Sandusky *Register* in its issue of July 3d.

Prof. Herrick's address, "The Summer Laboratory as an Instrument of Biological Research" (printed in full in SCIENCE, Vol. XVIII, No. 452, p. 263, August, 1903), after treating in a very instructive and interesting manner of the sphere of the summer biological laboratory or station, its duties and responsibilities, closed with the following encouraging words for the Cedar Point Station:

"The summer laboratory should be a clearing house of scientific ideas, not merely a hotbed or forcing house for budding researches. To meet this need it is evident that the greater the diversity in personnel and range of interests represented, the better. That which the university student prizes most is the intimate daily contact in the lecture room and laboratory with his instructors. In the properly organized summer biological station every worker comes into that same sort of relation with every other worker, and this, I take it, is the best that the station can offer to its patrons. To attain the highest efficiency there must, therefore, be sufficient flexibility of organization and diversity of interests represented to correct the tendencies toward intellectual inbreeding which we find in most of our university and college laboratories and to secure a sort of cross-fertilization of scientific organizations.

"Regardless of the individual investigator's problem and method, he can well afford to utilize such opportunities; indeed, he cannot afford, except in unusual cases, to neglect them for long periods, if he would retain his intellectual tone and elasticity. The station, in short, is an exceptionally favorable aid in effecting that breadth of view and perfection of co-ordination which we have seen to be the keystone in the arch of scientific achievement.

"It is a source of congratulation to us, the members of this laboratory, that these liberal principles are clearly at the foundation of our present organization. Our director has made it very plain not only by word of mouth, but much more forcibly in practical ways, that it is to be the policy of our laboratory to secure the widest co-operation among all the men of science of our State. To this, as the representative of organized science in Ohio, I have pleasure in responding with equal cordiality that it will be our purpose to share in the great work here established to the full extent of our ability, by attendance when possible, and by sympathetic interest at all times. While we are the gainers by this liberal hospitality offered by the laboratory, it is certain that the laboratory in thus casting its bread upon the waters will find it again after many days."

Address of Capt. Alexis Cope, Secretary Board of Trustees, Ohio State University.

The movement toward the establishment of a lake laboratory for the Ohio State University at Sandusky began in the fall of 1894. The late lamented Dr. D. S. Kellicott, then Professor of Zoology and Entomology, in an interview with the secretary expressed some discouragement over the prospects of the scientific departments of the university. It was just after registration day and a number of students in the scientific courses who came later had not yet returned. The secretary suggested some special advertising of the science courses. In this conversation Professor Kellicott mentioned the fact that the University of Michigan had a lake laboratory somewhere on the lakes, I think at Charlevoix, supported by the Fish Commission. The secretary at once said, why not have such a laboratory for the State University at Sandusky, in co-operation with our own State Fish Commission? They have a building there and, for the present at least, might allow us to use a portion of it for a laboratory. He at once responded eagerly to the suggestion, and said Sandusky was the best point on the lakes for a station. We at once opened the matter with Hon. H. B. Vincent, then president of the Board of Commissioners of Fish and Game, who took the matter up and considered it favorably, and as a result of such conferences, Dr. Kellicott drew up the following communication to the Board of Trustees, which was presented to them at a meeting held January 15, 1895. It is given in full because it has never been printed, and because it states so fully the objects and purposes of the laboratory as conceived by Dr. Kellicott, who may well be called its founder. It is as follows:

To the President and Trustees of the Ohio State University:

SIRS—At different times I have had conversation with President Scott, Secretary Cope and others concerning a lake laboratory under the patronage of the university. I now ask the privilege of stating to you in writing my views of this matter, and, in this connection, of another closely connected with the former, and ask you to consider both propositions.

The questions are: 1, The establishment in the near future of a lake laboratory at or near Sandusky; and 2, the creation of a State collection of the fishes of Ohio.

THE LABORATORY.

The purpose of the plant that I would advocate is to afford an opportunity and a stimulus to instructors and students of biology in the university to spend their vacations investigating living problems in biology, especially such as are connected with important industries like the fisheries.

The obvious advantages to the university are: 1, Prestige. 2, Practical training of our students. 3, The sure increase of our collections; and 4, it should extend the usefulness and influence of the university.

THE LOCATION.

I think it would be difficult, if not impossible to find, anywhere about the Great Lakes, a more suitable place for such a station than at some point near Sandusky.

I may say that I spent the greater part of the time from June 23 to August 1st last, at Sandusky, Toledo and about the islands, and found the whole region unsurpassed in richness of material and in advantages for study.

The plant that I consider necessary for success in this undertaking may be briefly outlined as follows: 1, The main thing is a building that shall give shelter and security to the investigators and their outfit. This could be constructed in the simplest manner; the size should be sufficient to accommodate six to ten men, say 24 x 30 feet, and with two floors; the lower for the storage of boats and apparatus, and for the coarser operations of "preparing"; the upper for tables and aquaria. 2, The necessary furniture for convenience in work (apparatus, books, etc., could be moved up from the university and returned annually); 3, boats, nets and aquaria.

NOTE: Michigan has such a station supported by the Fish Commission, the university furnishing the investigators and the apparatus. The station is movable. It is this year as last at Charlevoix, where a building has been rented for a term of years as I understand it. The president, at least, of the Fish and Game Commission of Ohio favors a similar arrangement, but has, at present, no funds.

The State Hatchery at Sandusky, which Mr. Vincent kindly allowed me to use last summer, is well located, but it is not suitable for the work contemplated, as the main room is wholly occupied by hatching jars and apparatus. By making comparatively slight changes it would serve the purpose very well.

I was told by men interested that the United States Fish Commission want the hatchery for a railway shipping station to accommodate distribution of fry from the United States Hatchery at Put-in-Bay.

NOTE 2: I cannot help but think it would be better, if expedient, for the university to own and control the matter without reference to the Fish and Game Commission, except to co-operate with it in every way possible in securing knowledge of the habits of fishes, on which intelligent culture depends. It would then be a university affair and those in charge would have but one aim and one master. It would leave us independent to work in any line without criticism.

THE COLLECTION.

The second question may be more briefly stated. A complete collection of the fishes of the State does not exist. It is much needed: 1, Students of fishes often want an authentic collection for comparison and identification. 2, Questions in law often arise that cannot be truthfully settled without such specimens. 3, Such a collection must awaken interest in the subject; and 4, it would surely prove of much immediate usefulness in the Department of Zoology.

The amount needed to enable a vigorous prosecution of the work during the coming summer, I estimate as follows: 1, A barrel of alcohol, \$30; 2, five pounds of formaline (a new preservative), \$6; 3, bottles and anatomical jars, \$50 (for one year's work); 4, nets, etc., \$15; 5, for buying desired species of fishermen and in the market some student help in dredging and for transportation, \$50. Total, \$150

The last fish cannot be secured the first or second year, but all the food fishes and many others may be had at once; these will include nearly all the larger species, so the cost hereafter will be slight annually and no special appropriations will be necessary.

I would like to begin preparation at once and to be able to secure during the winter such species as come to the Columbus market in good condition.

Mr. Vincent has agreed to aid in every way possible in this matter.

Respectfully, D. S. KELLICOTT.

The Board of Trustees referred the report to a committee consisting of Trustee John T. Mack, President W. H. Scott, Professor D. S. Kellicott and the secretary to make an investigation and report on the feasibility of the plan proposed at the next June meeting of the board. For some reason the committee did not submit its report to the Board of Trustees until September 2, 1895.

The report was drawn by Professor Kellicott and appears in the printed proceedings of the board. It was adopted and the sum of $350 was appropriated to carry out the recommendations of the report.

On September 17, 1895, the secretary wrote to Hon. H. B. Vincent, president of the Commissioners of Fish and Game, submitting a formal proposition to erect a second story to the Hatchery Building at Sandusky, with details for its joint occupancy, which, if accepted, would constitute a binding contract.

Mr. Vincent wrote saying he would call a meeting of the commission as soon as practicable and would recommend its acceptance.

The meeting was afterwards called and held at the Chittenden Hotel, in Columbus, December 19, 1895. The committee on the part of the university was present and the proposition was formally adopted.

Early in the summer of 1896, the addition, a second story to the Hatchery Building, was begun. The contract was let by Mr. Mack, who looked after the construction of the improvement and saw that it was properly done.

We learn from the Sandusky *Register* of July 10, 1896, that the building was about completed and would be accepted by Professor Kellicott that week. We also read in the same paper that "a second story has been added to the entire Hatchery Building and fitted up and provided with a large room for laboratory work, and several dormitories to be occupied by students during the summer."

The movement having in view the fine and commodious building which is formally opened to-day, began over four years ago. In September, 1899, the matter of further provision for the Lake Laboratory at Sandusky came before the Board of Trustees and was deferred until the next meeting. The matter came up again at a meeting held in November of the same year and was referred to a committee consisting of Trustee Mack, President Thompson and Professors Osborn and Kellerman.

The record does not show that this commitee submitted any formal report. It is presumed, however, that temporary arrangements were made for the further accommodation of the increasing number of students.

In June, 1901, President Thompson reported to the Board of Trustees that a petition had been sent to the Ohio Fish and Game Commission, asking for the use of the lower story of the building at Sandusky heretofore occupied by the Lake Laboratory, and produced a letter from Mr. L. H. Reutinger, secretary and chief warden, saying that the request had been granted. The preparation of such story was devolved upon Mr. Mack with the result that we all know. The provision was only temporary, and the indefatigable, silent and efficient Professor Osborn "kept at it," to use a little pardonable slang, until June 16, 1902, at a meeting of the Board of Trustees, President Thompson presented a list of improvements which, in his opinion, were desirable to be made in the next two years, and among them was a Lake Laboratory building at Sandusky to cost $2,500. After a full discussion of president's report the erection of a Lake Laboratory building was authorized and the sum of $2,500 was appropriated therefor. At the same meeting a committee consisting of Trustee Mack, President Thompson and Secretary Cope was appointed to secure if practicable a permanent lease of land on which to erect such laboratory. The rest is recent history and is quickly told. Plans were at once prepared by Professor Bradford under the direction of Professor Osborn. The Cedar Point Pleasure Resort Company, through its officers, Messrs. Jacob Kuebler, president, Geo. A. Boeckling, manager, and Hon. Eugene Guerin, generously tendered the present site, and on April 1, 1903, a formal lease thereof at a nominal rental was tendered to the Board of Trustees and accepted. On the same day the plans drawn by Professor Bradford were approved and the committee before named to secure the lease was directed to let the contract for the building.

At the opening of this fine building so well adapted to the purposes for which it was intended, it is fitting that proper acknowledgements should be made to those who have been connected with the Lake Laboratory in its origin, growth and final consummation.

The Lake Laboraty at Sandusky was first conceived by the late Professor David S. Kellicott. He thought out the plan for its establishment, indicated the scope of its work, and organized and directed it until the time of his death. It would be most fitting and proper if some memorial or tablet commemorating this fact could be perpetuated.

To the Hon. H. B. Vincent of McConnelsville, late President of the State Fish and Game Commission, we owe a debt of gratitude for the friendly co-operation which made the establishment of a Lake Laboratory at Sandusky a possibility.

To all those who have been connected with the location and erection of the present building, thanks and congratulations freely flow from all who are assembled here to-day; to the architect, Professor Bradford; the contractor, Mr. George Feick; to the officers of the Cedar Point Pleasure Resort Company, and especially to the Hon. John T. Mack, Trustee of the University, who from the beginning has been its watchful and thoughtful guardian.

To Professor Osborn, whose quiet, earnest effort has largely contributed to this better opportunity for scientific investigation, thanks and congratulations are due for his part in the work. But he and his able associates, Professors F. L. Landacre and James S. Hine are to be further congratulated that to them is entrusted the present responsibility of seeing that this great laboratory shall be used with an eye single to the advancement of science and the public welfare in accordance with the aims of its founder, and that the students who go forth from it shall be so inspired by the spirit of truth that they shall be its devoted servants and loyal to it all their lives.

Remarks by Professor Herbert Osborn, Director.

After what has been said already I need not detain you with an extended statement of our purposes and plans in the work of our summer station. I would like, however, to mention some phases of our work and if possible, emphasize our position in regard to our relations to other institutions and to scientific workers in general.

Only about thirty years ago there was begun on a little island off the coast of Massachusetts what has proved to be the pioneer of the seaside and aquatic laboratories now so plentiful in different parts of the world. When Agassiz opened up his summer laboratory on Penikese he not only started a movement for the closer study of animal life under inspiring surroundings but he really inaugurated a movement in American education which has had a remarkable effect on the methods of teaching here and abroad. A method that involves the inspiration of personal contact with nature under the guidance of a lover of nature expert in understanding her ways.

I can myself remember the kindling of boyish ambition to go to Agassiz's school, for his name had then become a familiar one throughout the land. To study under his guidance was to my youthful fancy the height of opportunity. I remember, too, most distinctly, how bewildered and dazed I felt when I learned that Agassiz was dead. It had never occurred to me that Agassiz might die. I had never thought of him as a man who possibly was old but only as the representative teacher. In the airy castles of youth I had dreamed that possibly, some day, I might be able to come under his inspiring instruction.

Of course we may say that the direct method of study must have originated long before Agassiz's time, in fact such method can be referred readily to Aristotle and other early interpreters of nature, and the plan has come forward as a new method of education at intervals ever since; only, however, to lapse again and again into dependence upon the indirect one of reference to printed authority or the mere dictum of the teacher. Nature study is certainly old, but it needs constant rehabilitation or it reverts to the methods of repetition.

But while Agassiz died and the Penikese station was abandoned, the spirit of the enterprise has blossomed out in hosts of schools and research stations where the fundamental purpose is identical with his. First and foremost of these is the famous zoological station at Naples, and our own Woods Holl stands, doubtless, next to it in length of life and scientific product.

Mere mention of the stations at Bayonne, Plymouth, Plon, Beaufort, Cold Spring Harbor, Casco Bay, Flat Head Lake, Illinois River, Madison, Winona Lake, Bermuda, Kingston, Jamaica and Vancouver's, shows the extent to which it has grown. They have contributed not only to the body of knowledge concerning plant and animal life but, more, they have taught the methods of original research and given inspiration to hosts of teachers throughout the country who have carried the research method into high schools and colleges to the profound improvement of methods of instruction.

This is not merely a process of teaching how to investigate; it is using the method of investigation as a process in education. Its purpose is to give the student both the impulse and the training by which he may gain new facts properly and correlate them with previous knowledge that is presented to him from the past. In short, to acquire and prove for himself that which he is asked to accept as the results of previous work by his predecessors.

It will be seen that we have a two-fold purpose though at bottom a single end—instruction and investigation. In our instruction we aim to show the methods of research used in investigations and to instruct or furnish information in the essential processes connected with the growth and perfection of science.

But we may go further and recognize that the acquisition of knowledge has wider purpose than the mere gratification of mental curiosity or the building up of an educational structure. Knowledge has its ultimate service in contributing to human needs, material as well as intellectual, in the promotion of human life and activity. I believe that we may, with perfect propriety, insist on the educational value of a method which involves, includes in its scope, the determining of facts that will be of practical service in the community and state.

The elaborate study of mosquito conditions on Long Island by the members of the laboratory at Cold Spring Harbor lose none of their scientific value and interest from the fact that they furnish a basis for most important service in prevention of disease and suffering. If in the course of our investigations here we may be able to gain some fragments of knowledge that will serve the comfort of the community these will but add force and inspiration to the educational effort we have inaugurated.

With the occupation of this new building, the future home of our efforts, devoted exclusively to our use and planned especially for our purposes, we have reason, I think, to feel gratified. It is but just, also, to recognize the generous spirit of the Board of Trustees in providing these facilities for our work, the cordial reception of the citizens of Sandusky and the liberality of the Cedar Point Pleasure Resort Company in granting the beautiful site and the privileges accorded to workers in the laboratory.

It is also a matter for sincere gratification to note the hearty encouragement given the enterprise by our associates in the University Faculty and by biologists scattered over the country. Such interest and encouragement may well stimulate us to our best effort in the utilization of the opportunities now at our command.

We cannot let this occasion pass without reference to the devoted, unselfish scientific worker under whose direction it was established. Professor Kellicott was a man of unusual devotion to research. He showed rare discrimination in the selection of this beautiful bay as the location for a laboratory. We owe to him a meed of praise to-day, a word of appreciation, a pause for silent, reverential recognition of his services to education, science and humanity. To him life was a persistent effort in the acquisition of knowledge, and while he died in the prime of manhood he left a record of scientific achievement which may well inspire us all to greater effort.

With the past history of the laboratory known it should be an easy matter to read its future purpose and policy. It is our aim to further biological study in its every phase. To give opportunity to research and to furnish instruction and experience to build a sure foundation for successful work in teaching or investigation.

It is our firm belief that biology and biological methods have much to offer in any system of education; that its cardinal method of direct appeal to nature in the solution of the problems of nature, should be pushed into every grade of school work and that to this end teachers trained in the actual processes of direct study are essential. That such teaching in our schools is far too limited is, I think, fully recognized by those familiar with this work.

It is our hope and aim to make the laboratory of service to any student in any phase of biology that can be profitably studied under the conditions here. To make this as broad and emphatic as possible, we may say that it will be our policy to assist to the extent of our ability any competent scientific worker, from any institution or locality, in the prosecution of any investigation which our locality and equipment may permit. I believe this represents the spirit of the Board of Trustees, the President, and all officially connected with the laboratory. I beleve this to be fully shown by the equipment already furnished and the attitude shown in making these facilities equally accessible to all who may desire to use them. We hope educators and scientific workers in our own and adjacent states especially will find it a profitable meeting ground and feel that its opportunities are open on the most liberal basis to all.

It may seem that the fragments of knowledge we gather are very insignificant, and it is entirely possible that we may not make any startling discoveries, but we should remember that the great body of science consists of innumerable individual facts, blended and related to a harmonious whole—as individual grains of sand comprise the long stretch of land, the magnificent beach, and the sightly dunes which constitute the basis of our new home. So we may hope that in all the new facts we gather we shall be able to correlate them with those already known, to blend them and round them to a more perfect symmetry, in short to add perhaps minute but essential parts to the completion of great structures.

Finally, I desire to express my profound thanks to the many who have evinced a cordial interest in our work, and especially to those who have taken the pains and time to be with us to-day.

FLORA OF CEDAR POINT.

W. A. Kellerman and O. E. Jennings.

This brief report represents the work on the Cedar Point Flora as completed to date, so far as listing the observed species is concerned.

Various botanists had collected there in the past,—E. L. Moseley, Wm. Krebs, Edo Claassen, L. D. Stair, W. A. Kellerman, and others,—but not until the publication of Prof. Moseley's excellent Catalogue was there any comprehensive list of the plants of this region. In the "Sandusky Flora" Prof. Moseley specifically reports 111 species for Cedar Point; for most of the commoner plants of Erie County no particular locality was given.

In the Cedar Point Herbarium, prepared in 1903, and deposited at the Lake Laboratory, we have 316 species of the flowering plants and ferns mounted. Besides these there have been reported, either in the "Sandusky Flora" or elsewhere, 71 species more, thus making a total list for Cedar Point of 387 species of the flowering plants and ferns.

In the following list of plants collected on Cedar Point, the authors are responsible for the items except where given and noted on other authority; those though not yet in the herbarium but definitely reported for this locality in the "Sandusky Flora" are indicated thus: [Cat.]. Space will not permit here an enumeration of the fungi [62 species] collected in this region; for the same, see the May No. of the JOURNAL OF MYCOLOGY.

FLOWERING PLANTS AND FERNS OF CEDAR POINT.

ACER nigrum Mx. [Cat.], rubrum L.
ACERATES viridiflora (Raf.) Eaton.
ACHILLEA millefolium L.
ACORUS calamus L.
ACTAEA rubra (Ait.) Willd.
AFZELIA macrophylla (Nutt.) Kuntze.
AGASTACHE nepetoides (L.) Kuntze.
AGROPYRON repens (L.) Beauv.
AGROSTIS alba L.
AGRIMONIA hirsuta (Muhl.) Bick., mollis (T. & G.) Britt.
AILANTHUS glandulosa Desf.
ALSINE longifolia (Muhl.) Britt.
ALISMA plantago-aquatica L.
AMARANTHUS graecizans L.
AMBROSIA artemisiaefolia L.
AMELANCHIER botryapium (L. f.) D. C. [Cat.], canadensis (L.) Medic.
AMMOPHILA arenaria (L.) Link.
AMYGDALUS persica L.
ANDROPOGON furcatus Muhl.
ANEMONE virginiana L., canadensis L.
ANTENNARIA plantaginifolia (L.) Rich.
ANTHEMIS cotula L.
APIOS apios (L.) MacM.
APLECTRUM spicatum (Walt.) B. S. P. [Cat.].
APOCYNUM cannabinum L.
AQUILEGIA canadensis L.
ARABIS brachycarpa (T. & G.) Britt. [Cat.], canadensis L., dentata T. & G. [Cat.], lyrata L.
ARALIA nudicaulis L.
ARCTOSTAPHYLOS uva-ursi (L.) Spreng.
ARENARIA serpyllifolia L , stricta Mx.
ARGENTINA anserrina (L.) Rybd.
ARTEMISIA caudata Mx.
ASCLEPIAS syriaca L. tuberosa L., incarnata L., pulchra Ehrh.
ASPARAGUS officinalis L.
ASPLENIUM platyneuron (L.) Oakes. [Cat.]
BATRACHIUM longirostris (Godr.) F. Schultz.
BIDENS aristosa (Mx.) Britt. [Cat.], beckii Torr., bipinnata L., discoidea (T. & G.) Britt. [Cat.]
BLEPHARIGLOTTIS psycodes (L.) Rybd.
BLEPHILIA hirsuta (Ph.) Torr.
BOEHMERIA cylindrica (L.) Willd.
BOLTONIA asteroides L'Her.
BOTRYCHIUM virginianum (L.) Schw.
BRASENIA peltata Ph. [Cat.].
BURSA bursa-pastoris (L.) Britt.
CAKILE edentula (Bigel) Hook.
CALAMAGROSTIS canadensis (Mx.) Beauv.
CAMPANULA americana L., uliginosa Rybd.
CAPNOIDES flavulum (Raf.) Kuntze. [Cat.].
CARDAMINE pennsylvanica Muhl.
CARDUUS arvensis (L.) Robs. (in herbarium of C. S. Mead), discolor (Muhl.) Nutt., lanceolatus L.
CAREX aquatilis Wahl. [Cat.], comosa Boot. [Cat.], lanuginosa Mx., Muhlenbergii Schk., sartwelii Dewey [Cat.], stipata Muhl., tribuloides Wahl.
CASTALIA tuberosa (Paine) Greene.
CELASTRUS scandens L.
CELTIS occidentalis L., crassifolius Lam.
CENCHRUS tribuloides L.
CEPHALANTHUS occidentalis L.
CHENOPODIUM album L., boscianum Moq. [Cat.], hybridum L., leptophyllum Nut. [Cat.].
CHIMAPHILA umbellata Nutt. [Cat.]
CICUTA maculata L.
CIRCAEA lutetiana L.
CLINOPODIUM vulgare L.
CONVOLVULUS sepium L.
COREOPSIS tripteris L.
CORNUS amomum Mill., asperifolium Mx., stolonifera Mx.

Corylus americana Walt.
Cyperus filiculmis Vahl., rivularis Kunth., schweinitzii Torr., strigosus L.
Daucus carota L.
Decodon verticillatus (L.) Ell.
Dianthera americana L.
Dioscorea villosa L.
Dryopteris thelypteris (L.) Gr. spinulosa (Retz.) Kuntze.
Dulichium arundinaceum (L.) Britt. [Cat.].
Eleocharis acuminata (Muhl) Nees. [Cat.], intermedia (Muhl) Schultze [Cat.].
Elymus canadensis L. striatus Willd. virginicus L.
Epilobium adenocaulon (L.) Haussk.
Equisetum robustum Br. arvense L., variegatum Schleich. [Cat.].
Eragrostis major Host., pectinacea (Mx.) Steud., spectabilis Steud. [Cat.].
Erechtites hieracifolia Raf.
Erigeron annuus (L.) Pers., philadelphicus, L.
Erysimum inconspicuum (Wats.) MacM.
Euonymus atropurpureus Jacq.
Eupatorium ageratoides L. f., maculatum L., perfoliatum L., purpureum L. [Cat.].
Euphorbia commutata Eng. [Cat.], corollata L., hirsuta (Torr.) Wieg., nutans Lag., polygonifolia L.
Euthamia graminifolia (L.) Nutt.
Falcata pitcheri (T. & G.) Kuntze [Cat.].
Festuca octoflora Walt. (F. tenella Willd.)
Fimbristylis autumnalis (L.) R. & S. [Cat.].
Fragaria vesca L. [Cat.], viginiana Duch.
Fraxinus americana L., lanceolata Borck., pennsylvanica Marsh.
Fumaria officinalis L. [Cat.].
Galium triflorum Mx., pilosum Ait., circaezans Mx.
Gaura biennis L.
Geranium carolinianum L., robertianum L.
Gerardia purpurea L. [Cat.].
Geum canadense Jacq., virginianum L.
Gleditsia triacanthos L.
Gnaphalium obtusifolium L.
Gyrostachys cernua (L.) Kuntze.
Helianthemum majus (L.), B.S.P. [Cat.].
Helianthus annuus L. [Cat.], decapetalus L. hirsutus Raf., strumosus macrophyllus (Willd.) Britt. [Cat.].
Heliopsis helianthoides (L.) B. S. P. [Cat.].
Heteranthera dubia (Jacq.) MacM.
Hibiscus moscheutos L., trionum L.
Hypericum maculatum Walt.
Hystrix hystrix (L.) Millsp.
Impatiens biflora Walt.
Ilex verticillata (L.) Gr.
Iris versicolor L.
Juglans nigra L.
Juncus balticus Willd., richardsonianus Schult., torreyi Coville. (J. nodosus megacephalus Torr.).
Juniperus communis L., nana Wild., virginiana L.
Lacinaria scariosa (L.) Hill., spicata (L.) Kuntze [Cat.].
Lactuca canadensis L., floridana (L.) Gaertn., virosa L.
Lappula lappula (L.) Karst., virginiana (L.) Greene.
Lathyrus palustris L., venosus, Muhl.
Lemna trisulca L.
Lechea major Mx.
Leonurus cardiaca L. [Cat.].
Lepargyraea canadensis (L.) Greene. [Cat.].
Lepidium virginicum L.
Leptilon canadense (L.) Britt.
Leptorchis loeselii (L.) MacM.
Lespedeza violacea Pers.
Ligustrum vulgare L. [Cat.].
Lippia lanceolata Mx. [Cat.].
Lithospermum gmelinii (Mx.) Hitch.
Lobelia syphilitica L.
Lonicera glaucescens (L.) Rydb.
Ludwigia alternifolia L. [Cat.].
Lycopersicon lycopersicon (L.) Karst.
Lycopus americanus Muhl.
Malus malus (L.) Britt.
Malva rotundifolia L.
Medicago lupulina L.
Meibomia canadensis (L.) Kuntze, grandiflora (Walt.) Kuntze.
Melilotus alba Desv. [Cat.].
Menispermum canadense (L.) Kuntze. [Cat.].

MENTHA canadensis L.
MICRAMPELIS lobata (Mx.) Greene.
MIMULUS ringens L.
MONARDA fistulosa L.
MORUS rubra L.
MYRIOPHYLLUM spictatum L.
NABALUS albus (L.) Hook.
NAIAS flexilis (Willd.) Rost. & Schmidt.
NAUMBERGIA thyrsiflora (L.) Duby. [Cat.].
NELUMBO lutea (Willd.) Pers.
NEPETA cataria L.
NYMPHAEA advena Soland. [Cat.] variegata Eng.
OENOTHERA rhombipetala Nutt. [Cat.].
ONAGRA biennis (L.) Scop., oakesiana (Gr.) Britt. [Cat.].
ONOCLEA sensibilis L.
OPULASTER opulifolius (L.) Kuntze.
OPUNTIA humifusa Raf.
OSMUNDA regalis L.
OSTRYA virginiana (Mill.) Willd.
OXALIS cymosa Small.
PANICUM clandestinum L., columbianum Scrib. (P. dichotomum L.) [Cat.], miliaceum L. [Cat.], scribnerianum Nash (P. scoparium Lam.) [Cat.], unciphyllum Trin. (P. pubescens Gr.), virgatum L.
PARIETARIA pennsylvanica Muhl.
PARTHENOCISSUS quinquefolia (L.) Planch.
PLASTINACA sativa L.
PENTHORUM sedoides L.
PENTSTEMON hirsutus (L.) Willd.
PERULARIA flava (L.) Rydb.
PHALARIS arundinacea L.
PHILOTRIA canadensis (Mx.) Britt.
PHLEUM pratense L.
PHRAGMITES phragmites (L.) Karst.
PHRYMA leptostachya L.
PHYSALIS pruinosa L.
PHYTOLACCA decandra L.
PINUS strobus L.
PLANTAGO lanceolata L. [Cat.], major L., rugelii Dec.
PLATANUS occidentalis L.
PODOPHYLLUM peltatum L.
POLANISIA graveolens Raf.
POLYGONUM aviculare L., convolvulus L., emersum (Mx.) Britt., lapthifolium L. [Cat.], punctatum Ell., sagitattum L. [Cat.], virginianum L.
POLYMNIA canadensis L., canadensis radiata Gr. (R. F. Griggs, O. Nat. I : 98).
PONTEDERIA cordata L.
POPULUS balsamifera L. (R. F. Griggs, O. Nat. I : 98), deltoides Marsh., tremuloides Mx.
POTAMOGETON lonchites Tuck., natans L., pectinatus L. [Cat.], perfoliatus L., pusillus L., zosteriaefolius Schum.
POTENTILLA monspeliensis L., paradoxa Nutt.
PRUNELLA vulgaris L.
PRUNUS americana Marsh., pumila L. (W. A. Kellerman and R. F. Griggs, O. Nat. I : 98), serotina Ehr., virginiana L.
PTELEA trifoliata L.
PYROLA elliptica Nutt. [Cat.].
QUERCUS imbricaria Mx., leana Nutt., macrocarpa Mx., rubra L. (reported by W. A. Kellerman), velutina Lam.
RANUNCULUS sceleratus L.
RHUS aromatica Ait., glabra L., hirta (L.) Sudw., radicans L. [Cat.].
RIBES lacustre Poir. [Cat.], cynosbati L., floridum L'Her.
RICCIA fluitans L., natans L.
ROBINIA pseudacacia L.
RORIPA armoracia (L.) Hitch., hispida (Desv.) Britt., palustris (L.) Bessey.
ROSA blanda Ait. [Cat.], carolina L., setigera Mx.
RUBUS frondosus Bigel., nigrobaccus Bailey, occidentalis L., procumbens Muhl., strigosus Mx.
RUDBECKIA hirta L.
RUMEX acetosella L., crispus L., obtusifolius L., verticillatus L.
SAGITTARIA latifolia Willd.
SALIX alba L., amygdaloides Anders., cordata Muhl., fragilis L., glaucophilla Bebb., interior Rowlee., (S. longifolia Muhl.), interior wheelerii Rowlee., lucida Muhl., amygdaloides x nigra.
SALOMONIA comutata (R. & S.) Britt.
SAMBUCUS candensis L.
SANICULARIA canadensis L.

SAPONARIA officinalis L.
SCIRPUS americanus Pers.,
lacustris L.
SCROPHULARIA marylandica L.
SCUTELLARIA cordifolia Muhl.,
galericulata L.
SEDUM acre L. [Cat.].
SICYOS angulatus L.
SILENE antirrhina L., virginica L.
SISYMBRIUM officinale Scop.
SMILAX herbacea L., rotundifolia L.
SOLANUM dulcamara L., nigra L.
SOLIDAGO juncea Ait., serotina Ait.
SONCHUS asper (L.) All.
SOPHIA pinnata (Walt.) Britt. [Cat.].
SPARGANIUM eurycarpum Eng.
SPIRODELA polyrrhiza (L.) Schleid. [Cat.].
SPOROBOLUS cryptandrus (L.) Gr.
STACHYS aspera Mx.
STEIRONEMA ciliatum (L.) Raf.
STIPA spartina Trin.
STROPHOSTYLES helvola (L.) Britt.
SYMPHORICARPOS pauciflorus (Robbins) Britt.
TARAXACUM erythrospermum Andrz.
TECOMA radicans (L.) DC.
TEUCRIUM canadense L.,
occidentale Gr.
THASPIUM barbinode (Mx.) Nutt.,
barbinode augustifolium Coult. & Rose. [Cat.].
TILIA americana L.
TRADESCANTIA reflexa Raf.
TRIFOLIUM hybridum L., pratense L. [Cat.].
TYPHA latifolia L.
ULMUS americana L.
UNIFOLIUM canadense (DesF.) Greene.
URTICA gracilis Ait.
UTRICULARIA gibba. L. [Cat.],
vulgaris L.
VAGNERA stellata (L.) Morong.,
racemosa (L.) Morong.
VALLISNERIA spiralis L.
VERBASCUM thapsus L.
VERBENA hastata L., urticifolia L.
VERNONIA maxima Small.
VIBURNUM lentago L.
VIOLA papilionacea Ph.,
rafinesquii Greene.
VITIS vulpina L.
WASHINGTONIA claytonia (Mx.) Britt.
WOLFFIA punctata Griseb. (W. braziliensis Eng.). [R. F. Griggs, O. Nat. I : 97]
columbiana Karst.
XANTHIUM canadense Mill. [Cat.].
XANTHOXYLUM americanum Mill. [Cat.].
ZEA mays L.
ZIZANIA aquatica L.

FLORA OF HEN AND CHICKEN ISLANDS, 1903.

W. R. KELLERMAN.

An interesting account of a summer visit to the Hen and Chicken Islands in Canadian waters, Lake Erie, was given by Professor Schaffner in the OHIO NATURALIST, III, pages 331-332, December, 1902. One year later, these Islands were visited and the flora again recorded, which is here reported briefly, referring the reader to Professor Schaffner's article for description of the Islands, and comments on the plants formerly enumerated.

My notes show the following list for these Islands — with one or two exceptions being the same species of plants observed by Professor Schaffner for Little Chick, the only one visited by him.

Plants on Little Chick Island, Lake Erie, August, 1903.

Agrostis alba	2 plants.
Atripex (hast. or pat.)	2 plants.
Ambrosia artemisiaefolia	1 plant.
Bidens connata	1 plant.
Bidens frondosa	12 plants.
Celtis occidentalis	1 plant.
Cnicus sp.?	1 plant.
Erechtites hieracifolia	8 plants.
Impatiens sp.?	40 plants.
Leptilon canadense	6 plants.
Lycopus sp.?	1 plant.
Micrampeles lobata	1 plant.
Polygonum lapathifolium	12 plants.
Polygonum pennsylvanicum	200 plants.
Salix amygdaloides	50 plants of various sizes.
Ulmus americana	1 plant 4 ft. high.

Plants on Big Chick Island, Lake Erie, August, 1903.

(About ten times area of Little Chick.)

Acer negundo	2 plants, 18 in. high.
Celtis occidentalis	1 plant 50 ft. high.
Salix alba	1 plant 30 ft. high.
Scirpus fluviatilis	1 plant 12 in high.
Sicyos angulatus	75 plants mostly small.
Urtica gracilis	12 plants 2 ft.

No Plants on Chick Island.

Plants on Hen Island, Lake Erie, August, 1903.

(Area about five acres.)

Acer nigrum.
Acer saccharum.
Achillea millefolium.
Agrostis alba.
Alsine media.
Arabis laevigata.
Aster shortii.
Bursa bursa-pastoris.
Campanula americana.
Chenopodium album.
Dactylis glomerata
Erigeron annuus.
Euthamia graminifolia.
Fraxinus pennsylvanica
Fraxinus sambucifolia.
Geranium robertianum.
Geum sp.
Gymnocladus canadensis.
Impatiens pallida.
Nepeta cataria.
Parthenocissus quinquefolia.
Pentstemon pubescens.
Phytolacca decandra.
Pilea pumila.
Polygonum scandens.
Populus deltoides.
Populus tremuloides.
Prunus virginiana.
Quercus acuminata (lvs. broad).
Rhus hirta.
Ribes cynosbati.
Rubus nigrobaccus.
Sambucus canadensis.
Sicyos angulata.
Sisymbrium canescens.
Ulmus americana.
Vaguera stellata.
Verbascum thapsus
Vitis riparia.

Also the following cultivated plants: Peach, Pear, Cherry, Gooseberry, Pieplant, Grape.

THE JACKET LAYER IN SASSAFRAS.

JOHN H. SCHAFFNER.

In the ovules of some angiosperms a definite nutritive tissue invests the embryo-sac, while in others no such layer exists. This nutritive jacket appears in all cases to be simply a modification of one or more layers of cells on the inner wall of the ovule. It is purely a physiological tissue and is usually described as consisting of cells with deeply-staining contents. It is much less definite in structure than the tapetum in the microsporangia of the stamen, but reminds one of the so-called spongy tissue in the ovule of the pines and related plants. Although usually described as a dark staining tissue, there are examples where just the opposite is the case. Cook (1) describes the tissue in the wall of the ovule of Agrostemma githago as consisting of two zones, the inner zone consisting of thin-walled cells which degenerate while the embryo-sac is enlarging. Although the cell walls of the zone were very delicate, the entire layer was sharply separated from the outer tissue by a very thick limiting wall.

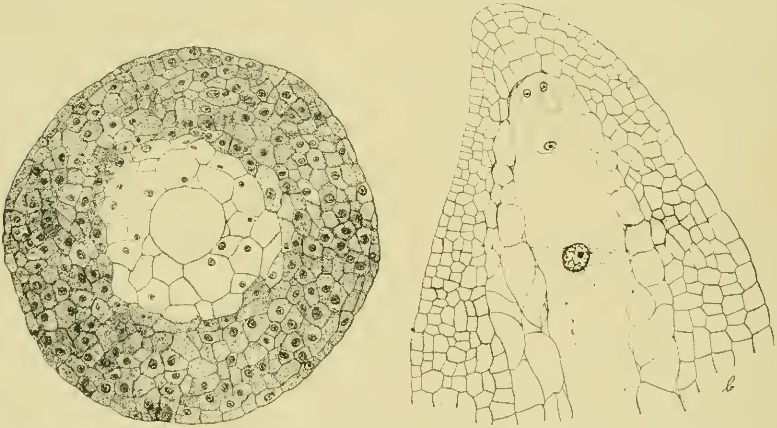


Fig. 1. Ovule of Sassafras, showing jacket layer. a, cross section; b, longitudinal section.

While studying some preparations of Sassafras sassafras, the writer observed a jacket of cells surrounding the mature embryo-sac. This layer shows some resemblance to the delicate zone in Agrostemma, but there is no distinct limiting wall on the outside. It is from one to several layers of cells in thickness and the cells are light-colored with Delafield's haematoxylin and Heidenhain's haematoxylin, while the cells of the outer zone stain very dark (Fig. 1, a, b). The cells have large vacuoles and comparatively little protoplasm and begin to degenerate when the embryo-sac is fully formed. This jacket layer thus performs an important function. First its cells nourish the developing female gametophyte, and later, by their disintegration a further food supply is furnished to the developing endosperm and embryo. By their rapid disintegration there is also a decided increase of room in the ovule. These processes correspond to the functions of the tapetum in the microsporangium.

As stated before, this jacket layer in the ovule must be regarded as purely a physiological tissue, being developed in various ways in different angiosperms. It may be entirely absent as in Sagittaria and Lilium ; it may be represented simply by disintegrating cells in contact with the embryo-sac as in many monocotyls and dicotyls ; it may have a development as in the examples just discussed ; or it may be a highly specialized layer of dark-staining cells. To the last type belongs Aster novae-angliae, where the layer is described by Chamberlain (2) as consisting of cells with dense protoplasm remarkably free from vacuoles. Stylidium (3) and Lobelia (4), as well as many other genera of Sympetalae, have highly developed jacket layers.

1. Cook, M. T. The Development of the Embryo-sac and Embryo of Agrostemma githago. Ohio Nat. **3** : 365–369. 1903.
2. Chamberlain, C. J. The Embryo-sac of Aster Novae-Angliae. Bot. Gaz. **20** : 205–212. 1895.
3. Burns, G. P. Beiträge zur Kenntniss der Stylidiaceen. Flora **87** : 313–354. 1900.
4. Billings, F. H. Beiträge zur Kenntniss der Samenentwickelung. Flora **88** : 253–318. 1901.

MEETINGS OF THE BIOLOGICAL CLUB.

Townshend Hall, March 7, 1904.

The meeting was called to order by the President, Mr. Sanders, and the business meeting was dispensed with. The paper of the evening was given by Dr. Bleile on "The Anti-bodies." Much interest was shown in the lecture and a large audience was present.

Orton Hall, April 9, 1904.

The meeting was called to order by President Mr. Sanders.

Prof. Kellerman reported inoculations with rust on corn. He experienced great difficulty in procuring good host plants on account of the cold weather. He secured uredospores on popcorn inoculated with spores of Puccinia sorghi from sweet-corn.

Prof. Hine spoke on the Gulf Biological station in Louisiana. The station is located on the coast, at the mouth of the Calcasieu river, and was established for the study of various economic problems of interest to the people of the State. The station has a good building valued at $6.000. Special precautions have been taken to overcome dangers arising from inundations to which the region is subject during severe storms. Prof. Hine identified about fifty birds, among them the snake bird, boat-tailed grackle, black vulture, little blue heron, mocking bird, Louisiana clapper-rail, and Wilson's plover. There are very few sparrows. Land mammals are scarce but porpoises are very numerous. A number of species of insects were collected, of which about 150 have been identified. The address was closed with a brief description of the flora found in the region of the laboratory and the speaker's experience in flounder, schrimp and crab fishing.

ORTON HALL, May 2, 1904.

In the absence of the President, the meeting was called to order by Prof. Schaffner. It was moved and seconded that he act as chairman for the evening. The motion was carried. The program for the evening consisted of reports on theses.

Mr. York reported work on the life history of Nelumbo. Mr. Morse gave an outline of his work on the embryology of the spider's egg.

Under personal observations, Prof. Kellerman reported that he had secured uredospores of Puccinia sorghi on dent corn inoculated with uredospores from pop-corn, which, together with previous experiments, showed that rusts on sweet-corn, pop-corn and dent corn are not physiological varieties. Mr. Frank reported culture experiments with Sphaeropsis rosae. Prof. Schaffner reported observations on the time when leaves come out on various trees and shrubs.

Prof. Alfred Vivian, Prof. Rudolph Hirsch, and J, C. White were elected to membership.

J. N. FRANK, *Secretary pro tem.*

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TABLE OF CONTENTS.

NOTES ON SOUTH AMERICAN HEMIPTERA-HETEROPTERA.*

Herbert Osborn.

The following notes are based mainly upon collections made in Peru and Bolivia by William J. Gerhard during the years 1898-1899, and purchased by the writer from Mr. Weeks of Boston, the package having been entirely undisturbed, and a collection made at Bartica, British Guiana by Mr. H. S. Parrish during the spring of 1900. Collections by these parties are entered without further reference. Other material has been secured from various sources but recorded here so as to make the notes as complete as possible based upon the material in the author's collection. The collection made by Mr. Parrish in Guiana was made at the same time and in practically the same localities as those furnished by Mr. Crew and reported upon by Mr. Van Duzee. (Trans. Ent. Soc., Vol. 27, p. 343, 352, Dec., 1901.)

Very many species therefore in Mr. Van Duzee's list and mine are similar and I have avoided repetition of data included in his paper and in some instances the species. Some additional species however, are to be noted and in some cases variations worthy of note have been observed. The arrangement is practically that of Lethierry and Severin in the "Catalogue General des Hemipteres." The types of the new species described are in the author's collection.

*Contributions from the Department of Zoology and Entomology, O. S. U., No. 20.

CORIMELÆNIDÆ.

Corimelæna notatipennis Stal–? Numerous specimens, Bartica Br. Guiana. Has broad yellowish spot on base of corium, no distinct spot at apex. Scutellum as long as abdomen. Van Duzee doubts the reference to this species and lists it under Corimelæna spp.

Corimelæna schmidti Fab. One specimen, Bartica Br. Guiana, May 12, 1902

SCUTELLERIDÆ.

Polytes velutinus Dall. A number of specimens from Cochabamba; two from Coroica Yungas and one specimen from Yungas de la Paz, Bolivia, the latter kindly given me by Mr. E. P. Van Duzee. This is a handsome velvety green insect with a reddish border to pronotum, base of elytra and abdomen and apical portion of scutellum. When the velvety surface is lost the ground color is deep brown thickly punctured with metallic green.

Polytes lineolatus Dall. Bolivia, Yungas de la Paz. Two specimens for which I am indebted to Mr. E. P. Van Duzee, who is also to be credited with this determination, also one specimen from Cochabamba, Bolivia, Aug. and Sept., 1899, and one from Coroica Yungas Bolivia, April, 1899

Polytes obscurus Dall. Seven specimens from Coroica Yungas, April, 1899.

Symphylus ramivitta Walk. Yungas de la Paz, Bolivia. From Mr. Van Duzee by whom determination is made.

Camirus conicus Germ. Bartica Br. Guiana. Evidently common as a number of examples are in the collection taken during April, May and July. Larvæ for April and May are included.

PENTATOMIDÆ.

Discocephala umbraculata Fab. Bartica Br. Guiana. March and April. Three specimens.

Mormidea geographica Fab. Bartica Br. Guiana. Two specimens April and May. (Det. Van Duzee).

Mormidea ypsilon Linn. Bartica Br. Guiana. Taken in abundance March to July. Cochabamba, Bolivia, one mutilated specimen which is almost certainly this species

Mormidea angulosa Stal. A specimen from Yungas de la Paz, Bolivia has been sent to me by Mr. Van Duzee, also one from Trinidad.

Galedanta myops Fab.* One specimen Bartica, Br. Guiana.

Sibara armata Dall. Numerous examples from Bartica, Br. Guiana where it must be a very abundant species.

Euschistus acutus Dall.* Evidently quite abundant at Bartica, Br. Guiana.

Thyanta patruelis Stal. Three specimens from Arequipa, Peru agree closely with Stal's description for this species.

Loxa flavicollis Drury. One specimen Coroica Yungas, Bolivia.

Murgantia fasciata H. S.* Two species from Yungas de la Paz, Bolivia from Mr. Van Duzee.

Arocera apta Walk.* A single specimen of this handsome species from Bartica, Br. Guiana.

Nezara marginata P. B. Santiago Chili. One specimen collected by Prof. J. C. Hambleton is referred here. It agrees with specimens of this species from San Rafæl and Jicultepec, V. C., Mexico. The apex of scutellum is faintly luteous. There are no traces of the black dots on thorax said to distinguish læta Stal.

Banasa alboapicata Stal.* One specimen Bartica, Br. Guiana.

Arvelius albopunctatus De Geer. Bartica Br.. Guiana.

Taurocerus edessoides Spin. Four specimens Bartica, Br. Guiana.

Edessa discors Erich.* Bartica, Br. Guiana. Two specimens.

Edessa quadridens Fab.* Numerous specimens Bartica, Br. Guiana.

Edessa jugata Westw.* Coroica Yungas, Bolivia, April, 1899.

Edessa moschas Erich.* Four specimens Bartica, Br. Guiana.

Edessa rufo-marginata De Geer. Cochabamba and Cholumani, Bolivia.

Discocera ochrocyanea Lep. My specimen from Bartica, Br. Guiana agrees closely with the description of Amyot and Serville.

Piezosternum subulatum Thunb. Two specimens from Cochabamba, Bolivia, Aug. and Sept., 1899.

Oplomus tripustulatus Fabr. One specimen from Yungas de la Paz, Bolivia, kindly sent me by Mr. Van Duzee.

COREIDÆ.

Spathophara biclavata Fab. Bartica Br. Guiana. Several specmens of this large and striking species.

Molchina compressicornis Fab. Bartica Br. Guiana. One specimen—April.

Pachylis laticornis Fab. Cholumani, Bolivia. One male taken in Nov., 1898. A female probably this species from Bartica, lacks antennæ.

Melucha lineatella Fab. Bartica Br. Guiana, March 20–30, 1901. Several specimens—evidently an abundant form.

Melucha phyllocnemis Burm. Coroica Yungas, Bolivia. April, 1899.

Nematopus indus Linn. Bartica, Br. Guiana—collected in large numbers.

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* Determined or verified by Mr. E. P. Van Duzee.

Nematopus fasciatus Westw. Bartica, Br. Guiana, March 29, 1901. A single very handsome specimen of this species. It is dark steel blue above, a bright orange red band across front part of pronotum, the corium lined with yellow, beneath testaceous, apex of femora steel blue. Mentioned and described by Van Duzee.

Crinocerus sanctus Fab. Coroica Yungas, Bolivia. One specimen agrees perfectly with original description. It has length of 15 mm. Body is rufous. Elytra and membrane black, the former with broad light rufous stripes starting at base converging but not quite meeting at tip of clavus then diverging to apex of corium, giving an elongate cruciate figure, spines and tubercles of hind femora black.

Acanthocerus clavipes Fab. Bolivia, Coroica Yungas, April and Cochabamba, Aug., 1899.

Acanthocephala declivis Say. var. **guianensis**, n. var. Differs from the typical forms of declivis in having the angles of the pronotum much larger, much elevated and directed somewhat forward. The antennæ are very long, the terminal joint especially elongated, segments measuring 9, 7, 6, and 13 mm. respectively. The tibiæ are more dilated than in typical declivis but less so than in guatemalena Dist., the expanded part of tibia measuring 15 mm. long, the basal part 5 mm. and the apical portion 3 mm. wide. Length of body 30 mm. Width of humeral angles16 mm. I do not have access to the description of fulvitarsa H. S. and equalis Westw. but this specimen seems properly associated with declivis especially if the intermediate varieties guatemalena and panamensis of Distant be compared.

Acanthocephala latipes. Drury. Bartica Br. Guiana, listed also by Van Duzee.

Acanthocephala femorata, var. Bartica Br. Guiana. A rather small variety apparently closely related to femorata but with joints of antennæ all pallid.

Petalops thoracicus Fab. Bartica Br. Guiana. Also listed by Van Duzee.

Holymenia rubescens A. & S. Bartica Br. Guiana. Mr. Van Duzee records H. intermedia from the same locality from which species this is easily separated by the uniformly rufous color of thorax, scutellum and most of under surface. The antennal joints are black except basal half of fourth.

Leptoglossus chilensis Spin. Santiago, Chili, J. C. Hambleton. One female, varies from Signoret's description in having less yellow on tibiæ.

Leptoscelis bipustulatus Linn. Bartica Br. Guiana. Evidently an abundant species as the collection from Mr. Parrish included several dozen specimens and Mr. Van Duzee also lists it.

Leptoscelis nigripes Stal. Cochabamba, Bolivia, Aug., 1899. One specimen, differs from Stal's description in being slightly larger, 18 mm. instead of 16 mm.

Pthia cyanea Sign. Cochabamba, Bolivia. A very beautiful species, brilliant iridescent blue-green with an orange-red band on the pronotum. (Absent in two of the nine specimens).

Spartocera fusca Thunb. Cochabamba, Bolivia, Aug., 1899.

Spartocera denticulata Stal. Cochabamba, Bolivia. In some points this agrees better with granulata, but in structural details of genitalia it appears to belong here.

Spartocera alternata Dall. Coroica Yungas, Bolivia. Picture of diffusa Say to which it must be closely related.

Plapigus foliaceatus Blanch. Coroica Yungas, April, 1899. Two specimens which are dark fuscous rather than black and have the anterior border of the pronotum, three longitudinal stripes, the scutellum, costal border of elytra, dull ferruginous brown, otherwise agrees well with Stal's description.

Margus sp. "Quillota" Chili. An undetermined, possibly undescribed species received from Prof. J. C. Hambleton.

Margus pectoralis Stal? Puno, Peru, Nov., 1898. A number of the specimens of this species were received. They seem to agree better here than with any other described species.

Zicca nigropunctata De Geer. Cochabamba, Bolivia. Aug. and Sept., 1899.

Zicca rubricator Fab. Cochabamba, Bolivia, Aug. and Sept., 1899.

Hypselonotus concinnus var. Coroica Yungas, Bolivia, April, 1899. Resembles atratus Dist. exactly for upper side except scutellum has border and central line testaceous. Beneath lacks central black line of meso-and meta-sternum; legs marked somewhat with testaceous.

Hypselonotus linea Fab. Bartica Br. Guiana, March 21, 1901. Agrees perfectly with Fabricius' description.

Hypselonotus fuscus n. sp. Coroica Yungas, Bolivia, April, 1899. Pattern of linea above but light lines narrower, black areas have luteous or ochreous ground so thickly covered with black punctures as to appear dark fuscous where linea is black. Antennæ black. Beneath yellow testaceous, spotted with black, spots round or oval in the two series each side, legs densely annulate and spotted with black. Length, 12 mm.

Paryphes lætus Fab. Five specimens from Bartica, Br. Guiana, March and April.

Paryphes splendidus Dist? Coroica Yungas, Bolivia, April, 1899. A very handsome species, the size and general picture of lætus but the color is a rich orange-red for the encircling band and the femora, while the general color is a lighter, more brilliant and metallic green. The band is narrower especially beneath. Length, 17 mm. Referred here with some doubt.

Trachelium tesselatum Dist..Bartica, Br. Guiana.

Cydamus adspersipes Stal, Bartica, Br. Guiana.

Cydamus trispinosus De Geer. Bartica, Br. Guiana.

Leptocorisa filiformis Fab. Bartica, Br. Guiana, May. Two specimens.

Leptocorisa tipuloides Fab. Bartica, Br. Guiana. Two specimens

Hyalymenus dentatus Fab. Bartica, Br. Guiana, May. One specimen. This, like the other members of the genus, has very well marked characters which appear from agreement with descriptions to be very constant. It is perhaps worthy of note that out of sixteen specimens received from this locality there are representatives of eight well marked species.

Hyalymenus dubius Dall. Bartica, Br. Guiana. One specimen only.

Hyalymenus gracilispinus Stal. Bartica, Br. Guiana. Two specimens June and August.

Hyalymenus pulcher Stal. Bartica, Br. Guiana. Three specimens March, June and August, 1901. Two have hind legs entirely black. One specimen is lighter, hind tibiæ only, black, otherwise apparently identical.

Hyalymenus puncticeps Dall. Bartica, Br. Guiana. Two specimens, March and April.

Hyalymenus sinuatis Fab. Bartica, Br. Guiana. Two specimens March and May.

Hyalymenus tarsatus Fab. Bartica, Br. Guiana. Two specimens, March and May.

Hyalymenus vespiformis Fab. Bartica, Br. Guiana. Three specimens, April and July.

Jadera sanguinolenta Fab. Bartica, Br. Guiana. April and May

LYGÆIDÆ.

Lygæus sulcatus n. sp. This species appears to be closely related to obsoletus Stal and interstinctus Distant, but cannot be referred to any of the variations of these species since there are differences in the plan of coloration. The pronotal sulci are deep, curved, and with prominent margins.

Head ferruginous with a fuscous central stripe widest at occiput narrowing and becoming obscure on tylus. Antennæ dull fuscous with apex of 1st and 3d joints yellow Pronotum fuscous with the lateral margins, a central carinate line and the margins of the transverse sulci ochreous or light ferruginous. Margins of sulci are much swollen, and a short carina extends from their posterior borders parallel with central carina. Scutellum with strong central carina and transverse elevations which are ochreous. Elytra with veins and costa, commisural line and apex of corium indistinctly ochreous, membrane light fuscous, the apical portion smoky hyaline, the veins blackish. Beneath light fuscous with margins of pleuræ, acetabulæ, orifices and most of the ventral segments, especially on the disk, pallid. Legs mostly fuscous with coxæ, trochanters, base and apex of femora and central part of tibiæ pallid. Length 5 to 5.5 mm., width 1.5 mm.

Three specimens from Bartica Br. Guiana, March, April and May, collected by H. S. Parrish.

Were it not for generic differences this might be considered as the female of Acroleucus maurus as the coloration is of a similar pattern, the strong ochreous and ferruginous markings here being obsolete or obscured in maurus. The membrane, however, is subhyaline with fuscous veins. Observations on the possible relationship of the two forms are desirable.

Lygæus variegatus De G. Bartica, Br. Guiana. Two specimens. March and April. Mr. Van Duzee listed specimens for June.

Oedancala notata Stal. Bartica, Br. Guiana. Numerous specimens. March and May.

Heræus cincticornis Stal. Cochabamba, Bolivia. August. One specimen agreeing perfectly with Stal's description.

Pamera globiceps Stal. Bartica, Br. Guiana. Four specimens. March and April.

Pamera vicinalis Dall. Bartica, Br. Guiana. July 14, 1901. One specimen.

Pamera Dallasi Dist. Bartica, Br. Guiana. Two specimens. March and May.

Pamera consuta Dall. Bartica, Br. Guiana. One specimen. April.

Pamera costalis Stal. Bartica, Br. Guiana. March, April, and May, 1901.

Pamera parvula Dall. Bartica, Br. Guiana. Two specimens. Agrees with Dallas' description but anterior femora are black except at base and apex, not mentioned by Dallas.

Pamera tineodes Burm. Bartica, Br. Guiana. Three specimens. April, May and August, 1901.

Pamera serripes Fab. Bartica, Br. Guiana. Three specimens. August, 1901.

Pamera tuberculata n. sp. General shape of costalis, the pronotum with two distinct conical tubercles within impunctate, circular areas. Length of female, 7.5 mm.

Head large, ocelli elevated, a little nearer the eyes than to each other. Antennæ, first joint rather thick extending about half the length beyond the apex of the head, second joint long, slender, longer than third, third enlarging at tip, fourth about as long as third, a little thicker. Pronotum deeply constricted, the anterior lobe but little longer than posterior; a rather broad granulate collar, two conspicuous conical tubercles about as far apart as the eyes and situated within naked, impunctate areas; a median stripe and lateral lines scantily clothed with minute golden hair, posterior lobe distinctly punctate, the lateral margins orange and two slightly divergent rather diffuse orange stripes on the disk. Scutellum with fine golden hair, apex ochreous. Elytra brown, the clavus nearly black, margined to beyond its middle with ochreous. Corium with a blackish diffused spot towards the base, a black band across the centre extending forward in an angle. Apex black, the extreme base, a line next to claval suture and most of costa yellowish. Membrane fuscous with subhyaline, large spots next to corium at its apex and on the middle of the apical line. Beneath black, the disk of the abdomen slightly reddish, border of fourth segment yellowish, middle portion of the margin light yellow. Legs yellow, the anterior femora and tibiæ and outer portion of the femora and tibiæ of the intermediate and hind legs suffused with fuscous, anterior tibiæ distinctly enlarged at apex. One specimen from Bartica, Br. Guiana collected April 18. It is at once distinguished from any of the other members of the genus by the peculiar nipple-like tubercles on the anterior lobe of pro-thorax.

Erlacda arhapheoides Sign. Quillota Chili, J. C. Hambleton. Has ocelli small but well developed. Signoret says, "No ocelli" ("Pas d'ocelles") but in other respects, both generic and specific description agrees perfectly.

Petizius assimilandus Dist. Bartica, Br. Guiana. May, 1901. Distant described the species from Guatemala.

Gonatas divergens Dist. Two specimens from Bartica, Br. Guiana, agree so closely with this species that I refer them here though previous records place it in Guatemala and Panama only.

PYRRHOCORIDÆ.

Dysdercus ruficollis L. Coroica Yungas Bolivia. April.

CAPSIDÆ.

Lygus cuneatus Dist. Bartica, Br. Guiana. Two specimens. In these the apices of femora and tibiæ are touched with vermillion or rose and the cuneus is bordered only in part with ochraceous.

ARADIDÆ.

Hesus sp. I have one specimen from Bartica, Br. Guiana, which is doubtless the same as Mr. Van Duzee refers to cordatus or acuminatus. Not having specimens of the three species in hand comparisons with descriptions are unsatisfactory, especially as the available descriptions are indefinite in some important details.

REDUVIIDÆ.

Pothea frontalis Lep. Bartica, Br. Guiana. Two specimens

Ectrichodia immarginata Stal. Bartica, Br. Guiana. Two specimens.

Apiomerus pilipes Fab. Numerous specimens of this large hairy rather coarse species from Bartica, Br. Guiana.

Apiomerus sp. Bolivia. A small jet black species with a small rose red spot on disk of corium.

Micrauchenus lineola Fab. Bartica, Br. Guiana. Numerous specimens.

Callicopius nigripes Linn. Bartica, Br. Guiana. A fine series of this species.

Heniartes flavicans Fab. Bartica, Br. Guiana. A large number included in the collection. The extreme amount of adhesive secretion on the legs played havoc with many other specimens.

Conorrhinus renggeri Stal. One specimen from Santiago Chili, collected by Prof. J. C. Hambleton.

SERIDENTUS, nov gen.

Quite similar to Shaumannia, head slightly elongate and broad, anterior portion widening before the eyes, spinous laterally, tylus deeply cleft, antenna with basal joint thick, thicker than second but of equal length, 3d and 4th together about equal to second, ocelli placed in line with hind border of eyes, margin of head and pronotum denticulate, elytra shorter and narrower than abdomen, abdomen behind broadly widened into mucronate lobes, margin minutely denticulate, legs slender, anterior femora somewhat swollen, rather sparsely denticulate. Prothorax with strong anteriorly projecting spines.

Seridentus denticulatus, n. sp. Body widening posteriorly, head, thraox, abdomen, rows along the pleura beneath and the femora denticulate. Length 19 mm., width of prothorax 2.3 mm. posterior segment of abdomen 3.5 mm.

Eyes large, globose, coarsely granulate; lateral lobes in front of eyes prominent, terminating in coarse spur; tylus directed upward and forward, deeply cleft; antennæ, second joint equal to or slightly longer than first but more slender, third and fourth together nearly as long as second, fourth little shorter than third, all joints thickly pilose; hinder border of head below set with a row of four strong spines, prothorax narrowing from base to head, lateral margins denticulate, elytra reaching onto base of sixth segment, nearly as wide as the abdomen; abdomen with a small denticulate spine behind border of each segment from first to fifth, sixth segment expanded at the posterior margin into a broad mucronate lobe; beneath, prothorax bears numerous denticulations arranged in somewhat regular lines.

Color light yellowish, head above and a broad stripe on the cheek, a broad annulation on each segment of beak, pronotum, scutellum except two basal spots, costal areas, most of clavus and discal cell and a large part of the two apical cells blotched, with most of the exposed portion of the abdomen, lateral stripes on thorax and median line from prothorax to tip of abdomen, irregular annulations and blotches on anterior and middle legs, dark fuscous or black. A conspicuous black dot occurs on the dorsal margin of fore and middle femora.

Described from five males collected in British Guiana by Messrs. Parrish and Crew, April and May, 1901. Mr. Van Duzee has kindly placed three which were received in his collection at my disposal. The species is a striking one and while presenting characters that ally it closely to Shaumannia is evidently representative of a different genus.

VELIADÆ.

Velia brunnea n. sp. Near vivida, Buch. White. A rich chocolate brown with hind border of pronotum yellow and the elytra nearly black. Length, 8 mm.

Head rather long, projecting nearly half its length in front of eyes, strongly deflexed, antennæ long, first joint longest, second and fourth nearly equal, third shortest, beak reaching base of middle coxæ. Pronotum with prominent humeri, hind border broadly bisinuate the margin elevated. Posterior femora without spines.

Head, basal joint of antennæ, prothorax, except hind margin, femora, border and disk of abdomen below, rich chocolate brown, hind border of prothorax yellow, elytra velvet black; three outer joints of antennæ, beak, tibiæ, tarsi, and most of under surface black. A fine short velvety pile covers the body except on posterior border of prothorax.

Seven specimens from Coroica Yungas, Bolivia, April, 1899.

This seems to agree pretty closely with vivida White, but is separated at once by absence of femoral spines.

NOTES ON THE OHIO FERNS.

W. A. Kellerman and H. A. Gleason.

Of the eighty-three species and varieties of ferns included in the flora of the north-eastern United States forty-three are known definitely to occur in Ohio and are represented by specimens in the State Herbarium. Some of the forms are quite rare, and a few of them are very limited so far as their distribution in the State is now known. It is with the hope of increasing the State collection and extending our knowledge of these interesting plants that special attention is called to this subject. Critical inspection of the list appended below is also solicited. Possibly interest and convenience may be enhanced by the publication of a State Fern Florula, with notes on characters and distribution, figures illustrating venation, fructications, and such taxonomic characters as beginners, amateurs and students might appreciate. Partial material for such a brochure is at hand but we would much desire for examination a fuller set of specimens from the various counties of the State. Can not every teacher of Botany in Ohio and every one interested in our fern flora assist by sending specimens?

The Fourth State Catalogue, published in 1899, lists forty-nine species of ferns, and a fiftieth is mentioned in the appendix, but not fully authenticated. Since its publication three others have been reported, and a fourth is added in this paper, bringing the total number of ferns reported from the State to fifty-four. Of these eleven must be excluded from the list, as they are not authenticated by herbarium specimens. These are the following.

Species to be Excluded from the Ohio List.

Ophioglossum engelmanni Prantl. The specimens from Painesville, Lake County, labeled as this species in the herbarium, and upon which the publication of the species as a member of the Ohio flora was based, do not differ in any essential respect from Ophioglossum vulgatum L. The range given in Britton's Manual for O. engelmanni is Virginia and Indiana to Missouri, Texas, and Arizona. It is thus southern in its distribution, with a range about like that of Polypodium polypodioides (L.) A. S. Hitchcock, and may therefore yet be found in some of the counties along the Ohio river.

Botrychium simplex E. Hitchcock. Included in the Fourth State Catalogue on the authority of the Newberry Catalogue, in which it was reported from Lorain county by Dr. Kellogg. Its range according to Underwood in Britton's Illustrated Flora is from Prince Edward's Island to Maryland, Wyoming, and California.

Mateuccia struthiopteris (L.) Todaro. (*Onoclea struthiopteris* Hoffm.) ; Reported by Kellerman and Werner in their Catalogue of Ohio Plants from "Lorain Co., A. A. Wright (Cat.); Painesville, H. C. Beardslee, (Cat.), Wm. C. Werner." Doubtless to be secured for the State Herbarium.

Woodsia ilvensis (L.) R. Br. Has been reported from Licking county by H. L. Jones, and should probably be regarded as a member of the Ohio flora, although no specimens have been seen by the writers.

Woodsia glabella R. Brown. This was reported in the J. S. Newberry Catalogue from Lorain county. It is a distinctively northern fern, extending south only to New Hampshire, Vermont, northern New York and the north shore of Lake Superior and its occurrence in Ohio is extremely doubtful.

Dryopteris cristata clintoniana (D. C. Eaton) Underw. The single specimen from Wayne county in the herbarium belongs to the species, Dryopteris cristata (L.) Gray, rather than to the variety, which is much larger, with pinnæ four to six inches long. It has been reported by Otto Hacker and by H. C. Beardslee in his Catalogue of the Plants of Ohio.

Dryopteris spinulosa dilatata (Hoffm.) Underw. Included in the Fourth Catalogue on the authority of H. C. Beardslee.

Dryopteris bootii (Tuckerm.) Underw. Specimens in the herbarium accredited to this species are all referable to other species.

Woodwardia areolata (L.) Moore. Listed in the Newberry Catalogue from northern and eastern Ohio.

Asplenium fontanum (L.) Bernh. Prof. Underwood mentions this fern as occurring at Lycoming, Pennsylvania and Springfield, Ohio. The latter locality, however, is probably an error due to confusing the labels, since the fern has never been seen growing there, and the collector to whom it is accredited can not remember it herself.

Botrychium ternatum (Thunb.) Sw. All the Ohio specimens formerly included under this name are Botrychium obliquum Muhl. Prof. Underwood has shown* that B. ternatum is an Asiatic species occuring in China, Japan, and northern India, and not at all in North America.

Asplenium parvulum to be added.

A critical study of the specimens of Asplenium in the State Herbarium shows that one species is to be added to the list:

Asplenium parvulum Mart. & Gal. A specimen of this southern fern was collected by W. A. Kellerman in Greene township, Adams county, November 7, 1900. It was at the time confused with Asplenium trichomanes L., and inserted in the

*Bull. Torr. Club, 25:526.

herbarium under that name. It resembles Asplenium platyneuron (L.) Oakes more closely but the three species are easily separated by the following characters. A. trichomanes has short rounded pinnæ almost or quite as broad as long, without a definite mid-vein, and without an auricle on the upper side near the base. A. platyneuron and A. parvulum have oblong pinnæ, auricled at the base, and with a definite mid-vein. In the former the pinnæ are mostly alternate, the rachis brown; in A. parvulum the pinnæ opposite and the rachis black. This fern, which is here reported for the first time from Ohio, is said to grow upon limestone, and ranges from Virginia to southern Ohio and Missouri, and south to the Gulf.

SPECIMENS IN THE STATE HERBARIUM (SEPT., 1904).

The following is a list of the Ohio ferns represented in the State Herbarium, with their distribution by counties.

OPHIOGLOSSUM VULGATUM L., Adder's-tongue.—Auglaize, Clark, Cuyahoga, Franklin, Lake, Lucas, Portage, Warren.

BOTRYCHIUM MATRICARIÆFOLIUM A. Br., Grape-fern.—Cuyahoga.

BOTRYCHIUM OBLIQUUM Muhl., (*Botrychium ternatum obliquum*) Grape-fern.—Ashtabula, Auglaize, Clermont, Cuyahoga, Fairfield, Franklin, Logan, Lucas, Paulding, Sandusky, Scioto, Stark, Warren, Wyandot.

BOTRYCHIUM DISSECTUM Spreng., (*Botrychium ternatum dissectum*) Grape-fern.—Auglaize, Clermont, Defiance, Delaware, Fairfield, Franklin, Lake, Logan, Sandusky, Williams, Wyandot.

BOTRYCHIUM LUNARIA (L.) Sw., Grape-fern.—Lake.

BOTRYCHIUM LANCEOLATUM (S. G. Gmel.) Angs., Grape-fern. —Portage.

BOTRYCHIUM VIRGINIANUM (L.) Sw., Grape-fern.—Auglaize, Belmont, Brown, Clark, Clermont, Clinton, Cuyahoga, Defiance. Delaware, Fairfield, Franklin, Fulton, Greene, Hamilton, Hardin, Lawrence, Lucas, Madison, Medina, Montgomery, Morrow, Ottawa, Portage, Preble, Richland, Sandusky, Trumbull, Tuscarawas, Warren, Wayne, Wyandot.

OSMUNDA REGALIS L., Flowering-fern.—Ashtabula, Clermont, Clinton, Defiance, Fairfield, Fulton, Hamilton, Hardin, Huron, Lake, Licking, Logan, Lorain, Paulding, Sandusky, Seneca, Stark, Summit, Warren, Wayne, Williams, Wood.

OSMUNDA CINNAMOMEA L., Cinnamon-fern.—Ashtabula, Auglaize, Champaign, Defiance, Erie, Fairfield, Gallia, Knox, Licking, Lorain, Lucas, Paulding, Richmond, Sandusky, Stark, Summit, Wayne, Williams, Wyandot.

OSMUNDA CLAYTONIANA L., Clayton's Fern.—Adams, Ashtabula, Belmont, Carroll, Defiance, Fairfield, Fulton, Hamilton, Hocking, Knox, Lake, Licking, Morrow, Noble, Wayne, Wood.

Polypodium vulgare L., Polypody.—Belmont, Cuyahoga, Fairfield, Greene, Hocking, Jackson, Knox, Lake, Lawrence, Licking, Lorain, Monroe, Perry, Summit, Vinton, Wayne.

Polypodium polypodioides (L.) A. S. Hitchcock, Gray Polypody.—Adams, Hamilton.

Adiantum pedatum L., Maiden-hair.—Adams, Auglaize, Belmont, Brown, Carroll, Champaign, Clermont, Clinton, Crawford, Delaware, Fairfield, Franklin, Gallia, Greene, Hamilton, Hardin, Harrison, Highland, Holmes, Huron, Jefferson, Lake, Logan, Lorain, Madison, Medina, Monroe, Morrow, Noble, Paulding, Pike, Portage, Preble, Richland, Scioto, Seneca, Vinton, Warren, Wayne, Williams.

Pteridium aquilinum (L.) Kuhn., (*Pteris aquilina* L.) Brake. —Ashtabula, Carroll, Defiance, Erie, Fairfield, Fulton, Gallia, Harrison, Knox, Lorain, Lucas, Monroe, Paulding, Richland, Sandusky, Stark, Tuscarawas, Wayne, Williams, Wood.

Pellæa atropurpurea (L.) Link., Cliff-brake.—Adams, Clark, Franklin, Greene, Highland, Ottawa, Stark.

Woodwardia virginica (L.) J. E. Smith., Chain-fern.— Ashtabula, Defiance, Summit, Wayne, Williams.

Asplenium pinnatifidum Nutt., Spleenwort.—Fairfield, Hocking, Lawrence.

Asplenium ebenoides R. R. Scott, Spleenwort.—Hocking.

Asplenium parvulum Mart. & Gal., Spleenwort.—Adams.

Asplenium platyneuron (L.) Oakes, (*A. ebeneum* Ait.) Spleenwort.—Brown, Clermont, Defiance, Delaware, Fairfield, Gallia, Green, Jackson, Lawrence, Montgomery, Morgan, Portage, Scioto, Summit, Vinton, Wayne.

Asplenium trichomanes L., Spleenwort.—Ashtabula, Coshocton, Fairfield, Green, Hocking, Holmes, Knox, Lawrence, Licking, Paulding.

Asplenium angustifolium Michx., Spleenwort.—Auglaize, Belmont, Clermont, Cuyahoga, Fairfield, Franklin, Gallia, Hardin, Huron, Medina, Meigs, Monroe, Portage, Preble, Seneca, Warren, Wayne, Wyandot.

Asplenium ruta-muraria L., Spleenwort.— Green.

Asplenium montanum Willd., Spleenwort.—Summit.

Asplenium achrostichoides Sw. (*A. thelypteroides* Michx.) Spleenwort.—Belmont, Clermont, Clinton, Hardin, Hocking, Huron, Medina, Meigs, Miami, Wayne.

Asplenium filix-fœmina (L.) Bernh., Lady-fern.—Adams, Auglaize, Brown, Carroll, Clermont, Clinton, Cuyahoga, Defiance, Erie, Fairfield, Fulton, Hocking, Huron, Madison, Perry, Richmond, Summit, Wayne.

Camptosorus rhizophyllus (L.) Link., Walking-fern.— Adams, Champaign, Delaware, Fairfield, Franklin, Gallia, Green, Highland, Holmes, Jefferson, Licking, Lorain, Meigs, Morgan, Muskingum, Pike, Portage, Scioto.

POLYSTICHUM ACHROSTICHOIDES (Michx.) Schott. (*Dryopteris achrostichoides* (Michx.) Kuntze, *Aspidium achrostichoides* Sw.) Sword-fern, Christmas-fern.—Adams, Athens, Auglaize, Belmont, Brown, Carroll, Clermont, Columbiana, Defiance, Fairfield, Franklin, Fulton, Gallia, Harrison, Highland, Hocking, Holmes, Huron, Jackson, Jefferson, Lorain, Lucas, Monroe, Morrow, Noble, Paulding, Perry, Portage, Richland, Sandusky, Scioto, Seneca, Summit, Vinton, Warren, Wayne.

DRYOPTERIS NOVEBORACENSIS (L.) Gray, (*Aspidium noveboracense* Sw.) Shield-fern.—Belmont, Defiance, Fairfield, Geauga, Hocking, Lorain, Paulding.

DRYOPTERIS THELYPTERIS (L.) Gray, (*Aspidium thelypteris* Sw.) Shield-fern.—Auglaize, Clark, Cuyahoga, Fairfield, Hocking, Lake, Licking, Lucas, Richland, Stark, Summit, Wayne, Wyandot.

DRYOPTERIS CRISTATA (L.) Gray, (*Aspidium cristatum* Sw.) Shield-fern.—Ashtabula, Champaign, Cuyahoga, Fairfield, Licking, Miami, Portage, Richland, Stark, Wayne.

DROYPTERIS GOLDIEANA (Hook.) Gray, (*Aspidium goldieanum* Hook.) Shield-fern.—Clark, Cuyahoga, Fairfield, Franklin, Hardin, Lorain, Miami, Portage.

DRYOPTERIS MARGINALIS (L.) Gray, (*Aspidium marginale* Sw.) Shield-fern.—Belmont, Columbiana, Delaware, Fairfield, Gallia, Geauga, Green, Holmes, Jackson, Jefferson, Lawrence, Licking, Lorain, Monroe, Morgan, Richland, Scioto, Summit, Wayne.

DRYOPTERIS SPINULOSA (Retz.) Kuntze, (*Aspidium spinulosum* Sw.) Shield-fern.—Ashtabula, Carroll, Champaign, Clinton, Crawford, Defiance, Fairfield, Hardin, Knox, Lake, Licking, Logan, Medina, Miami, Monroe, Paulding, Seneca, Stark, Summit, Wayne, Wyandot.

DRYOPTERIS SPINULOSA INTERMEDIA (Muhl.) Underw., (*Aspidium spinulosum intermedium* D. C. Eaton) Shield-fern.—Ashtabula. Auglaize, Columbiana, Fairfield, Hamilton, Hocking, Lake, Licking, Logan, Lorain, Lucas, Summit, Wayne.

PHEGOPTERIS PHEGOPTERIS (L.) Underw., (*Phegopteris polypodioides* Fée) Beech-fern.—Ashtabula, Hamilton, Hocking, Mahoning, Montgomery, Summit.

PHEGOPTERIS HEXAGONOPTERA (Michx.) Fée, Beech-fern.—Adams, Auglaize, Clark, Clermont, Clinton, Defiance, Fairfield, Franklin, Holmes, Jackson, Lake, Logan, Medina, Monroe, Morrow, Perry, Preble, Warren, Wyandot.

PHEGOPTERIS DRYOPTERIS (L.) Fée, Oak-fern.—Ashtabula, Lake.

FILIX BULBIFERA (L.) Underw., (*Cystopteris bulbifera* (L.) Bernh.) Bladder-fern.—Adams, Ashtabula, Champaign, Clark, Clermont, Cuyahoga, Fairfield, Franklin, Highland, Hocking, Licking, Summit.

FILIX FRAGILIS (L.) Underw., (*Cystopteris fragilis* (L.) Bernh.) Brittle-fern.—Ashtabula, Auglaize, Clark, Clermont, Clinton, Fairfield, Franklin, Green, Hamilton, Hancock, Hardin, Huron, Knox, Lake, Lorain, Portage, Wayne.

WOODSIA OBTUSA (Spreng.) Torr.—Clark, Fairfield, Green, Jackson, Lawrence, Perry, Scioto.

DENNSTÆDTIA PUNCTILOBULA (Michx.) Moore, (*Dicksonia punctilobula* (Michx.) Gray, *D. pilosiuscula* Willd.) Hay-scented fern.—Ashtabula, Cuyahoga, Hocking, Miami, Scioto.

ONOCLEA SENSIBILIS L., Sensitive fern.—Ashtabula, Auglaize, Belmont, Champaign, Clermont, Clinton, Delaware, Erie, Fairfield, Fulton, Gallia, Hardin, Hocking, Huron, Jackson, Jefferson, Knox, Lucas, Madison, Medina, Morrow, Ottawa, Seneca, Stark, Summit, Vinton, Warren, Wayne, Williams, Wood, Wyandot.

Since this article was sent to press, specimens of Mateuccia struthiopteris (L.) Todd. have been received from L. D. Stair of Cleveland.

Will you kindly send specimens of every species of your County not noted in the above list as already in the State Herbarium? They will be incorporated in the collection to the credit of the donors and collectors. Unusual forms and abundant material of the rarer species are especially solicited. Photographs of plants of any species in their natural habitats will be most welcome, and will be filed in the State Herbarium along with the specimens.

LEAF EXPANSION OF TREES AND SHRUBS IN 1904.

JOHN H. SCHAFFNER.

During the past spring an accurate record was kept of the time of appearance, at Columbus, of the leaves of our common native and cultivated woody plants. The results are given below. The spring was unusually cold and late so that the actual time of leafing is not to be taken as representing the usual date for this locality.

The trees were listed when the leaves began to break through the bud and became definitely distinguishable as leaves. In some species the leaf is nearly expanded in a day or two after this and the tree looks quite leafy, while in others the development is very slow. There is also much difference in individuals, even those standing side by side and apparently with the same environment. Ulmus americana showed bursting buds on April 30 in isolated individuals; but the last trees were just coming out on the 14th of May. A period of fifteen days, therefore, intervened between the leafing of the first individuals and the last. In such cases the period marked was the time when the leaves were appearing rather commonly rather than the first individuals. The willows showed interesting peculiarities. Some species appear very early, others quite late. If this is the usual course, the time of leafing might be of some value in determining species in early spring. Some of the maples and buckeyes are the most sudden in the unfolding of their leaves. The catalpas, coffee-bean, fringe-tree, and hop-tree develop the foliage very slowly. It was also observed that many trees begin to leaf at the top.

April 1.

Syringa vulgaris L.

April 2.

Larix laricina (Du R.) Koch., L. decidua Mill., Salix babylonica L.

April 5.

Salix fragilis L., Lonicera tartarica L., L. korolkowi Stapf.

April 7.

Salix alba L.

April 8.

Prunus serotina Ehrh.

April 11.

Euonymus atropurpureus Jacq., E. europæus L., Ribes aureum Pursh., Cydonia japonica Pers., Sambucus canadensis L.

April 14.

Euonymus obovatus Nutt., Spiraea hypericifolia DC.

April 16.

Rubus occidentalis L., Prunus virginiana L.

April 18.

Aesculus glabra Willd.

April 21.

Philadelphus coronarius L.

April 23.

Betula alba L., Sorbus aucuparia L., Symphoricarpos racemosus Mx., S. symphoricarpos (L.) MacM.

April 25.

Staphylea trifoliata L., Acer negundo L., Cornus baileyi Coult. and Ev., Ligustrum vulgare L., Viburnum opulus L.

April 26.

Berberis vulgaris L., Rosa rubiginosa L., Malus malus (L.) Britt., Prunus japonica Thunb., Cornus alba L.

April 28.

Pyrus communis L., Acer saccharinum L.

April 29.

Betula papyrifera Marsh., Opulaster opulifolius (L.) Ktz., Prunus cerasus L., Amygdalus persica L., Syringa villosa Vahl., Viburnum prunifolium L.

April 30.

Ostrya virginiana (Mill.) Willd., Cydonia cydonia (L.), Hypericum prolificum L., Acer rubrum L., Syringa persica L.

May 2.

Populus balsamifera L., P. tremuloides Mx., Carpinus caroliniana Walt., Hydrangea arborescens L., Amelanchier canadensis (L.) Medic., Parthenocissus quinquefolia (L.) Plan., P. tricuspidata (Sieb. and Zucc.) Plan., Acer platanoides L., Fraxinus americana L., Cornus alternifolia L.

May 3.

Picea excelsa Link., Juniperus communis L., Taxus baccata L., Populus alba L., P. dilatata Ait., Salix amygdaloides Anders., Quercus palustris Du Roi., Xanthoxylum americanum Mill., Cladrastis lutea (Mx.) Koch., Aesculus hippocastanum L.

May 4.

Pinus laricio Poir., Populus deltoides Marsh., P. grandidentata Mx., Ulmus americana L., Liriodendron tulipifera L., Menispermum canadensis L., Acer saccharum Marsh., Fraxinus quadrangulata Mx.

May 5.

Hicoria minima (Marsh.) Britt., Celtis occidentalis L., Hamamelis virginiana L., Prunus americana Marsh., Cratægus coccinea L., Gleditsia triacanthos L., Cotinus cotinus (L.), Celastrus scandens L., Vitis labrusca L., V. vulpina L., Acer nigrum Mx., Fraxinus lanceolata Borck.

May 6.

Pinus rigida Mill., P. silvestris L., Juglans nigra L., Hicoria alba (L.) Britt., Castanea dentata (Marsh.) Bork., Quercus rubra L., Q. macrocarpa Mx., Q. acuminata (Mx.) Houda., Ulmus racemosa Thom., Platanus occidentalis L., Cratægus pruinosa (Wendl.) Bead., Robinia pseudacacia L., Rhus radicans L., Acer pseudo-platanus L., Rhamnus cathartica L., Tilia americana L., Tecoma radicans (L.) D C., Cornus florida L.

May 7.

Ginkgo biloba L., Pinus strobus L., Abies balsamea (L.) Mill., Tsuga canadensis (L.) Carr., Taxodium distichum (L.) Rich., Thuja occidentalis L., Juniperus virginiana L., Salix nigra Marsh., Juglans cinerea L., Hicoria ovata (Mill.) Britt., H. laciniosa (Mx.) Sarg., Fagus americana Sw., Quercus coccinea Wang., Q. velutina Lam., Q. alba L., Q. platanoides (Lam.) Sudw., Liquidambar styraciflua L., Amorpha fruticosa L., Rhus aromatica Ait., Ailanthus glandulosa Desf., Acer campestre L., Ampelopsis cordata Mx.

May 8.

Smilax hispida Muhl., Ulmus fulva Mx., Morus alba L., Toxylon pomiferum Raf., Gymnocladus dioica (L.) Koch.

May 9.

Ulmus campestris Sm., Sassafras sassafras (L.) Karst., Diospyros virginiana L., Fraxinus nigra Marsh.

May 10.

Quercus imbricaria Mx., Rhus glabra L., Catalpa catalpa (L.) Karst., C. speciosa Ward.

May 11.

Morus rubra L., Asimina triloba (L.) Dun., Tamarix galica L.

May 12.

Magnolia acuminata L., Nyssa sylvatica Marsh.

May 13.

Celtis mississippiensis Bosc.

May 14.

Ptelea trifoliata L.

May 16.

Chionanthus virginica L.

UNUSUAL COLOR MARKING IN THE PRAIRIE MOLE.

LUMINA C. RIDDLE.

During the spring of 1904 there was turned over to the Department of Natural History of Washburn College, Topeka, Kansas, a peculiar mole which had been trapped in a yard near by. The specimen was prepared and placed in the Museum where it can be found at the present time.

From general characters the mole was identified as a young adult male of the Prairie Mole, *Scalops aquaticus* subspecies *machrinus* (Raf.) but presented some striking variations. From tip to tip it was 7¼ inches, or 5¾ inches without the tail which was 1½ inches long, and nearly naked; the nostrils were somewhat superior, the snout being $\frac{7}{16}$ inch long. Width of front feet 1 inch and length with claws, 1 inch. Width of hind feet, ½ inch, length of hind feet ⅞ inch.

On the abdomen there was an irregular diamond shaped spot of fur 2 inches long and 1¼ inches wide which was bright orange in color. There were several tiny spots scattered here and there around the larger one and the fur about the snout and front feet was tinged with the same color. The man who trapped the specimen said that of the hundreds he had taken in his lifetime this was the only one he had ever seen with color marking.

A NEW SUNFLOWER FROM ILLINOIS.

H. A. Gleason.

Helianthus illinoensis. Erect, six to ten dm. high, from a long running rootstock. Stem simple, slightly angled, densely villous below, pubescent above. Leaves six to eight pairs, strictly opposite, slightly scabrous above, softly pubescent beneath and villous on the veins, obtuse; the lowest four or five pairs oblong-lanceolate to ovate-lanceolate, three-nerved, entire, ten to fifteen cm. long, tapering at the base into a villous winged petiole equalling or but little shorter than the leaves; the upper two or three pairs much smaller or bractlike, petiole short or none. Lower internodes five to eight cm. in length, or the two lowest pairs of leaves approximate, upper internodes much longer. Inflorescence of one to seven heads; peduncles three to ten cm. long; involucre broadly campanulate or hemispherical, eight mm. high; scales lanceolate, acuminate, ciliate. Disk flowers yellow, rays about thirteen, two to three cm. long, bright yellow, achenes minutely pubescent. Flowers in August.

On the sand dunes along the Illinois river near Havana, where it is common in the black-jack oak woods, especially along the edges and in the more open and sunny places. Material was collected in 1903 and 1904, and the type, collected on August 17, 1904, is in the herbarium of the Missouri Botanical Garden.

Helianthus illinoensis is evidently closely related to *Helianthus occidentalis* Riddell, which it resembles in the reduction in size of the upper leaves. It is at once distinguished from the latter species by the villous pubescence and the greater length of the lower internodes. The two are sometimes associated in the field, but in general appearance they are entirely distinct. *Helianthus occidentalis* has broad, scabrous, light-green, short-petioled leaves which are nearly erect in a basal cluster, while in Helianthus illinoensis they are darker green, more or less spreading and scattered on the stem.

SIX NUTATING PLANTS.

John H. Schaffner.

The diurnal nutation of certain herbaceous plants during their period of development has aroused interest for a long time. Allusion is made to it by a number of poets and some of the older reading books had quite accurate accounts of the nutation of the Common Sunflower. The observation of such phenomena should aid considerably in arousing the student's interest in plant life and the subject offers an inviting field suitable for nature study.

A number of nutating plants have been studied by the writer in the past and during the present year observations were continued on various species which it was thought might show the peculiarty. The following six species show a movement of the stem tip and terminal leaves when conditions are favorable.

Chenopodium album L.
Polygonum lapathifolium L.
Polygonum pennsylvanicum L.
Euphorbia hexagona Nutt.
Euphorbia dentata Mx.
Iva ciliata Willd.

The two Euphorbias have a very decided nutation, the curvature of the stem often being as great as in the Sunflower.

TWIGS OF THE COMMON HACKBERRY.

John H. Schaffner.

Our Hackberries demand careful study in the field in order that some of the obscurities may be removed which now appear in the descriptions of our Manuals. Celtis occidentalis L. is said to have "glabrous twigs" and "leaves smooth above." Celtis crassifolia Lam. is said to have "the young shoots puberulent" and "leaves scabrous above." Now, we can find all of these characters on different twigs of the same tree.

So far as Celtis occidentalis is concerned, I have not found a Hackberry in Ohio or Kansas that did not have pubescent twigs. The tree has two types of twigs; fruiting twigs and twigs which bear no flowers. The fruiting twigs have a few scattered hairs when young but these usually fall off early. The leaves are very glabrous above and of a peculiar appearance. These fruiting twigs dry off at the outer ends while the fruit ripens and they are then very abundantly detached, a brittle layer being developed at the base. Often the twigs come down with the drupes still attached. The purely vegetative shoots are usually quite pubescent when young, the pubescence extending to the leaves. In most cases the pubescence is persistent on the twigs and the mature leaves are quite scabrous or hairy. As one goes westward the pubescence of the vegetative shoots appears to become more pronounced, and one can find trees with very smooth fruiting twigs and very hairy vegetative twigs.

Are there any characters to establish the species, Celtis crassifolia Lam.? From an examination of supposed C. crassifolia and C. occidentalis identified by competent botanists I can find no specimens in either set which cannot be duplicated by twigs taken from one tree. The shape of the leaf is also exceedingly variable in the Hackberries, so that one can find leaves of a decidedly ovate type or of a decidedly lanceolate type on the same individual.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, June 6, 1904.

The meeting was called to order by the President and the minutes of the previous meeting were read and approved.

Prof. Kellerman reported innoculation experiments with Puccinia sambuci. Prof. Landacre spoke of a peculiar fœtal heart in a pig. Prof. Hine gave notes on the stay of warblers in this locality.

The committee on nominations for the staff of the OHIO NATURALIST reported as follows:

Editor-in-chief, ... JOHN H. SCHAFFNER
Business Manager . . . . . JAMES S. HINE

ASSOCIATE EDITORS.

Zoology, ... FRANCIS L. LANDACRE
Botany, ... HARLAN H. YORK
Geology, ... JOHN A. BOWNOCKER
Archæology, ... WILLIAM C. MILLS
Ornithology, ... JAMES G. SANDERS
Ecology, ... JOHN N. FRANK

The report of the committee was accepted as read. After hearing reports on plans for the summer's work by various members the club adjourned.

J. N. FRANK, *Secretary.*

The fourteenth annual meeting of the Ohio State Academy of Science will be held at Cleveland, Nov. 25 and 26. The meetings will be in the Biological Building of Adelbert College.

Date of Pnblication of November Number, November 9, 1904.

The Ohio Naturalist,

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The Biological Club of the Ohio State University.

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THE TABANIDÆ OF WESTERN UNITED STATES AND CANADA.*

JAMES S. HINE.

This paper although incomplete in many respects is offered as an aid for determining the Tabanidæ of the part of the country not so thoroughly covered by Osten Sacken's most valuable Prodrome. I have spent much time and study on an extensive collection of Tabanids from the region, and although I have not satisfied myself in all particulars, some definite conclusions have been reached which are offered with the desire that they may be of service to future students.

In this work I have been aided in various ways and without this help I realize that it would not have been possible to do much that has been done. It is with the greatest pleasure therefore, that I make the following acknowledgements: The U. S. National Museum has loaned me all their undetermined material and Mr. Coquillett has aided me materially besides; Dr. Snow of Kansas University has loaned me much undetermined material, as well as the material he and his associates have collected on several of his numerous collecting trips in the West; Prof. R. C. Osburn has donated several hundred specimens he collected in British Columbia during two summers spent at the Minnesota Seaside Station; Prof. R. V. Harvey of the Queen's School, Vancouver has sent me a large quantity of excellent material from his region; the University of Illinois through Dr. Forbes and Prof. Hart have sent me material for study and Prof. Chas. W. Johnson of the Boston Society of Natural History, besides sending me much material for study has aided me in other ways. Dr. James Fletcher and Profs. E. D. Ball, V. L. Kellogg, R. A. Cooley and M. J. Elrod have each furnished valuable material. From this variety of sources and from other collectors I shall mention

*Contributions from the Department of Zoology and Entomology, O. S. U., No. 21.

later it has been possible to get together a large and representative collection from the region covered by this paper. Through correspondence with Miss Gertrude Ricardo who has studied Bigot's types and also the Tabanidæ of the British Museum I have gained much. She has even redescribed several of Bigot's types for me and by this means I have satisfactorily identified a number of his species.

The European material I have for comparison consists of a large number of species acquired by exchange with Prof. Morio Bezzi of Italy, Dr. K. Kertesz of the Hungarian National Museum and E. Brunetti of England. In comparing one is convinced, with Dr. Loew, that hardly any of the species of the two countries seem to be exactly the same but in some cases they are very close.

Since I have been studying this family I have visited The Museum of Camparative Zoology, The U. S. National Museum and The Museums of Kansas University and The University of Illinois. At each place I was given every opportunity to study the contained material and am under obligations for these privileges.

In most cases under each species only those characters of most consequence in determination are mentioned.

Key to the North American Genera.

1.	Hind tibiæ with spurs at the tip	2
	Hind tibiæ without spurs	6
2.	Third segment of the antenna composed of eight annuli the first of which is only a little longer than the following ones	3
	Third segment of the antenna composed of only five annuli the first of which is much longer than the following ones; ocelli present	5
3.	Front of female narrow; ocelli present or absent; fourth posterior cell at least open	*Pangonia**
	Front of female broad with a denuded callus; ocelli present	4
4	Eyes in the female acutely angulated above; wing in both sexes with a dark picture	*Goniops*
	Eyes in the female not acutely angulated above; wings hyaline	*Apatolestes*
5.	Second segment of the antenna about half as long as the first; eyes in life with numerous small dots	*Silvius*
	Second segment of the antenna as long or but little shorter than the first; wing with a dark picture	*Chrysops*
6.	Third segment of the antenna with a well developed basal process	*Tabanus*†
	Third segment of the antenna without, or with a rudimentary basal process	7
7.	All the tibiæ enlarged, the hind pair ciliate	*Snowiellus*
	None of the tibiæ enlarged and the hind pair not ciliate	8
8.	Front of the female as broad as long the callus transverse	*Hæmatopota*
	Front of the female narrow	*Diachlorus*

* Including Diatomineura and Corizoneura.

† Including Atylotus and Therioplectes.

Chrysops Meigen.

The species of this genus have fairly good characters. We have recognized the males of a number of the western species, but there are still several unknown. Twenty species are recognized in the following pages, one described as new. I offer the following key as an aid in separating them:

1.	Apex of the wing beyond the cross-band hyaline	2
	Apex of the wing beyond the cross-band not entirely hyaline	4
2.	Abdomen yellow on the sides of at least the first two segments	*excitans*
	Abdomen uniformly black	3
3.	Base of the fifth posterior cell hyaline	*carbonarius*
	Base of the fifth posterior cell not hyaline	*mitis*
4.	Second antennal segment decidedly longer than the third	*ceras*
	Second antennal segment not longer than the third	5
5.	First antennal segment distinctly enlarged	6
	First antennal segment not enlarged	10
6.	First and second antennal segments distinctly enlarged	*virgulatus*
	Second antennal segment not distinctly enlarged	7
7.	Hyaline triangle separated from the posterior margin of the wing by an infuscated space	*fulvaster*
	Hyaline triangle reaches the posterior border of the wing	8
8.	Facial and frontal callosities almost entirely black or brown	*facialis*
	Facial and frontal callosities yellow or the latter margined with brown	9
9.	Slender species, male with base of anal cell hyaline, female with two small black spots on the middle of the second abdominal segment	*pachycera*
	Robust species, male with base of the anal cell infuscated, female usually with a geminate black spot on the second abdominal segment	*coquillettii*
10.	A hyaline spot in the discal cell	*discalis*
	No hyaline spot in the discal cell	11
11.	Whole face black in ground color	12
	Part or whole of face yellow	14
12.	Abdomen yellow on the sides	*frigidus*
	Abdomen black	13
13.	Apical spot separated from the cross-band	*noctifer*
	Apical spot united with the cross-band	*nigripes*
14.	Abdomen with longitudinal black stripes	15
	Black abdominal markings not in the form of stripes	16
15.	Four black stripes running the whole length of the abdomen	*sequax*
	Two black stripes running the whole length of the abdomen, the two lateral stripes abbreviated	*pikei*
16.	Frontal callosity yellow with narrow brown border	*coloradensis*
	Frontal callosity black	17
17.	Cheeks entirely yellow	*furcatus*
	Cheeks with a black band from the eyes to the margin of the mouth	18
18.	Yellow on each side of the second segment not enclosing any black, apex of the second basal cell hyaline for its entire width	*lupus*
	Yellow on each side of the second abdominal segment enclosing a small black dot, hyaline at the apex of the second basal cell crossed by brown	19

19. The facial callosity on either side inside of the suture yellow, making the yellow stripe on the middle of the face appear wide ... *proclivis*
The facial callosities on either side entirely black, making the yellow stripe on the middle of the face appear narrow ... *surdus*

Chrysops carbonarius Walker. The synonymy given in the list has been worked out mainly by Osten Sacken and Miss Ricardo. The species has a wide distribution and the uniformly black abdomen, light colored hairs on the sides of the thorax and hyaline spot at the base of the fifth posterior cell of the wing, serve to separate both sexes from related species.

Chrysops ceras Townsend. The near relatives of this species are to be found in Mexico. Townsend pointed out the differences separating ceras from tanyceras O. S. and megaceras Bell. when he described it. I have not the proper material to offer any suggestions upon what Townsend published. The peculiar structure of the antennæ referred to in the key separates it from all described species of the United States and Canada. The whole body is brown with dark posterior margins to the abdominal segments. The dark color of the wings is confined to the costal margin and distal half; the cross-band includes dark coloration in the region of the stigma, at the bases of the first submarginal and first posterior cells, and conspicuous margins to the cross-veins and their intersections with the longitudinal veins. The apical spot is separated from the cross-band, and is mostly confined to the apexes of the marginal and first submarginal cells, although a trace extends into the second submarginal. The furcation of the third vein is prominently margined with dark brown.

Chrysops coloradensis Bigot. The cheeks are yellow with the exception of a small brown spot near the eye, the frontal callosity is yellow with a narrow brown margin, the general color of the body is lighter than in proclivis, there are usually two spots on the second abdominal segment instead of a single geminate one; also the black on the third and fourth abdominal segments is somewhat reduced in extent and exists in the form of spots.

Chrysops coquillettii n. sp. Female 9 millimeters, some specimens slightly smaller. Facial and frontal callosities yellow, the latter with a dark margin, anterior part of cheeks a median line on face, and front exclusive of callosity, covered with bright yellow pollen and grayish hairs; palpi yellow, antenna, first segment distinctly swollen, first two segments brown with black hairs, third segment much longer than the second; basal annulus dark brown, remainder black. Thorax with the usual stripes which are somewhat obscured by thick grayish hairs; legs yellow with black at the joints and on apical part of anterior tibiæ, all of anterior tarsi and last three or four segments of other tarsi. Wing with costal margin and cross-band black, apical spot fills out the marginal, with the exception that there may be a trace of hyaline across the second vein, the broad apex of first submarginal, and reaches into the second submarginal. The cross-band occupies about half of the first submarginal, first, third and fifth posterior, one-fourth of second posterior, all of discal and fourth posterior and small apical parts of anal, and first and second basal; one-half or more of second basal, all of axillary and anal, except apex of latter are hyaline. Abdomen black and yellow, black as follows: first segment beneath the scutellum, second with two triangular spots united on anterior margin of the segment, but not reaching posterior, third and fourth segments each with four spots longitudinally separated by yellow, fifth and following segments except posterior margins. In some cases the fifth segment is colored like the previous one. Venter with a rather wide median stripe and a narrow lateral one.

Male, 8 millimeters, some specimens slightly smaller and some slightly larger. Head and its parts differing from those of the female only in sexual characteristics. Thorax not showing stripes as plainly, but otherwise this and the legs are as in the other sex. Wings with a spot in each basal cell equal to about one-fourth the length of its respective cell, and a fuscous patch in the base of the anal cell, otherwise like wings of the female. Abdomen, first segment black with the exception of a small yellow area on each external lateral margin, second segment yellow on sides and on posterior margin, the black is extended and reaches the anterior margin, but posteriorly is divided by anterior projections from the yellow posterior margin, so that it may be said to send backward four projections, the narrow lateral ones of which may be cut off by yellow and exist as separate spots, the third and fourth segments are like the second, but the lateral black spurs are not cut off, the fifth segment suggests the one before it, but the yellow is more or less obscure, excepting a narrow posterior margin, sixth segment black. Venter as in female.

A number of specimens from different collectors, taken in southern California. The species is named for D. W. Coquillett, who has produced a large number of valuable contributions to Dipterological literature and to entomology in general, and who collected several of the specimens near Los Angeles.

The species is nearest related to pachycera, but its larger size, different abdominal markings and a more extended coloration on the basal part of the second basal and anal cells are distinctive in both sexes.

Chrysops discallis Williston. This distinct species has somewhat the appearance of fulvaster, but does not have the enlarged first antennal segment. It is rather large in size and may be known by the prominent hyaline spac in the dis cl cell of the wing.

The male which hitherto has not been described, is much darker than the female; the antennæ, proboscis and four small spots on the face are black; the facial callosities are shining yellowish, otherwise, the face is covered with gray pollen. Thorax dark with gray hairs and well marked gray stripes above; legs mostly black with the exception of the middle and hind tibiæ, which are largely yellow. Wings black with various sized hyaline spots in all the cells except the costal, marginal and fifth posterior; axillary cell almost altogether hyaline. Abdomen black with narrow lateral margins and rather wide posterior margins of the segments gray. On the second to the fifth segments the posterior border sends forward three extensions besides the lateral margins. Venter of the abdomen gray with three rows of black spots. Length, 10 millimeters.

Two males, one from Utah and the other from Montana. The latter sent in by Prof. R. A. Cooley, who has also contributed other material of interest from that State.

Chrysops excitans Walker. So far as western species of Chrysops are concerned this one is readily separated from all others by the absence of an apical spot on the wing and the bicolored abdomen. The second basal cell infuscated on more than basal half separates it from sordidus of the eastern states.

Chrysops facialis Townsend. Female: Antennæ blackish above, yellowish beneath on first two segments; first segment distinctly enlarged but not so large as in some related species. Facial callosities shining black or dark brown, remainder of face yellow. Frontal callosity shining black, yellowish on disk. Ocellar area large, black, nearly reaching the eye on either side. Thorax black with yellow stripe on each side above the root of the wing; clothed everywhere with rather long yellow hairs. Legs yellow with joints, apical half or more of anterior tibiæ, and all the tarsi except metatarsi blackish; wings with costal margin and cross-band black. The hyaline triangle crosses the second vein contributing a small spot to the marginal cell, the apical spot fills out the apexes of the marginal and first submarginal cells and extends into the second submarginal; otherwise the apex of the wing beyond a line from outer end of the stigma to distal end of vein separating third and fourth posterior cells is hyaline. Also apical half of first basal, two-thirds of second basal, all of the anal except apical narrowed part, and all of axillary are hyaline. The distal half of fifth posterior cell is infuscated, but not so strongly as the basal half. Abdomen black and yellow, black as follows: Large spot beneath the scutellum, two spots united at base on middle of second and third segments, four spots united basally on fourth and fifth segments, and all of remaining segments except narrow posterior margins. Ventrally a wide stripe on middle, a row of narrow spots on each side, and apical segments black, remainder yellow.

Male: Colored like the female except more black on legs and wings. In the latter the apical triangle is the same in both sexes, but in each basal cell there is only a small hyaline spot, and the hyaline in the anal cell is much reduced. Length of both sexes 8 millimeters.

A male and female in the Bolter Collection at the University of Illinois, and through the kindness of Dr. Forbes and Prof. Hart, I have been permitted to study them. Taken at Las Vegas, New Mexico.

Separated from related species by the black frontal callosity of the female and the black facial callosities of both sexes.

Chrysops frigidus Osten Sacken. Variable in size and coloration of the abdomen. Some of the western specimens are considerably larger than the average eastern specimens. The prominent apical spot united with the cross-band, together with the prominent yellow on the sides of the abdomen and the black ground color of the middle of the face, makes this species one of the easiest to recognize.

Chrysops fulvaster Osten Sacken. The first antennal segment is distinctly swollen. The dark of the wings is brownish and there is often a hyaline spot in distal cell of the wing of the female, but I have not observed it in the male. The wings are brownish along the whole posterior marign and the hyaline triangle is represented by a crescent-shaped sub-hyaline space in both sexes. A most abundant species over a number of western states.

Chrysops furcatus Walker. This species was placed as a synonym of striatus by Osten Sacken, but Miss Ricardo who recently studied the type in the British Museum, states that it is not identical with striatus and then points out differences. Previous to the past summer I had not recognized the species, but it was included among a number of specimens received from Mr. Jos. C. Ouellet of Montreal. Two specimens which agree with Walker's description and Miss Gertrude Ricardo's additional remarks, were taken at Val Morin a few miles north of Montreal. The wing is colored like that of coloradensis, the frontal callosity is pure black, and the face and cheeks are yellow with the exception of a black indented spot immediately below each facial callosity. The black spot on the second abdominal segment is deeply emarginate posteriorly and black on the third and fourth segments is in the form of four black spots on each, remaining segments black with a yellow hind border. The species is separated from lupus and proclivis by the wholly yellow cheeks. It does not come within the scope of this paper rightly, but since it has not been fully considered heretofore in connection with species most like it it is included.

Chrysops lupus Whitney. Resembles proclivis, furcatus and coloradensis. The frontal callosity, the facial callosities outside of the sutures and a band on each cheek are black. Abdomen, black, arranged almost as in proclivis except there is no small black dot on either side of the second segment and the third and fourth segments have the black more distinctly in the form of spots necessitating more yellow and consequently making the whole abdomen appear lighter in general coloration. The type was collected in Colorado and specimens are before me from Laggan, Alberta, collected by Professor R. C. Osburn.

Chrysops mitis Osten Sacken. Much like carbonarius. In fact there is some doubt whether or not it should be considered as distinct from that species. The absence of a hyaline spot at the base of the fifth posterior cell and the somewhat larger size separate mitis from its near relative.

Chrysops nigripes Zetterstedt. Loew first reported this species from Alaska and Coquillett recognized a specimen taken by Kincaid of the Harriman expedition. This latter specimen is the only one that I have seen, for it appears to be difficult to get even European examples. The union of the apical spot and cross-band seems to be the best means of separating it from noctifer its nearest American relative.

Chrysops noctifer Osten Sacken. I have seen the types of both Osten Sacken and Williston and cannot see how it is possible to recognize the two species noctifer and pertinax. The difference in the two descriptions is mainly found in the presence or absence of reddish on the sides of the first two abdominal segments, and this appears to be too variable to be of specific value I believe the two names are synonymous, and as noctifer is the older, it must be retained for the species. The prevailing black color of the whole body, and the apical spot separated from the cross-band are characteristics.

Chrysops pachycera Willison. Dr. Williston's types, a fine series of specimens from Dr. F. H. Snow and collected by him and his associates in Arizona and other specimens collected in Lower California have given me the opportunity for studying this species.

The first antennal segment is swollen, the third segment is much longer than the second, the facial and frontal callosities are yellow. In both sexes the anal cell is hyaline at base and the yellow on the sides of the first four abdominal segments is more extended than in related species.

Chrysops pikei Whitney. This recently described species has affinities with sequax and univittatus. The first basal cell is infuscated with the exception of a small elongate hyaline spot contiguous with the hyaline base of the discal cell, the second basal cell is hyaline with the exception of a slight infuscation at base. The outer border of the cross-band is nearly straight, the hyaline triangle is rather small and does not cross the second vein and the apical spot fills out the marginal cell and much of the first and second submarginal and first posterior cells. The abdomen is yellow with two black stripes extending from the scutellum to the apex and on either side of these another narrower stripe of the same color extending backward from the anterior part of the third segment. The type was collected in Missouri and I have specimens from Kansas.

Chrysops proclivis Osten Sacken. Frontal callosity, antennæ, each facial callosity outside of the suture and cheeks black. First basal cell of the wing black for its entire length in the middle but near the apex on either side next the longitudinal veins there is some hyaline, the second basal is hyaline, the outer margin of the crossband is curved, the hyaline triangle is rather large and its apex crosses the second vein, and the apical spot is rather large occupying the apical part of the marginal and the first and second submarginal cells. Abdomen with a black spot beneath the scutellum widest before and connected with a black spot of the second segment. The black of the second segment is slightly emarginate behind and all but attains the posterior margin, and the broad yellow sides of this segment each inclose a small black dot. The remaining segments are black with a narrow serrate yellow posterior border, or there may be more or less separation of the black to form spots as in some of the related species.

The male is much darker than the female. The thorax is black with gray stripes, the wing is black with a small spot at the apex of each basal cell, a suggestion of a hyaline spot on the middle of the discal cell, and a hyaline triangle in all respects like that in the female. Parts of the fifth posterior, anal, and axillary cells are not so dark as the remainder of the wings. The abdomen is black with gray posterior borders to the segment, and three rows of faint triangles. The venter is yellowish with a broad black stripe in the middle and less plainly marked narrow spots on each side.

Adams has stated that the male of this species was described with some doubt by Williston, as the male of his pachycera.

Chrysops sequax Williston. The species has somewhat the aspect of univittatus and striatus. Separated from the latter by the hyaline triangle reaching or slightly transcending the second longitudinal vein, and the apical spot entering the first posterior cell. From the former by having four longitudinal black stripes on the abdomen instead of two.

Chrysops surdus Osten Sacken. Somewhat like proclivis but smaller. The facial callosities are black on both sides of the suture leaving a narrow yellow stripe on the middle of the face. The male is darker than the female and much like the male of proclivis in general appearance. However, the same characters which separate the females may be used in regard to the males.

Chrysops virgulatus Bellardi. Although this species has not been taken in the United States so far as I know, it seems best to include it in treating our species with the first antennal segment enlarged. Female 6 to 9 millimeters. First two antennal segments decidedly swollen, shining brownish, darkest above; third segment with basal annulus decidedly yellow, remainder black, slightly longer than the second, but not so long as the third. Ocellar area black, widely separated from the eye on either side; legs yellow with the exception of the knees, apical part of front tibiæ and their tarsi and distal parts of other tarsi black or brown. Wings with costal margin and cross-bands black, apical spot rather wide, entirely filling out the marginal cell, the apex of first submarginal and extending into the second submarginal. The cross-band includes more than half of the first submarginal cell and about half of the first posterior, not quite half of the second posterior, and more than half of the third posterior, all of the fourth posterior and discal, basal half or more of fifth posterior and apexes of anal and first and second basal cells; basal two-thirds of first basal and one-third of second basal also black; a whitish area invades the hyaline areas on the outer and inner margins of the cross-band. Abdomen black and yellow, black as follows: An oblong patch beneath the scutellum, two or four usually connected spots on anterior part of second segment, and four oblong spots on each of the remaining segments separated longitudinally by yellow. The black on all the segments may be connected anteriorly and the last two segments may be altogether black. Venter yellow with a wide median black stripe and a narrower one on each side.

The male is decidedly darker than the female, the hyaline triangle of the wings is the same in both sexes, but the hyaline in the basal and anal cells consists of a spot in each, and taken together form a crescent, the spot in the anal cell being located nearer the wing base; the whole axillary cell is smoky.

Distinguished from related species by the short third antennal segment and the bright yellow basal annulus of the same. Several males and females taken at Guadalajara, Mexico, by Jesse McClendon in June and July, 1903. The synonomy is by Williston and I believe it should be adopted.

Pangonia Latreille.

Following previous American authors I have not used all the generic names used by some European authors, but have considered the species as all belonging to Pangonia. By some our two speiecs with the eyes naked and the first posterior cell closed would be considered under Pangonia; those with the eyes naked and the first posterior cell open under Corizoneura; while those with the eyes pilose and the first posterior cell open would come under Diatomineura. Our species of this group do not seem to appear in numbers like various species of Tabanus, consequently good series are not often met with in collections. There are seven western species considered in this paper and these may be separated as follows:

1.	First posterior cell closed	2
	First posterior cell open	3
2.	Legs uniformly dark brown	*saussurei*
	Legs yellow	*incisa*
3.	Eyes hairy	4
	Eyes naked	5
4	Antennæ black; body uniformly blackish gray	*hera*
	Antennæ yellow with apex black; body banded with black and yellow	*divès*
5.	Whole body including the antennæ pale yellowish	*ruficornis*
	Body largely black	6
6.	Whole antennæ black, second abdominal segment yellow on the sides	*fera*
	Third segment of antennæ yellow, second abdominal segment not yellow on the sides	*velutina*

Pangonia dives Williston. The eyes are pilose, the antennæ are yellow with black at the apex of the third segment; legs reddish with apexes of tibiæ and tarsal segments more or less fuscous wings hyaline with costal border dilute yellowish, anterior branch of the third vein with a stump at the base; abdomen with the anterior part of each segment black, posterior part yellow. The yellow often predominates on the first three segments while I have not observed any variation of the remaining segments. Length about 15 millimeters.

It appears that Diatomineura californica Bigot is a synonym.

Pangonia fera Williston. The antennæ and legs in both sexes are black, and the abdomen is black with red on the sides of the second and often the third segments, and in the female especially the posterior border of each segment is fringed with yellow hairs; the eyes are naked and the wings are nearly hyaline with brown veins and stigma and dilute yellowish costal margin; ocelli present, thorax black with black pile. Length 12 to 18 millimeters.

Pangonia hera Osten Sacken. I have only seen the type of this species. Osten Sacken characterizes it as follows: "Proboscis short, hardly projecting beyond the palpi; body uniformly blackish-gray; wings grayish brown; eyes pubescent, first posterior cell open. Length 13 to 14 millimeters. The type locality is San Francisco, California.

Pangonia incisa Wiedemann. First posterior cell closed, legs and antennæ yellow, ocelli present, proboscis slender longer than the height of the head; wings uniformly yellowish; thorax dark in ground color and clothed with yellow pile. In the female the abdomen is black on the anterior part of each segment, and narrowly yellowish posteriorly; posterior margin also fringed with yellow hairs. In the male the abdomen is yellow with black beneath the scutellum, and a triangular black marking on the middle of the anterior half of the second segment. Length 14 to 17 millimeters. Specimens of both sexes are at hand from Oklahoma, received from Professor E. E. Bogue.

Pangonia ruficornis Bigot. What appears to be this species was received from Professor V. L. Kellogg, taken at Palo Alto, California, July 27. Eyes naked, ocelli present; face, front, antennæ and palpi yellow; proboscis brownish, thickened, scarcely longer than the slender palpi; thorax reddish yellow, legs concolorous with the thorax, wings with a yellowish tinge, more pronounced on the costal margin; anterior branch of the third vein with a stump at base. Abdomen yellow. Has the appearance of being a very distinct species. Length 12 millimeters.

Pangonia saussurei Bellardi. I have a single male specimen that I have identified from Bellardi's descrlption and figure as this species. The specimen was taken in the Huachucas Mountains of southern Arizona by Dr. R. E. Kunze. The antennæ are yellow, third segment slender, quite prominent at the base, proboscis longer than the height of the head, palpi short and slender, eyes naked, ocelli present. Thorax brown, clothed with gray pollen and brown and gray pubescence; legs brown, anterior and middle tibiæ and tarsi a shade lighter than their femora; wings dilute yellowish hyaline, with yellowish more distinct along the costa and margins of some of the veins; a long stump at the base of the anterior branch of the third vein; first posterior and anal cells closed. Abdomen in general grayish, with the anterior margin of each segment brownish; posterior margin of each segment with white hairs, remainder of segments clothed with black hairs. Length 18 millimeters.

Very distinct from the other species of the genus from our fauna, but with some affinities with incisa.

Pangonia velutina Bigot. I have not seen this speceis. Some characters which Bigot gives are as follows: antennæ yellow with first two segments black, eyes naked, first posterior cell of wing open, abdomen black, second segment with a large yellowish spot on the middle of the posterior border. Length 11 millimeters. The type is from California.

Silvius Meigen.

Members of this genus are widely distributed, being found on nearly all the large land areas of the globe. Our three species are western, none of them having been taken on the Atlantic coast, but quadrivittatus has been collected several times on the gulf coast of Texas. In North America the genus is divided into two distinct groups, gigantulus belonging to one and the remaining species to the other. The following key is offered as an aid in separating them:

1. Wings hyaline, without spots, yellowish along the costa; whole body yellowish ... *gigantulus*
   Wings hyaline, usually spotted; whole body gray pollinose ... 2
2. Abdomen above with four longitudinal rows of spots ... *quadrivittatus*
   Abdomen above with two longitudinal rows of spots or none ... *pollinosus*

Silvius gigantulus Loew. Length 10 to 13 millimeters. Although this one is very distinct in coloration from the other American species of the genus the generic characters are the same in all. It has the appearance of vituli of Europe, the wings are uniformly colored, being hyaline with the exception of the costal border which is yellowish, the antennæ are yellowish with the third segment except the extreme base dark brown, two small spots on the face, a triangular frontal callosity and ocelli dark brown, remainder of the face and front, rear of the head, and thorax covered with yellow pollen and yellow pile. The abdomen is yellow with a dark spot beneath the scutellum and a spot of the same color on the anterior middle of the second segment and in some specimens there is an irregular middorsal black stripe running the whole length of the abdomen. The male is colored like the female.

Silvius pollinosis Williston. The specimens that fall in this and quadrivittatus are variable and it is usually a difficult matter to make satisfactory determinations. The character which I have given in the key above, namely: the arrangement of the dark coloration on the abdomen may be used but even this is variable. In this one the color may be in two series, or these two series may be united to form a middorsal rather wide band, or lacking altogether. In some specimens the abdomen is yellow on the sides and in others not. The wings usually have prominent black markings on the cross-veins and at the furcation of the third vein and the stigma is black. The male is colored like the other sex, and has as many variations, although it appears to be more often yellow on the sides of the abdomen. Length 8 to 11 millimeters. Type from western Kansas.

Silvius quadrivittatus Say. This species was placed in the genus Chrysops when its description was written by Say and was not recognized by Osten Sacken when he published his Prodrome, and Williston made no comparison with it when he descried pollinosus. However the latter author, in the Tenth Volume of Transactions of the Kansas Academy of Science, recognizes both species and says of quadrivittatus: "The species differs from pollinosus in being darker throughout, in the antennæ being more slender, in the dorsum of the thorax having gray stripes on a black ground, and in the four abdominal stripes being better marked." Type from "Near the Rocky Mountains." Male colored like the other sex. Length 7 to 10 millimeters.

Apatolestes Williston.

Specimens belonging to this genus look some like members of the genus Tabanus, but have spurs at the apex of the posterior tibiæ, a character which places it in a different subfamily from that to which Tabanus belongs. The genus was described by Dr. Williston in 1885.

Apatolestes comastes Williston. In a long series of specimens of the species from California and Arizona, most of them collected by Coquillett, I find some variations. The size varies from 8 to 17 millimeters. Some specimens are quite black while others are gray from being covered with dense gray pollen and some of the males have reddish on the sides of the second and third abdominal segments. The first two segments of the antennæ are usually covered with gray pollen while the last segment is black and ocelli are prominent in both sexes. In the female the front is rather wide and, differing from many species of its subfamily, is narrowest at the vertex and gradually widens toward the face. There is some variation but in most specimens there is a narrow pollinose space just above the antennæ, after which the whole front is mostly shining black.

Apatolestes eiseni Townsend, from Lower California seems to be a synonym.

Snowiellus n. gen.

Front rather wide, narrowest at the vertex and gradually widening toward the antennæ. Antennæ inserted beneath the middle of the eyes, proceeding from beneath the swollen subcallus, first segment normal on upper side but strongly produced downward, second segment small, third segment elongate somewhat enlarged at the base but with only an indication of a basal process. All the tibiæ enlarged and the hind pair distinctly ciliate outwardly. Anterior branch of the third vein without a stump at base, its distal end meeting the costa at the first third of the distance from where the second vein meets the costa to the apex of the wing.

Snowiellus atratus n. sp. General color black with the extreme apex of the wing hyaline. A gray pollinose patch beneath the antennæ, otherwise the face including the cheeks, and the front below to above the frontal callosity denuded and shining black; above the frontal callosity and connected with it by a narrow interval is a nearly rectangular shining black spot, otherwise the front is covered with dark gray pollen. No ocelli. The third segment of the antenna appears slightly reddish caused it seems by a covering of grayish pollen, slightly enlarged at base but not with a distinct basal process, basal annulus as long or a little longer than the other four taken together; second segment small with a few black hairs at the anterior upper angle; first segment of normal form above but strongly produced below making it appear almost as though the second segment is attached to its side, furnished above and below with short black hairs; legs black ,all of the tibiæ enlarged but not so much as in Lepidoselaga lepidota, hind pair with a dense row of cilia on the outer side. Wings black with the exception of apexes of the first and second submarginal cells which are clear hyaline. The line of union of this hyaline and the black forms a strong curve, and at no point is the hyaline wider than the fourth of the total length of the second submarginal cell. Abdomen uniform blue-black above and below. Length 13 millimeters.

A female taken in Oak Creek Canyon, Arizona, in August, 1904, by Dr. F. H. Snow for whom the genus is named.

The insect has affinities with both the genera Selasoma and Bolbodimyia but does not fall in either. It is an interesting species and a splendid addition to the known North American fauna.

Hæmatopota Meigen.

A genus of nearly fifty species widely distributed in the Eastern Hemisphere but represented by only two speices in the Americas. The peculiarly enlarged first antennal segment and the wide transverse front are characteristic.

Hæmatopota americana Osten Sacken. The two known American species are both found in the United States, but only this one is western. It is larger than punctulata of the eastern states, and in the specimens before me the third antennal segment, although somewhat compressed in both, is wider and shorter in punctulata. Osten Sacken states that americana is closely related to pluvialis of Europe and has published his results of a comparison of the two. There are only a few specimens of punctulata in collections so the opportunity for a careful comparison of our two species has not appeared.

Tabanus Linne.

Some authors have considered the species here included under this one genus as belonging to three genera. The species with pilose eyes and ocelligerous tubercle are put in Apatolestes, those with pilose eyes and without the ocelligerous tubercle in Atylotus and the others with naked eyes and no ocelligerous tubercle form the genus Tabanus. A large number of the species from the region covered by this papar fall into Apatolestes and are the hardest to characterize so others can recognize them. They look much alike and it would seem sometimes that species are made on meager characters, but a study of European species of the genus convinces one that the older authors have done the same thing, and moreover when one studies our own forms he gradually comes to the same conclusion that the Europeans evidently have, that is, it is practically impossible to characterize a species at all when so many points are considered as only variations of the same.

It is my purpose that this paper supplement Osten Sacken's Prodrome, therefore some of the species that occur almost as far west as the Rocky Mountains may not be considered while some that are rightly eastern species are included because they are not treated by Osten Sacken.

The following key is offered as an aid for separating a most difficult group:

1. Eyes naked ... 2
   Eyes pilose ... 13
2. Large species, abdomen uniformly black or brown ... 3
   Smaller species, abdomen bicolored ... 6
3. Wings with a dark spot at the furcation of the third vein ... 4
   Wing without dark coloration at the furcation of the third vein ... 5
4. Thorax covered with white pollen or down ... *punctifer*
   Thorax brown with narrow white stripes ... *benedictus*
5. Wings black ... *atratus*
   Wings subhyaline ... *ægrotus*
6. Wings with large brown patches ... *venustus*
   Wings hyaline ... 7
7. Abdomen brown with white posterior margin to each segment ... *annulatus*
   Abdomen not so marked ... 8
8. Abdomen with a uniform white stripe from the scutellum to the end of the abdomen ... *lineola*
   Abdominal markings not in the form of a uniform band ... 9
9. Abdomen with a middorsal row of unconnected white triangles ... 11
   Abdomen not so marked, small species, not more than 12 millimeters in length ... 10
10. Abdomen gray, with four small black spots on each of segments two to six ... *cribellum*
    Abdomen with three irregular gray stripes composed of contiguous spots, base of anterior branch of the third vein with a long oblique stump ... *productus*
    Abdomen black with a very narrow white border to each segment, and on either side a row of very small white spots ... *fratellus*
11. General color of abdomen brown ... *flavidus*
    General color of abdomen black ... 12

12. White triangle on the second abdominal segment of the same size as on the third and fourth segments. Length about 13 millimeters *coffeatus*
White triangle on the second abdominal segment much smaller than those on the third and fourth segments. Length about 15 millimeters *hyalinipennis*

13. Palpi clear black, general color of the whole body black 14
Palpi yellowish 15

14. Costal cell dark brown *procyon*
Costal cell hyaline *sequax*

15 A single narrow transverse brown band across the eye, no ocelligerous tubercle *insuetus*
No such band across the eye, ocelligerous tubercle usually present 16

16. Whole body shining black, if there are gray spots on the abdomen there is no red ground color beneath them. Ocelligerous tubercle denuded *osburni*
Whole body not black, or if so the subcallus not denuded; sometimes black with red ground color beneath the gray abdominal spots 17

17. Each abdominal segment black with a wide irregular gray border, wings dilute brownish *zonalis*
Abdomen not so marked, wings hyaline or nearly hyaline 18

18. Abdomen with a wide middorsal brown stripe and on either side of it a gray stripe of about equal width. *dodgei*
Abdomen not so colored 19

19. Abdomen largely black with hree rows of white spots, often with red ground color beneath the lateral spots 20
Abdomen broadly red on the sides; this color not usually in the form of spots 30

20. Antennæ black, or at most with a trace of reddish at the base of the third segment 21
Antennæ largely red 26

21. Wing with distinct fuscous on the margins of the cross-veins and on the furcation of the third vein. 22
Wing with at most only a trace of fuscous on the margins of the cross-veins and furcation of the third vein 24

22. Subcallus not denuded in the female *illotus*
Subcallus denuded in the female 23

23. Venter of the abdomen largely red *centron*
Venter of the abdomen black, covered with gray pollen *rhombicus*

24. Wings reddish hyaline, lateral abdominal spots usually rounded *septentrionalis*
Wings clear hyaline, lateral abdominal spots angular and oblique 25

25. Base of the anterior branch of the third vein with a stump *opacus*
Base of the anterior branch of the third vein without a stump *itensivus*

26. Basal part of the third segment of the antenna fully as wide as long *laticornis*
Basal part of the third segment of the antenna longer than wide 27

27. No red beneath the lateral gray abdominal spots *gilanus*
With red beneath the lateral gray abdominal spots 28

28. Head distinctly wider than the thorax *laticeps*
Head not noticeably widened 29

29. Base of the anterior branch of the third vein with a stump *frenchii*
Base of the anterior branch of the third vein without a stump *susurrus*

30.	Antennæ black, or at most with a trace of red at the base of the third segment	31
	Antennæ largely red	33
31.	Subcallus denuded	*centron*
	Subcallus not denuded	32
32.	Wing with brown clouds on the cross-veins and the furcation of the third vein	*sonomensis*
	Wing with no clouds on the cross-veins and furcation of the third vein	*phænops*
33.	Front of the female unusually wide above, distinctly narrowed anteriorly	*captonis*
	Front of the female not unusualiy wide, sides nearly parallel	34
34.	Third antennal segment fully as broad as long	*laticornis*
	Third antennal segment longer than wide	35
35.	Costal cell brown	36
	Costal cell hyaline	37
36.	Palpi robust	*epistatus*
	Palpi slender	*affinis*
37.	Head decidedly wider than the thorax	*laticeps*
	Head not noticeably widened	38
38.	Base of the anterior branch of the third vein with a stump	*frenchii*
	Base of the anterior branch of the third vein not with a stump	*susurrus*

Tabanus ægrotus Osten Sacken. Easily identified by Osten Sacken's description. It appears some like our eastern atratus, but the wings may be said to be subhyaline instead of black as in that species. Usually the whole body is black, but in some specimens the abdomen above has a median row of very small white triangles, one on the posterior border of each segment.

Tabanus affinis Kirby. There is some variation in the extent of red on the abdomen. This seems to occur in specimens from the same locality to the same extent as in specimens from different localities. Its size, fifteen to nineteen millimeters, makes its determination rather easy, as it is the largest of our species with pilose eyes. Some specimens of affinis and some of sonomensis are rather close together, but the third segment of the antennæ is narrower in sonomensis and the basal process less prominent. The palpi are very slender in affinis.

Tabanus annulatus Say. Rarely collected and probalby there is not more than a dozen good specimens in the collections of the country. The front is narrow and the frontal callosity and what in other species is called the spindle shaped line, unite to form a very narrow raised line of nearly uniform width reaching nearly to the vertex, eyes naked, a small ocelligerous tubercle. Thorax uniform gray, abdomen brown with a gray posterior border to each segment; wings hyaline. Length 12 to 14 millimeters. Taken as far west as Kansas and Missouri. The species is one of the anomalies of its family.

Tabanus atratus Fabricius. Its large size and black color serve to separate this species from all others of the western region. Taken as far west as Colorado.

Tabanus benedictus Whitney. A large species related to nigrescens of the eastern states. The first posterior cell of the wing is closed or nearly closed. The front is rather narrow, narrowest anteriorly, the frontal callosity before almost as wide as the front, gradually narrowed, about twice as long as wide, and connected behind with a narrow line which extends to near the last third of the front. Abdomen dark brown, pruinose, resembling the abdomen of the common atratus. Length nearly 25 millimeters. Specimens from Louisiana. The types were taken in Missouri.

It is not properly a western species in the sense of this paper, but is included because it has been described only recently, and therefore is not mentioned in papers treating eastern species.

Tabanus captonis Marten. In his bibliography of North American Dipterology Dr. Williston has omitted Marten's paper entitled "New Tabanidæ" in the Canadian Entomologist XI, 210, and in his paper "Notes and Descriptions of North American Tabanidæ" published in Trans. Kan. Acad. of Sci. he did not mention the four species described therein, although he mentions all the species described in Marten's other paper. It would appear that the first paper was omitted through oversight. At any rate, I believe that Williston's comastes is synonymous with Marten's captonis. The species has somewhat the aspect of affinis, but the female is easily known by its very wide front, gradually narrowed anteriorly, and the denuded subcallus.

The male is like the female. The antennæ are red with the exception of the apical portion of the third segment which is more or less black. the frontal triangle is covered with silvery white pollen.

Tabanus centron Marten. As stated under rhombicus I consider this equivalent to Osten Sacken's second form of rhombicus. The subcallus is denuded, the antennæ are black with base of third segment red, and in some specimens the two basal segments are reddish with short black hairs. There is no stump at the base of the anterior branch of the third vein, and the wings are hyaline with costal cell yellowish and faint clouds on the margins of the cross-veins and furcation of the third vein. In some specimens the abdomen is reddish on the sides of the first three or four segments. The male is colored like the female. Length 16 to 17 millimeters.

Tabanus coffeatus Macquart. A dark colored species measuring 12 to 13 millimeters in length. Taken in many of the eastern states and as far west as Colorado. Each abdominal segment is black with a white posterior border which expands into a prominent triangle on the middle of the dorsum. Very distinct from all western species but much like small specimens of melanocerus from the eastern states.

Tabanus cribellum Osten Sacken. I have seen Townsend's types of guttatulus in Kansas University collection, and have compared with Osten Sacken's figure of cribellum. It is my opinion that the two are synonyms and as the latter name is the older it would stand for the species.

The eyes are naked, the antennæ reddish with the annulate portion of the third segment black and about the length of the basal. Wings hyaline, abdomen gray with four brown markings on each segment. These markings may be united in varying ways. Length about 10 millimeters.

Specimens from Mesilla Park, N. M., taken by T. D. A. Cockerell. As I understand it, Osten Sacken's types were taken in northern Mexico, only a few miles from where Townsend procured his specimens.

Tabanus dodgei Whitney. There are two conspicuous white stripes on the thorax separated by a wider dark brown stripe, which in most specimens is divided for the anterior half of its length by a very narrow white line. Exterior to the white stripe on each side is a dark stripe followed by gray on the pleura. The abdomen is marked by a rather narrow dark brown stripe on the median line, followed by a gray stripe of about equal width on either side, and these followed by obscure brownish on the outer margins. First two segments of antennæ red, third black with basal prominence rounded. The male is colored like the female in all details. The head in both sexes is rather small and flattened so that the longitudinal diameter is shorter than in most other species of its size. Length 14 to 16 millimeters.

It is a very distinct species and cannot be confused with any others of our fauna. A number of specimens taken at Onaga, Kansas, by F. F. Crevecœur, who has sent me much interesting material.

Tabanus epistatus Osten Sacken. This species averages much smaller than affinis, but small sized specimens of the latter are much like the larger ones of epistatus. A good character for separating the two species may be seen in the palpi. In affinis these are long and slender while in the latter they are robust. The antennæ are usually red with the annulate portion of the third segment black. However, there is some variation but in all the specimens I have studied the base of the third segment is invariably red. The subcallus is often denuded; length 13 to 17 millimeters.

The larger specimens, which I cannot separate from the others by any constant character, agree in detail with Marten's description of californicus. Therefore I am of the opinion that the latter should be considered a synonym.

Tabanus flavidus n. sp. Female: Length 12 to 14 millimeters. Eyes naked, antennæ red with annulate portion of the third segment black, second segment with a few black hairs above, basal portion of the third segment angulate above, widest at first third of its length and gradually narrowing to the beginning of the annulate portion; subcallus covered with gray pollen, front rather narrow, narrowest before; frontal callosity dark brown, occupying the whole width of the front, nearly square and connected above with a narrow line which reaches half way to the vertex; an indication of an ocelligerous tubercle. Usual parts of front covered with gray pollen. Face and cheeks covered with gray pollen, beard white, palpi yellowish with short white hairs. Proboscis shorter than the length of the head. Thorax fuscous with the usual gray stripe, sides and sternum covered with white hairs. Upper side of front femora, apex of each front tibiæ, front tarsi and last three or four segments of other tarsi fuscous, other parts of legs red. Wings hyaline, stigma and veins clear brown, anterior branch of the third vein with a stump. Abdomen light brown above with posterior borders of segments and mid dorsal row of triangles gray. On the sides of the segments and on the last three segments above there are indistinct fuscous areas, and in some specimens there are faint indications of lateral rows of small grayish spots. Venter red, darker, almost fuscous at apex.

Specimens collected by Dr. R. E. Kunze in southeastern Arizona and by C. H. T. Townsend in Chihuahua, Mexico; the latter the property of the U. S. National Museum. I have received specimens of this species labelled "T. sodalis Williston." Tabanus sodalis was described without locality but a study of the types convinces me that the name is synonymous with T. trispilus Wied. The specimen to which the name sodalis was originally given was taken in White Mountains, New Hampshire.

The reddish or brownish color is characteristic of flavidus.

Tabanus fratellus Williston. Very easily known from its resemblance to pumilus of the eastern states. The whole body is dark colored, the abdominal segments have narrow gray posterior margins, and on each side of segments 1–6 is a similarly colored small round spot, which does not touch either margin. The basal part of the third antennal segment is narrower than in pumilus. Eyes naked. Length about 10 millimeters.

I have received specimens of this species from Miss Ricardo who studied Bigot's type, with the statement that they are identical with the type of Bigot's Diachlorus (?) hæmatopotides. The latter name is therefore a synonym of T. fratellus.

Tabanus frenchii Marten. I have before me several specimens which agree with Marten's description. This species with tetricus and susurus are described as having three rows of gray triangles on the abdomen and red antennæ with apical part of third segment black, which is a combination not often met with, but is found in the specimens here considered.

Tabanus gilanus Townsend. Whole body dark colored. Abdomen with a median longitudinal row of small gray triangles and on either side a row of oblique spots of the same color; otherwise black with very narrow gray posterior borders to the segments. The red on the sides of the abdomen found in so many species is lacking. Wings hyaline without stump on the anterior branch of the third vein. First two segments of the antennæ and base of third red, remainder black. Basal part of third antennal segment at widest point about as wide as the length of this part. In the United States National Museum are some specimens which have been compared with the type by Mr. Coquillett. Length 13 to 15 millimeters.

Tabanus hyalinipennis Hine. The eyes are naked. It has the aspect of trimaculatus but is smaller, wings hyaline without dark margins to the cross-veins, and with white triangular spots on the third and fourth abdominal segments. Length 15 millimeters. Specimens from Oak Creek Canyon, Arizona, taken by J. T. Lloyd and Dr. F. H. Snow.

Tabanus illotus Osten Sacken. The wings in this species may be said to be subhyaline, especially on the anterior part. Faint clouds on the cross-veins and furcation of the third vein. Antennæ with the third segment rather broad and reddish at the base. Basal annulus almost as broad as long, distinctly excised and with a well marked upper angle; apical portion black and distinctly shorter than the basal annulus. Legs black, somewhat lighter at bases of all the tibia. Length 12 to 14 millimeters. A northern species taken in Alaska and the Hudson Bay region.

Tabanus insuetus Osten Sacken. This appears to be a variable species. The size of the head and width of the front are variable; some specimens have a long stump on the anterior branch of the third vein, while in others there is no vestige of it. Other parts are variable and it would seem that more than one species is included under the name, but constant characters for separation appear to be lacking. As it now stands insuetus is separated from all western species by the presence of a single narrow brown stripe across the eye. This shows almost as well in dry as in living specimens. Length about 12 millimeters. Known from Alaska, British Columbia, Washington, Wyoming, Colorado, California, Nevada and Utah.

Tabanus intensivus Townsend. When Townsend described this species he compared it with gilanus which appears to be its nearest relative. The general color of the whole body is black clothed with gray pile. The abdomen has a median row of triangles, on each side of which is a row of oblique spots; wings hyaline with no stump on anterior branch of third vein. The antennæ are usually black but the first and second segments and even the base of the third may be obscure reddish. The third segment is rather narrow, basal part quite long, upper angle slightly prominent, annulate portion decidedly shorter than the basal portion. The form of the third antennal segment is sufficient to separate it from gilanus. The male is like the female in coloration. Length 14 to 15 millimeters. Reported from Colorado and New Mexico.

Tabanus laticeps n. sp. Female: Length 12 to 14 millimeters. Head distinctly wider than the thorax, eyes pilose; antennæ with first two segments and base of third red, remainder black; first segment rather large with upper anterior angle narrowly black, third segment rather long and narrow, basal prominence distinct, basal part slightly longer than annulate, front rather wide sides nearly parallel, frontal callosity dark brown, shining, narrowly connected with a prominent denuded spot above, ocellar area large, whole front thinly covered with gray pollen, and upper part with some dark hairs which are most numerous at the apex; face clothed with white hairs, palpi very light colored, with short white hairs. Thorax dark with about five narrow gray lines above, antealar callosity red, sides and sternum clothed with gray hairs; legs with all femora, tips of anterior tibiæ and nearly all the tarsal segments dark brown or black, otherwise red; wings hyaline with stigma and veins clear brown, no stump on the anterior branch of the third vein. General color of the dorsum of the abdomen black, gray as follows: a row of small dorsal triangles and on each side a row of prominent oblique spots with their bases on the posterior margins of the segments. In some of the specimens the black is largely replaced by red and in all the ground color beneath the lateral spots is red; venter of abdomen red with apex dark, or in some of the darker specimens a rather wide median fuscous band extends from base to apex.

Male: Length 12 to 14 millimeters. Like the female except the gray spots on the abdomen are smaller thus increasing the extent of the black.

Specimens collected by Mr. D. W. Coquillett and Sarah E. Harris, and others sent in by Professors V. L. Kellogg and Charles W. Johnson without collector's name.

Habitat, California and Washington. The wide head is characteristic of the species.

Tabanus laticornis n. sp. Female: Length 14 to 16 millimeters. Eyes pilose, antennæ red with the exception of the annulate portion and sometimes the apex of the basal portion of the third segment, which are black; first and second segments with rather coarse short black hairs above; basal portion of the third segment as wide as long, above abruptly widened to basal third and gradually narrowed to beginning of the annulate portion, below gradually curved. Front very gradually narrowed anteriorly, frontal callosity nearly square, scarcely as wide as the front, shining brown, with spindle shaped spot above; otherwise whole front including ocellar area and subcallus, covered with grayish yellow pollen. Face and cheeks covered with gray pollen and rather long white hairs; palpi white clothed with short white and black hairs mixed. A noticeable thing is that the hairs on the palpi in a number of species appear black from certain views while from other views the same hairs appear white. This seems to be the case here. Thorax black above thinly covered with gray pollen and with the usual gray stripes; sides and sternum with rather long white hairs. Legs in general red, anterior femora and tarsi and apex of tibiæ, basal half or more of middle and posterior femora and three or four distal segments of middle and posterior tarsi fuscous or black. Wings hyaline, stigma yellowish, also costal cell and narrow margins of some of the cross-veins dilute yellowish. Abdomen with a rather narrow dorsal black stripe on which is a row of small elongate gray triangles; lateral rows of spots large and red, largest on second segment and decreasing toward apex of abdomen; a fuscous patch on each segment outside of the rows of red spots. Venter red with apex and a midventral stripe, abbreviated in some specimens, black.

Male: Length 14 to 15 millimeters. Colored like the female, abdomen decidedly attenuated posteriorly. Third antennal segment not so wide as in the female.

Several specimens from Arizona and northern Mexico, those from the latter locality collected by C. H. Tyler Townsend.

Tabanus lineola Fabricius. This well known eastern species extends as far west as Utah and Colorado. The naked eyes are sufficient to separate it from the western species resembling it. Length 13 to 15 millimeters.

Tabanus opacus Coquillett. The female type of this species is dark colored with gray stripes on the thorax and three rows of gray spots on the abdomen. Wings hyaline with brown stigma, and a long stump on the anterior branch of third vein. Antennæ black with the first segment partially reddish; subcallus not denuded, legs black with basal half of front tibiæ and nearly all of the other tibiæ reddish. On the second and third segments of the abdomen the ground color beneath the lateral gray spots is reddish and there is also a suggestion of reddish on the sides of the second segment, but the latter is so small that it is hardly worth mentioning.

The male is colored like the female except the reddish on the sides of the first two abdominal segments is slightly more extended and there is a trace of reddish at the base of the third antennal segment. The stump of the anterior branch of the third vein is only suggested in this sex.

A number of specimens before me agreeing with the female type were collected in southern Idaho, Logan, Utah, by E. D.

Ball, and near Lander, Wyoming, by R. C. Moodie of Lawrence, Kansas. Some slight color variations occur, and in many specimens the antennæ are entirely black. The long stump is present on the anterior branch of the third vein in all the females.

Tabanus osburni n. sp. Female: Length 12 to 16 millimeters. General color of the body shining black. Eyes pilose, first and second segments of the antennæ black or they may be partly reddish, clothed with black hairs, third segment black except the base which is red, basal portion with a blunt prominence above, longer than the annulate portion. Subcallus denuded and shining black, frontal callosity shining black with unconnected mark above; ocellar area partly denuded black, remainder of front covered with gray pollen; face and cheeks clothed with gray pollen and dark yellowish hairs, palpi yellowish with short black hairs; thorax with inconspicuous narrow gray stripes above; pleuræ clothed with long gray pile. Legs black but bases of tibiæ showing a reddish tinge. Wings hyaline but with costal margin and narrow margins of cross-veins and furcation of third vein fuscous; these infuscations on the margins of the veins are less conspicuous in some specimens than in others. Abdomen black with three rows of faint gray spots above and the posterior margin of each segment both above and beneath with a fringe of rather long white hairs.

Male: Length 12 millimeters. Like the female except the grayish spots on the dorsum of the abdomen appear to be lacking, and the third segment of the antennæ is noticeably narrower than in that sex. This latter character is characteristic of this sex in a large number of species. The head is larger and nearer hemispherical than in the female.

A large number of specimens, most of them taken by Prof. R. C. Osburn, for whom the species is named. Known from British Columbia, Alberta, Montana, Washington and Alaska.

This species is some like rhombicus but more robust and no suggestion of red on the abdomen of either sex.

Tabanus phænops Osten Sacken. The antennæ are black, the wings are hyaline and the abdomen is broadly red on the side. Length 13 to 14 millimeters. Distributed from Alaska and British Columbia to California, and specimens are also at hand from Wyoming and Colorado. Osten Sacken fully described this species in his paper on ''Western Diptera'' and his description should be consulted.

Tabanus procyon Osten Sacken. The palpi, legs and antennæ, as well as the whole body, are black; the subcallus is denuded and shining black, the wings are hyaline except the costal cell, margins of cross-veins and furcation of third vein which are black. Length 13 millimeters. Known from California, and specimens are at hand from Eldorado collected by Sarah E. Harris.

The black palpi is a character it shares with sequax but the denuded subcallus and the black unspotted abdomen easily distinguish it. The costal cell is also much blacker than in the last named species.

Tabanus productus n. sp. Female: Length 11 millimeters. Antennæ black, first segment rather long and narrow, third not much excised above and with a small basal prominence; frontal callosity square, black and as wide as the front with unconnected square black spot above it; front rather wide slightly narrowed anteriorly and clothed with gray pollen; face and cheeks covered with gray pollen and white pile, palpi white with white bairs and also some that look black from certain views; eyes naked. Thorax dark with narrow gray stripes above and white pile on the sides and beneath; legs black except about one-third of front tibiæ and more than half of the other tibiæ which are white; wings hyaline with clear brown stigma and veins and with a long oblique stump at the base of the anterior branch of the third vein. This stump has a direction which is nearly parallel with the last section of the posterior branch of third vein. Abdomen dark with a middorsal gray stripe and on each side a series of somewhat oblique spots joining one another end to end, thus forming a stripe with the outer border serrate; posterior margins of the segments both above and beneath narrowly whitish.

Male: Length 11 millimeters. Colored in detail like the other sex; line of separation of large and small facets of the eye distinct.

Specimens taken near Lander, Wyoming, at an elevation of from 5000 to 7000 feet the past summer by R. C. Moodie of Lawrence, Kansas.

This species looks some like lineola but is smaller, the legs and antennæ are darker and the distinctive stump on the anterior branch of the third vein differs from what I have observed in that species.

Tabanus punctifer Osten Sacken. Distributed over a great deal of the western country, especially from Colorado to California and southward. The general black color of the body except the thorax, which is covered with white pile and the white base of the anterior tibiæ, makes it the easiest western species to distinguish. Length 19 to 22 millimeters.

Tabanus rhombicus Osten Sacken. Osten Sacken described this species in his "Prodrome" and later in his "Western Diptera" gave additional notes upon it. At the time of the latter writing, he had better material than when he first wrote, and from this material he characterized three forms, as he called them, which when arranged in series appear quite distinct from one another; and present characters by which in good specimens they can be separated readily.

T. rhombicus has been misdetermined by many and consequently exists under various names in American collections. The specimens used in this study of the species were compared with Osten Sacken's types and there are before me a long series of specimens agreeing with each of the three forms. Dr. John Marten has described some species of Tabanus in Vol. 14 and 15 of the Canadian Entomologist, which seem to correspond with these forms, and after collecting all available information and studying Marten's descriptions carefully, it appears to me that centron is the same as Osten Sacken's second form of rhombicus, and as the latter author did not propose any name, Marten's name remains valid.

Tabanus rhombicus has the subcallus denuded and no stump on the anterior branch of the third vein. General color of the whole body dark with only a trace of red on the sides of the second and third abdominal segments and three rows of gray pollinose spots. Wings hyaline with traces of fuscous on the borders of the cross-veins and at the furcation of the third vein. Length 13 to 15 millimeters. Specimens from Albany Co., Wyoming, collected by E. B. Williamson; from Estes and Manitou Parks Colorado, collected by Dr. F. H. Snow, and from southwestern Colorado, collected by E. J. Oslar.

Therioplectes (?) melanorhinus Bigot seems to be this species, judging from the re-description of Bigot's type Miss G. Ricardo has been so kind as to send me.

Tabanus septentrionalis Loew. This species is somewhat variable in size and coloration but does not appear to be a difficult one to recognize. The subcallus is not denuded; the gray triangles in the middle of the abdominal segments are united to form what may be called a dorsal stripe and on either side of this a prominent row of spots extends from the first to the sixth segment, one spot to each segment. The ground color beneath these spots is often, but not always red., The wings have a dilute yellowish tinge all over and the veins are brown but there is no distinct fuscous margins to the cross-veins or at the furcation of the third vein. Length 13 to 17 millimeters.

Tabanus sequax Williston. The palpi are black, costal cells hyaline, and the stigma and margins of the cross veins and furcation of the third vein are also black. On account of the black palpi the species can only be confused with procyon, and the other characters mentioned will separate it from that. Length 13 to 16 millimeters.

Thinking that Bigot's leucophorus was this species, I sent specimens to Miss G. Ricardo who compared with the type and verified my determination. In her letter she makes the following statement: "The specimen sent on comparison with the type is certainly identical; the type is a trifle larger and the dark hairs at the sides of the antennæ are not so black or so thick as in your specimen, and the forehead is not so dark."

The specimen I sent Miss Ricardo measures fully 16 millimeters in length. As Bigot gives the length of his type as 11 millimeters, we see how misleading his statements may be.

Tabanus sonomensis Osten Sacken. The antennæ are black or they may be dark red at base, the third segment is narrow with the basal portion longer than the annulate portion, and the basal prominence is small; the palpi are brownish yellow clothed with black hairs, the sides of the front in the female are nearly parallel, the abdomen is plainly red on the sides. The usual dorsal row of gray triangles may be seen in well preserved specimens but no lateral rows are apparent. The red on the sides of the abdomen is somewhat variable in extent, and the posterior margins of the segments are furnished with a fringe of yellow hairs. The wings are hyaline but many of the veins, especially the cross-veins and furcation of the third vein, are margined with fuscous.

The species is separated from rhombicus and its allies by the nearly complete absence of lateral gray spots on the abdominal segments; and from affinis by the narrower third antennal segment, as well as its smaller average size, from epistatus by the blacker antennæ, and from phænops by its larger average size and clouding of the cross-veins and furcation of the third vein.

The several males I have are colored like the females and easily associated with them, although the fringes of hairs on the posterior margins of the abdominal segments are not so conspicuous in this sex. Length 13 to 18 millimeters.

I consider hæmaphorus Marten a synonym of sonomensis.

Tabanus susurrus Marten. The antennæ are red with the annulate portion of the third segment black; the wings are hyaline but there are faint clouds on the margins of the cross-veins and at the furcation of the third vein. All the femora, the apex of each anterior tibia, and the anterior tarsi are black or dark brown, other parts of legs red, except darker coloration on some of the tarsal segments. The abdomen is red on the sides of the first three or four segments. Specimens from Wyoming collected by Morrison. Marten's type was from Montana. Length 13 millimeters.

Tabanus venustus Osten Sacken. This species is known from all others of its genus by the large irregular dark patches on the wings. Eyes naked. Length 14 to 16 millimeters. Taken as far west as Oklahoma.

Tabanus zonalis Kirby. This distinct species has the wings uniformly tinged with yellowish and the abdominal segments are black anteriorly and broadly yellowish posteriorly. The antennæ are red but the apex of the third segment may be black, palpi brown, all the femora, apex of tibiæ and anterior tarsi, black, remainder of legs red. Length 17 millimeters. Specimens from Mission Mountains, Montana, received from Prof. M. J. Elrod, and from Laggan, Alberta, collected by Prof. R. C. Osburn. Widely distributed in northern United States and Canada.

Species not Identified.

Tabanus tetricus Marten. This is colored something like rhombicus but with red antennæ. Described in Canadian Entomologist XV, 111.

Tabanus fuscipalpis Bigot. This description suggests T. sequax. Blackish palpi are not found in many species of its group. Mem. Soc. Zool. France V, 681.

Tabanus hirtulus Bigot. I do not recognize this species. It seems to be colored much like some of the darker specimens of sonomensis. The antennæ are black with a trace of red at the base of the third regment, the subcallus is not denuded and the anterior branch of the third vein bears a long stump. Mem. Soc. Zool. Fr. V, 641.

Tabanus maculifer Bigot. Agrees in many respects with phænops but has the subcallus denuded. I have never seen a specimen of phænops with this character. Mem. Soc. Zool. Fr. V, 641.

Tabanus villosulus Bigot. Must resemble the male of Apatolestes comastes Will. Mem. Soc. Zool. Fr. V, 684.

Diachlorus notatus Bigot. Suggests Silvius pollinosus and quadrivittatus. There are some specimens of these species with wings such as Bigot describes. Mem. Soc. Zool. Fr. V, 623.

List, Synonymy and Bibliography of Species Treated in This Paper

pangonia.

dives Williston, Tr. Kan. Acad. Sci. X, 130. From California.
  californica Bigot, Mem. Soc. Zool. Fr. V, 618. From California.
fera Williston, Tr. Kan. Acad. Sci. X, 130. From Oregon, Washington and British Columbia.
hera Osten Sacken, West. Dipt. 214. From San Francisco, California.
incisa Wiedemann, Auss. zweifl. Ins. I, 90. From Ark. Col. N. M., Oklahoma.
  incisuralis Say, Jr. Ac. Nat. Sci. III, 31; Compl. Writ. I, 75.
ruficornis Bigot, Mem. Soc. Zool. Fr. V, 615. From California.
saussurei Bellardi, Sag. Ditt. Mes. I, 49. From southern Arizona and Mexico.
velutina Bigot, Mem. Soc. Zool. Fr. V. 615. From California.

CHRYSOPS.

carbonarius Walker, List I, 203, Ricardo, An. Mag. Nat. Hist., Series 7, VIII, 303. From Me., N. H., Mass., Col., Wyo., N. J., N. C., Canada.
niger Walker (not Macq), List I, 202.
provocans Walker, Dipt. Saund. I, 73.
(?) *atra* Macquart, Dipt. Exot., Suppl. 4, 40.
fugax Osten Sacken, Prodrome I, 375. Williston Tr. Ks. Acad. Sci. X, 132.

ceras Townsend, Psyche VIII, 38. From New Mexico and northern Mexico.

coloradensis Bigot (in part), Mem. Soc. Zool. Fr. V, 605. Ricardo, Ann. Mag. Nat. Hist., Ser. 7, VIII, 307. From Col., Cal., and Washington.

coquillettii Hine. Described in this paper. From Colorado.

discalis Williston, Tr. Conn. Acad. IV. 245. From Wyo., Col., Mont. and Utah.

excitans Walker, Dipt. Saund. 72. Osten Sacken, Prodrome I, 373. From Me., N. H., Pa., Wash., B. C., Ills., Mass.

facialis Townsend, Psyche VIII, 39. From N. M. and Ariz.

frigidus Osten Sacken, Prodrome I, 384. Prodrome II, 474. Hine, Taban. Ohio 37. From N. H., N. Y., Mass., N. J., Ohio, Wash., British Possessions.

fulvaster Osten Sacken, West. Dipt. 221. Ricardo, An. Mag. Nat. Hist., Ser. 7, VIII, 306. From Col., Utah, Wyo., Ariz., N. M., Mont.
coloradensis Bigot (in part) Mem. Soc. Zool. Fr. V, 605.

furcatus Walker, List I, 199. Osten Sacken Prodrome I, 391. Ricardo, An. Mag. Nat. Hist. Ser. 7, VIII, 302. From N. Y., Montreal, Canada.

lupus Whitney, Can. Ent. XXXVI, 205. From Colorado.

mitis Osten Sacken Prodrome I, 374. From Mont., Wash., Montreal, Canada.

nigripes Zetterstedt, Ins. Lap. I, 519. Loew, Vehr. Zool. Bot. Ges. VIII, 623. Osten Sacken, Prodrome I, 394. Coquillett, Wash. Acad. Sci. II, 406. From Europe, Lapland and Alaska.

noctifer Osten Sacken, West. Dipt. 220. From Cal., Wash., Mont., Br. Col.
pertinax Williston, Tr. Ks. Acad. Sci. X, 132. Ricardo, An. Mag. Nat. Hist., Ser. 7, VIII, 307.
nigriventris Bigot, Mem. Soc. Zool. Fr. V, 604.

pachycera Williston, Tr. Ks. Ac. Sci. X, 134. Adams, Ks. Un. Sci. Bull. II, 442. From Cal. and Ariz.

pikei Whitney, Can. Ent. XXXVI, 205. From Missouri.

proclivis Osten Sacken, West. Dipt. 222. Ricardo, An. Mag. Nat. Hist. Ser. 7, VIII, 306. From California and Washington.
atricornis Bigot, Mem. Soc. Zool. Fr. V, 603.
pachycera Williston (male only) Tr. Ks. Ac. Sc. X, 134. Adams, Ks. Un. Sc. Bull. II, 442.

sequax Williston, Tr. Ks. Ac. Sci. X, 133. From Ks. and N. C.

surdus Osten Sacken, West. Dipt. 223. Williston, Tr. Ks. Ac. Sci. X, 134. From Cal., Or. B. C.

virgulatus Bellardi, Saggio Ditt. Mes. I, 71, tab. 2. fig. 17. Williston, Biol. Cent. Am. 1, 255. From Mexico.
geminatus Macquart (not Wiedemann), Dipt. Exot. Suppl. IV, 39.
crassicornis v. d. Wulp, Wien. Ent. Zeit. III, 141.

SILVIUS.

gigantulus Loew, Dipt. Am. Sept, ind. Part 10, No. 12. Osten Sacken, West. Dipt. 215, Catalogue of 1878, 226. From Cal., Wash., B. C., N. Mex., Col.
trifolium Osten Sacken. Prodrome I, 395.

pollinosus Williston, Tr. Conn. Ac. IV, 244. Tr. Ks. Ac. Sc. X, 131. From Ks., Col.

quadrivittatus Say, Jr. Ac. Nat. Sci. Phil. III, 33. Compl. Writ. II, 54. Wiedemann, Auss. Zweifl. Ins. I, 200. Osten Sacken, Catalogue of 1878, 226. Williston Tr. Ks. Ac. Sc. X, 131. From Cal., Neb., N. Mex., Texas.

APATOLESTES.

comastes Williston, Ent. Am. I, 12. Townsend, Tr. Ks. Ac. Sc. XIII, 134, From N. Mex., Cal., and Lower California.

eiseni Townsend, Pr. Cal. Ac. Sc., Ser. 2, IV, 596. Ricardo, An. Mag. Nat. Hist. Ser. 7, V, 99.

HÆMATOPOTA.

americana Osten Sacken. Prodrome I, 395. From Dak., Mont., Col., B. Col., Cal.

SNOWIELLUS n. gen.

atratus Hine, Described in this paper. From Arizona.

TABANUS.

ægrotus Osten Sacken, West. Dipt. 219. From Cal., Wash., and B. C.

affinis Kirby, Faun. Bor. Am. IV, 313. Osten Sacken, Prodrome II, 466. Kirby's description is republished in Can. Ent. XIII, 166. From northern U. S. and Canada from the Atlantic to the Pacific.

triligatus Walker, List V, 183.

annulatus Say, Jr. Ac. Nat. Sc. Phil. III, 32. Compl. Writ. II, 53. Osten Sacken, Prodrome Supl. 555. From Mo., Ky., Ga., Ks., La.

atratus Fabricius, Syst. Ent. 789. Ent. Syst. IV, 366. Bellardi, Saggio Dit. Mess. I, 58. Osten Sacken, Prodrome II, 454. From eastern U. S. as far west as Colorado.

niger Palisot de Beauvois, Ins. Dipt. 54, tab. I, fig. 1.

americanus Drury, Ins. I, tab. 44, fig. 3.

validus Wiedemann, Auss. zwei. Ins. I, 113.

benedictus Whitney, Can. Ent. XXXVI, 206.

captonis Marten, Can. Ent. XIV, 211. From Cal., Wash., Or., Br. Col.

comastes Williston, Tr. Ks. Ac. Sci. X, 137. Townsend, Tr. Am. Ent. Soc. XXII, 58.

centron Marten, Can. Ent. XIV, 211. From Col. and Wyo.

coffeatus Macquart, Dipt. Exot. Supl. 2, 23. Osten Sacken, Prodrome II, 441. From D. C., Del., N. Y., Fla., Mass., Ind., N. J., Col.

(?) *nigripes* Wiedemann, Dipt. exot. 1, 75; Auss. zwei. Ins. I, 142.

cribellum Osten Sacken, Biol. Cent. Amer. I, 52. From Mexico and New Mexico.

guttatulus Townsend, Tr. Ks. Ac. Sci. XIII, 134. Psyche VIII, 147.

dodgei Whitney, Can. Ent. XI, 37. From Ks. and Neb.

epistatus Osten Sacken, Prodrome Supl. 555. Hine, Tabanidæ of Ohio, 50. From N. J., Can., Col., Ohio.

socius Osten Sacken, Prodrome II, 467.

californicus Marten, Can. Ent. XIV, 210.

flavidus Hine, Described in this paper. From Ariz. and Mex.

fratellus Williston, Tr. Ks. Ac. Sc. X, 140. From Wash., Br. Col.

hœmatopotides Bigot, (Diachlorus?) Mem. Soc. Zool. Fr. V, 624.

frenchii Marten, Can. Ent. XV, 111. From Mon., Wyo.

gilanus Townsend, Psyche VIII, 92. From N. Mex.

hyalinipennis Hine, Can. Ent. XXXV, 244. From Oak Creek Canyon, Ariz.

illotus Osten Sacken, Prodrome II, 469. From Alaska and northern North America.

insuetus Osten Sacken, West. Dipt. 219. From Cal., Wash., Col., Nev., Alaska.
intensivus Townsend, Psyche VIII, 93. From N. Mex., Col.
laticeps Hine, Described in this paper. From Cal. and Washington.
laticornis Hine, Described in this paper. From Ariz. and Mex.
lineola Fabricius, Ent. Syst. IV, 369. Syst. Antl. 102. Osten Sacken, Prodrome II, 448. Biol. Cent. Am. I, 56. From eastern N. A. west to Col. and Utah.
(?) *scutellaris* Walker, Dipt. Saund. 27.
simulans Walker, List I, 182.
trilineatus (Latr.?) Bellardi, Saggio Ditt. Mess. I, 63
opacus Coquillett, Invert. Pacifica I, 21. From Nev., Utah, Wyo.
osburni Hine, Described in this paper. From B. C., Alaska, Mont., Wash.
phænops Osten Sacken, West. Dipt. 217. From Cal., Col., Wash., B. C., Alaska.
procyon Osten Sacken, West. Dipt. 216. From Cal.
productus Hine, Described in this paper. From Wyoming and Utah.
punctifer Osten Sacken, Prodrome II, 453. West. Dipt. 220. From western N. A. as far north as San Francisco.
reinwardtii Wiedmann, Auss. zweifl, Ins. I, 130. Osten Sacken, Prodrome II, 461. From eastern N. A. as far west as Colorado.
erythrolctus Walker, Dipt. Saund. 25, tab. 2, fig. 1.
rhombicus Osten Sacken, Prodrome II, 472. West. Dipt. 218, From Col., Wyo., Or., Wash., Mont.
melanorhinus Bigot, (Therioplectes?), Mem. Soc. Zool. Fr. V, 642.
septentrionalis Lœw, Verh. zool. bot. Ges. VIII, 592. Osten Sacken, Prodrome II, 467. From Labrador, Alaska, Wis., Quebec, Alberta, Dak., Wyo., B. C., White Mts., N. H.
sequax Williston, Tr. Ks. Ac. Sc. X, 137. From Ore., Wash., B. Col.
leucophorus Bigot, Mem. Soc. Zool. Fr. V. 640.
sonomensis Osten Sacken, West. Dipt. 216. From Cal., Wash., B. Col., Alaska.
hæmaphorus Marten Can. Ent. XIV, 210.
susurrus Marten, Can. Ent. XV, 111. From Mont., Wyo.
venustus Osten Sacken, Prodrome II, 444. Hine, Tabanidæ of Ohio 56. From Texas, Okl. Ks., Ohio.
zonalis Kirby, Faun. Bor. Am. IV, 314. Republication of Kirby's description in Can. Ent. XIII, 167. Osten Sacken, Prodrome II, 463. Catalogue of 1878, 56 and 226. Townsend, Tr. Am. Ent. Soc. XXII, 58. From northern U. S. and Canada.
flavocinctus Bellardi, Sag. Ditt. Mess. I, 61. Osten Sacken, Catalogue of 1878, 226.
tarandi Walker, List I, 156.
terræ-novæ Macquart, Dipt. Exot. Suppl. 4, 35.

NOTES FROM THE OHIO STATE HERBARIUM. I.

H. A. Gleason.

Hypericum boreale (Britton) Bicknell. In 1891 N. L. Britton* made brief mention of this interesting St. John's-wort, regarding it as a variety of *Hypericum canadense* L. In 1895 E. P. Bicknell discussed its relationships in a comprehensive paper in the same journal†, in which he raised the plant to specific rank and showed that its affinities were with *Hypericum mutilum* L. rather than with *Hypericum canadense*. He credits it with a range from Maine and Nova Scotia westward through Canada and south in the mountains into Pennsylvania and New Jersey.

Two plants collected by O. E. Jennings at Geauga Lake, August 22, 1903, and one sheet from Defiance County in the State Herbarium under *Hypericum mutilum* are referable to this species. Its occurrence in two so widely separated counties suggests that it may be found to have a wide distribution over central and northern Ohio, and warrant the publication of a note calling attention to the characters by which it is separated from *Hypericum mutilum*, which in general appearance it closely resembles.

The two species are distinguished most easily by the character of the bracts, which in *Hypericum mutilum* are awl-shaped, and 1–2 mm. long. In *Hypericum boreale* they are foliaceous, elliptic, three-nerved, and from 2–6 millimeters long, the lower being the the largest. Also in *Hypericum mutilum* the mature capsules are ovoid, about 3 mm. long; the seeds oblong, about .2 by .4 mm., while in *Hypericum boreale* the capsule is ovoid-oblong, 4 mm. long; the seeds oblong, .2 by .6 mm.

Hypericum boreale also occurs still farther west in Wells County, Indiana, where it was first collected by Mr. Charles C. Deam, of Bluffton. It is found there abundantly in peat bogs, in company with *Triadenum virginicum* (L.) Raf., *Sarracenia purpurea* L., *Campanula aparinoides* Pursh, and other characteristic bog plants. Defiance County, Ohio, is not far from the Indiana station. The specimens from Geauga County were growing in a bog also, as is shown by the plants of Sphagnum moss clinging to their roots. It probably occurs in most of the peat bogs throughout the state.

Camelina microcarpa Andrz. was collected for the second time in Ohio by Prof. W. A. Kellerman at Columbus. It was found in great abundance by a roadside near the city. The only other known station is at Painesville, Lake County.

* Bull. Torr. Club. 18 · 365. † ibid. 22 :211-215

Cichorium intybus divaricatum D. C. was collected by S. E. Horlacher in Montgomery County in 1903. It differs from the species in having some or all of the heads on stout, divaricately spreading peduncles about 6 cm. long.

Gomphrena globosa L. is another commonly cultivated plant which has escaped from cultivation. It was collected in 1901 by Professor Kellerman at Bowling Green, Wood County, where it was growing along a roadside.

Thlaspi arvense L. This introduced crucifer has hitherto been listed only from Hamilton, Lucas and Cuyahoga Counties, indicating a rather limited distribution in the state. Mr. E. F. Lantz has recently given a specimen to the State Herbarium with the report that is it an abundant weed in Henry and Fulton Counties.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, Oct. 3, 1904.

President Sanders called the meeting to order. The program for the evening consisted of reports on the summer's work.

Prof. Hine reported the occurrence of about thirty-five species of mammals in the state, one of the bats being new. Prof. Prosser reported the completion of his work in Kansas and Maryland. The summer's work has shown that the rocks of the Lower Helderberg or Waterlime in Ohio are much older than has been supposed. The exact geological position of the rocks and faunas about Sandusky was also determined. Prof. Osborn spoke of his work on the Hemiptera of Ohio and New York, several forms having been found which will probably prove new. Prof. Schaffner reported nutation in six species of plants not previously noted; also work on nodding tips of plants and on Myxomycetes of Clay Co., Kansas. Mr .York reported thirty-six species of plants as new to the Cedar Point list, Fraxinus biltmoreana being new to the state.

J. E. Hyde, *Sec. pro tem.*

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OUR SMALLEST CARNIVORE.*

ALBERT A. WRIGHT.

On the 23d of January, 1904, there was brought to me a diminutive weasel in full white winter pelage. It was captured alive by Mr. Clarence Metcalf upon his farm four miles south of Oberlin. It was in a corn field and was chased out from one of the shocks of corn, where it may have gone in pursuit of the rodents that habitually pilfer the grain. It was accompanied by a second specimen, of similar size, but of a brown color above, with some white on the under parts. This one escaped and could not be critically examined.

The white one was without any visible spots of brown or black upon it. Even the black tip of the tail which characterizes most weasels, both in their winter and summer pelage, is wanting. A careful examination with a lens, however, will show that there are a few darker hairs present. The vibrissæ and the few long hairs of the eyebrow are of an inconspicuous brown color. The ghost of a spot an eighth of an inch across, consisting of a few submerged brown hairs can be detected upon the crown of the head. At the tip of the tail about ten distinctly black hairs can be counted, concealed by the more abundant white. There is no evidence of a brush of longer hairs at the end of the tail. The

* Read before the Ohio State Academy of Sciences, Nov. 26, 1904.

sex of the specimen is male, as was ascertained at the time it was mounted. It measured just six inches (152 mm.) in length for the head and body; the tail one inch, or, including the longest hairs, an inch and a quarter, making the total length seven and a quarter inches (184 mm.). In size this is the smallest of the weasels, and therefore of the carnivores.

The nomenclature of the weasels has been in great confusion for several reasons. The animals are nowhere very abundant, and the collections have been rather meager and carelessly made. The great disparity in size between the sexes makes the positive determination of the sex an essential matter in order to interpret correctly the measurements. The most thorough revision of the species is that of Mr. Outram Bangs,† published in 1896. Up to that date there were only two species recognized as belonging to our northern Ohio region, namely:

The New York Weasel, *Putorius noveboracensis* Emmons.

Bonaparte's Weasel, *P. cicognani* (Bonaparte).

The New York Weasel has a total length in the male of sixteen inches, and in the female of thirteen inches. Bonaparte's weasel measures eleven inches in the male and nine inches in the female. Both of these species have black tips to their tails both summer and winter. It is clear, therefore, that our specimen can not belong to either of the commonly recognized species.

In the year 1901, Mr. Samuel N. Rhoads published‡ a description of a much smaller species from a few specimens taken in the vicinity of Pittsburgh, Pa., giving it the name of *Putorius allegheniensis*. Our specimen agrees in dimensions with this species, and falls in with two other specific characters which may be mentioned, viz:, (1) the tip of the tail is never black, but of the same color as the rest of the body. (2) the two sexes are essentially of the same size.

Hitherto only seven specimens of this Alleghenian weasel have been brought to the notice of scientific men and placed on record in publications. These were all from Washington and Allegheny counties in Pennsylvania, and Jefferson county, Ohio. Six of these specimens were exhibited together at the February meeting of the Pittsburgh Academy of Science and Art, by Mr. Frederic S. Webster, who gives an account of the meeting in the issue of Science for May 27th last. Our specimen constitutes the eighth and extends the range of the species towards the shores of Lake Erie.

It is hardly possible that this should be so rare a species as the present figures would indicate. Other specimens have doubt-

† A Review of the Weasels of Eastern North America, by Outram Bangs. Proc. Biol. Soc. Washington Vol X, pp. 1–24, Feb., 1896.

‡ Proc. Acad. Nat. Sci. Phila. for 1900. Issued Feb. 7, 1901. Also Rhoads, Mammals of Penn. and New Jersey p. 173. 1903.

less been taken, but in the formerly confused condition of the nomenclature they may have been considered as immature, or as females of Bonaparte's weasel. But since the publications of Bangs and Rhoads there should be no further difficulty in separating them from all other species. Careful collecting, with measurements made in the flesh, the sex determined, and the skulls cleaned and preserved, are necessary in order that the distribution of this species may be correctly determined. The principal object of this notice is to suggest the need and the value of much additional work upon the entire group of weasels.

Fig. 1. Putorius allegheniensis Rhoads.

It remains to be stated that, as Mr. Rhoads observed when he first described the Pennsylvania specimens, the characters of *P. allegheniensis* agree essentially with those of *P. rixosus* of Bangs, a species whose type locality is Osler, Saskatchewan, and whose distribution is "Arctic and boreal America from Alaska south at least to Saskatchewan and Moose Factory."* The justification for the publication of the species *allegheniensis* must lie wholly in the fact that there is so vast a gap of territory between the Saskatchewan and the Pittsburgh region, crossed by one or two life zones, in which *P. rixosus* is not known to occur. The

* Bangs, loc. cit. p. 21

task before collectors is to show whether this territorial gap cannot be filled in; and if it is filled in, to ascertain whether the southern specimens have even a varietal difference from the northern type *rixosus*. The crowding of the mandibular incisors so that the second one is forced to take a position posterior to the others, which has been noted in some of the southern specimens, "can be found in many examples of any species"* and accordingly cannot be diagnostic of any one. Unless some substantial difference is found, the name *allegheniensis* will ultimately have to retreat, and all the specimens be called *rixosus*.

However, while this task is in progress, we may very properly make the most of this rare and beautiful addition to our local fauna, and let the designation stand as *allegheniensis*.

* Bangs, loc. cit. p. 12. The second lower incisors are so displaced in the Oberlin specimen.

Oberlin, O.

A LAND PLANARIAN IN OHIO.*

L. B. Walton.

The Land Planarians form a subdivision of the class Turbellaria which together with the Trematoda (parasitic flukes), and Cestoda (tape worms) constitute the phylum Platyhelminthes or flat worms. With a very few exceptions the planarians living a terrestrial life are tropical forms, only 7 of the 348 species now known to science being found in the palæartic (European subregion) and neartic regions. Of these a single species, excluding *Platocephalus kewensis* an introduced form occuring in hot houses, has been described from the United States. This species, *Rhynchodemus sylvaticus*, was established by Leidy in 1851 based on five specimens collected in Philadelphia.

The occurence of a species of Rhynchodemus at Gambier, Ohio, differing in many particulars from the form to which Leidy called attention is in consequence of considerable interest. Five representatives of this species were found on the partially decayed stem of a virginia creeper July 9, 1904, near Bexley Hall. A somewhat more extended study and a comparison, if possible, with the type of *R. sylvaticus* will undoubtedly show the relationship between the two forms.

* Read before the Ohio State Academy of Science, Nov. 26, 1904.

Kenyon College, Gambier, Ohio.

THE LIFE CYCLE OF A HETEROSPOROUS PTERIDOPHYTE.

JOHN H SCHAFFNER.

The Heterosporous Pteridophytes represent the highest stage of development in the second or intermediate series of plants. The term heterosporous is applied to plants in which there are two kinds of nonsexual spores, large and small, called respectively megaspores and microspores. This peculiar spore condition is also present in the seed plants. The megaspore always gives rise to a female individual and the microspore to a male. In the lower Pteridophytes there is only one kind of nonsexual spores and they are, therefore, called homosporous. The Homosporous Pteridophytes should be kept distinct from the Heterosporous, since the development of heterospory represents one of the advancing waves of evolution which brought about profound changes in the character of the vegetation of the earth. The elimination of chance environment in the development of unisexual individuals by predetermining the sex in the spore and the reduction in the size of the gametophytes appear to have been necessary conditions in the evolution of the seed plants.

The living species of Heterosporous Pteridophytes fall into six genera, the remnants of former extensive and dominant groups. The total number of species is about 635, somewhat more than the living Gymnosperms which constitute the next higher subkingdom. Because of their position as the lowest of heterosporous plants a thorough knowledge of their morphology and life history is necessary to a proper understanding of the structures and processes found in the Gymnosperms and Angiosperms. Nevertheless, much of their life history is still obscure and various statements rest on conjecture or imperfectly established facts.

The living Heterosporous Pteridophytes are small herbaceous perennials or rarely annual plants, usually not more than a few inches high. They are quite insignificant when compared with their ancient relatives some of which developed into great trees. The six living genera are named as follows: Azolla, Salvinia, Marsilea, Pilularia, Isoetes, and Selaginella. Selaginella is, however, a very complex genus. Azolla and Salvinia are small floating plants; Marsilea and Pilularia are creeping geophilous forms usually in wet places; Isoetes, known popularly as quillwort, grows in wet or swampy ground and has a short, upright, usually simple rhizome with grass-like leaves; Selaginella has very small leaves on branching herbaceous stems which grow either horizontal or erect in wet ground or sometimes in dry places subject to periodical moisture. These plants are usually placed in the classes and orders of the Homosporous Pteridophytes, but since they represent a very important advance in the plant kingdom.

a stage or step taken in several independent lines and by all the higher groups, it seems best to put them together in a sub-kingdom of their own.

The relationship of some of the included fossil forms is still imperfectly understood on account of the absence of properly preserved sporangia. The following orders are usually recognized:

1, Calamariales; 2, Sphenophyllales; 3, Salviniales; 4, Marsileales; 5, Isoetales; 6. Lepidophytales; 7, Selaginellales. The first, second, and sixth orders named above are entirely fossil. These seven orders fall naturally into five classes which may be designated as follows: Calamariæ, Sphenophylleæ, Hydropterides or water ferns including the Salviniales and Marsileales, Isoeteæ or quillworts and Selaginelleæ, including the Selaginellales and the fossil Lepidodendrids Sigillarids and other genera belonging to the sixth order.

The Hydropterides are the only plants among the Heterosporous Pteridophytes that are leptosporangiate. In this respect they are similar to some of the homosporous ferns. The resemblance, however, does not extend much farther and it is not probable that they are a branch from the homosporous leptosporangiate ferns. The fossil record indicates that the water ferns are much the older group. It might be stated that the term leptosporangiate refers to the origin of the sporangium which in these plants originates from an epidermal cell instead of from hypodermal tissue as in all other higher plants. The Selaginellas are probably descended from the primitive Lycopods but the quillworts show no evident relationship to any known homosporous forms.

Heterosporous Pteridophytes appear in the first known land flora, but these forms were not primitive types; for the primitive floras have either not been discovered or else have left no fossil trace of their existence. There is some evidence that members of this sub-kingdom were present in the Ordovician period; but however that may be they are definitely found in the Silurian and became very important in the Devonian. They culminated in the Carboniferous, which from a botanical point of view might be called the age of Heterosporous Pteridophytes. The coal swamps were full of great tree forms belonging to the genera, Lepidodendron, Sigillaria, Calamites, and others. These plants formed the larger part of the material preserved as coal and were therefore of great economic importance for the future welfare of man. They declined during the Permian and very few appear to have survived the great disturbance known in American geology as the Appalachian revolution. These plants were essentially moisture-loving and when the great changes occurred which mark the transition from the Paleozoic to the Mesozoic they seem to have been unable to adapt themselves to the new condition of things. The next higher subkingdom, the Gymnosperms, became the dominant group of plants.

In tracing out the life cycle, Selaginella kraussiana will be taken as a representative with incidental references to other types. There is, of course, a well-marked alternation of generations, the gametophyte and the sporophyte, and each generation usually leads an independent existence for at least a part of its life. The conspicuous plant is the sporophyte or nonsexual generation. It consists of a more or less dorsiventral leafy shoot

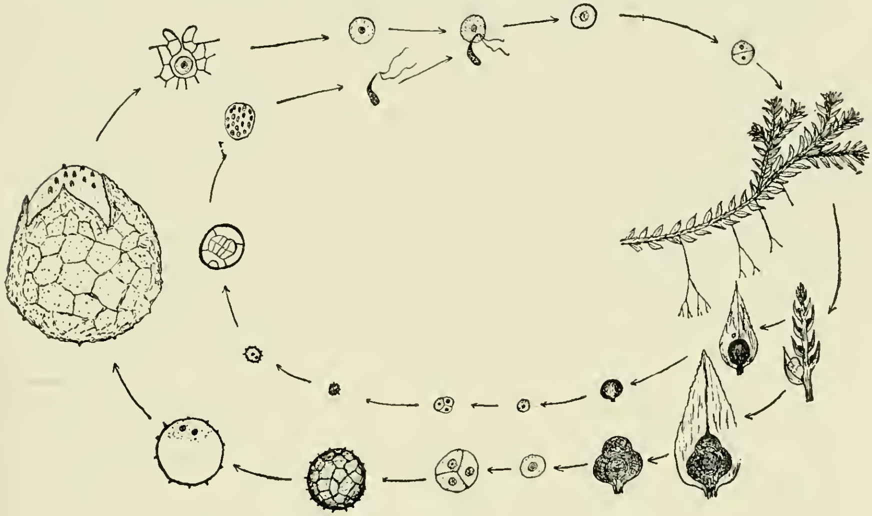

Fig. 1. Diagram of Life Cycle of Selaginella.

from the lower side of which dichotomously branched roots grow out. The roots strike ground usually after growing an inch or more in length. In this plant there is no increase in thickness of the stem but some Heterosporous Pteridophytes do grow considerably in thickness by the development of the general tissue but not by a true cambium layer. The vascular bundles are concentric with the xylem in the centre. The stem usually has two bundles side by side each contained in a tubular cavity or air space and connected with the walls of the cavity by means of numerous slender filaments. Other types have a different stem structure.

After attaining a considerable size the sporophyte begins to reproduce by developing cones or primitive flowers at the ends of some branches. The cones are bisporangiate, having two sets of sporophylls which are but slightly differentiated from the ordinary foliage leaves. The two kinds of spore-bearing leaves are called megasphorophylls and microsporophylls. There are numerous microsporophylls in each cone but usually only one megasporophyll which is the lowest one of the set. The microsporophyll has a single microsporangium on the upper side in the axil and the megasporophyll also produces but one megasporangium in the same position. In some of the other classes the two kinds of sporangia may be on the same leaf or leaf segment, which may be closed up like the ovulary of a carpel. The microsporangium and megasporangium produce the nonsexual spores, the microspores and the megaspores. The spores are produced in the following manner: In the microsporangium there are a number of cells called microsporocytes which become free in the cavity by the dissolution of their walls. Each microsporocyte divides twice giving rise to four cells. These cells develop into the microspores. During the first division of the microsporocyte the chromosomes of its nucleus are reduced so that the nuclei of the spores have only one-half as many chromosomes as were present in the nuclei of the sporophyte or nonsexual plant. The megasporangium also contains a number of megasporocytes which divide in the same way as the microsporocytes and form a spore tetrad. During the first of the two divisions the chromosomes are also reduced from the $2x$ number to x. The chromosomes are small bodies which appear in the nucleus during division and are probably special bearers of hereditary tendencies. These reduction divisions of the sporocytes are of great importance in the life cycle of the plant because of the profound changes which take place in the chromosomes. Only four megaspores develop and they become so large that the megasporangium bulges out and becomes somewhat four-lobed. In Marsilea only one megaspore develops in each megasporangium. The difference in size between microspore and megaspore in Selaginella kraussiana is very great. The ratio in volume in the mature condition is often more than 1 : 2000. The small spore having only a limited amount of cytoplasm and very little room for food material, always produces a male gametophyte when it germinates; while the megaspore always produces a female gametophyte. The determination of the sex is apparently not primarily an inherited character but depends on the environment during the early stages of embryonic development. Thus as stated above, the Heterosporous Pteridophytes by producing a difference of environment in the spore are able to keep the two sexes distinct. Since there are no hermaphrodite individuals there is no possibility of self-fertilization. This is true for all plants which have developed heterospory. The ripe sporangia open by vertical slits and the spores are thus discharged. In Azolla the microspores are imbedded in a foamy mass of substance called a massula on which peculiar anchor-like appendages are developed. In Marsilea the sporocarp or modified leaflet containing the sporangia, after being soaked for some time in water, opens in a very peculiar way by the protrusion of a gelatinous ring containing the sori. This process represents an extreme specialization and adaptation to a semi-aquatic life.

In Selaginella kraussiana the spores germinate sometime before they are discharged. The microspore has divided into two cells and the female gametophyte has developed to a considerable extent. This is a very interesting condition, since it represents one stage toward the development of seed plants in which the spores are not discharged and the gametophytes are completely parasitic in the sporangia. In some Selaginellas the cones with the sporangia and spores are shed.

The gametophytes are very small especially the male. The vegetative part of the male thallus is represented practically by a single cell. The remaining cells developed inside of the spore wall represent the antheridium or spermary. In some of the Heterosporous Pteridophytes the antheridium breaks through the microspore wall, in others the spermatozoids escape through the break in the wall, no part of the male thallus protruding. The cells of the antheridium are differentiated into peripheral or wall cells and two masses of central cells from which the spermatozoids are developed. The spermatozoids are very small and have two flagella. In the quillworts and water-ferns the spermatozoids are multiciliate. Externally the male gametophytes of most Heterosporous Pteridophytes look very much like the pollen-grains of the seed plants with which they are homologous.

The female gametophyte projects somewhat beyond the megaspore wall. It begins its development by free cell formation and later a layer of cells is formed in one side of the spore. This breaks through the spore wall and a number of archegonia or ovaries are produced, but the greater part of the spore cavity is filled with irregular vegetative cells. The female thallus is destitute of chlorophyll and is dependent upon the food laid up in the spore. In Marsilea the female gametophyte is much more reduced having only a single archegonium whose neck projects from one end of the megaspore. In its older stages the female gametophyte may develop some chlorophyll. Each archegonium as usual contains a single oosphere or egg which has been formed by the division of a mother cell. The sister cell of the egg, called the ventral canal cell, always dissolves. This small female gametophyte is homologous with the so-called embryosac of the seed plants.

While the gametophytes are lying on damp ground, and when covered with water, fertilization is accomplished. In some Selaginellas, however, fertilization occurs while the megaspores containing the female gametophytes are still in the megasporangium. The spermatozoids swim through the water and enter the necks of the archegonia. So far the Selaginellas are still dependent on an aquatic condition. When a spermatozoid reaches the egg its nucleus unites with the egg nucleus and as a result there is a double amount of chromation in the fertilized egg. When the oospore germinates its nucleus produces twice as many chromosomes as were present in the cells of the parent gametophytes. This conjugation or fertilization stage, therefore, represents the second profound change in the life cycle of the plant and is just opposite in its results to the reduction division.

The oospore is the first cell of the sporophyte generation. It is not discharged but begins to divide by a transverse wall. The outer cell develops into a suspensor while the inner gives rise to the embryo proper. In other classes the embryogeny is quite different and there seems to be much difference in the embryogeny of different Selaginellas. In the water ferns the development of the embryo is much the same as in the homosporous ferns.

The embryo is pushed down into the centre of the mass of food cells in the lower part of the female gametophyte by the rapid growth of the suspensor. It develops a foot, root, and stem tip with two small leaves called cotyledons. The foot occupies the cavity of the megaspore and takes up the food stored there. The root grows out, passes down into the ground, and begins to take up water with dissolved mineral salts. The stem with the cotyledons grows upward, develops chlorophyll, and thus begins the manufacture of food. The embryo changes gradually from a phagophyte, nourished entirely by the female parent, to a holophyte, manufacturing its own food from the simple compounds taken from the earth and air. It also passes gradually from the enclosed condition to the external world, there being no such sudden change as the embryo undergoes during the sprouting of a seed.

The little embryo sporophyte, having established relationships with the moist soil, air, and sunlight, continues to develop into a mature plant while the female gametophyte, its mother, dies. The gametophytes are short lived and are so reduced in body that their life consists mainly in accomplishing the important process of fertilization and in assisting the sporophyte to get a proper start during its early and helpless, juvenile stage.

ACTINOLOPHUS MINUTUS A NEW HELIOZOAN, WITH A REVIEW OF THE SPECIES ENUMERATED IN THE GENUS.*

L. B. Walton.

While examining late in October some sediment in a jar containing *Hydra fusca* collected September 17, 1904, in the Kokosing River, attention was attracted by a small stalked form of heliozoan like appearance. This (Fig. 1), a single example of which was observed, on more careful study proved referable to the genus Actinolophus (Heliozoa) the representatives of which are not met with frequently, none to the knowledge of the present writer having thus far been noted in America.

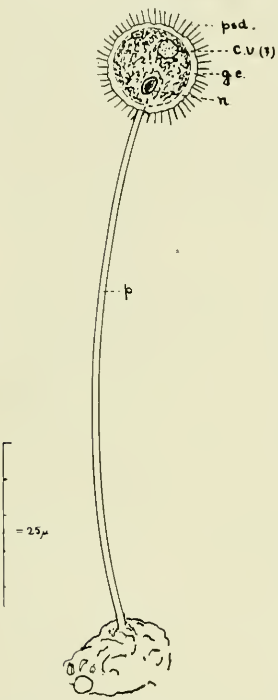

Fig. 1. Actinolophus minutus n. sp. (x 1000), psd.—pseudopodia, c. v.—contractile vesicle (?), p.—pedicle, g. e.—gelatinous envelope, n.—nucleus.

Although there is considerable uncertainty as to the exact relation of the species constituting the group to the other Protozoa, the characteristics of the form in question appear to merit record, differing as it does from *A. capitatus* Penard through the absence of knobbed pseudopodia as well as in its much smaller size, and from *A. pedatus* (Zach.) by the spherical form of the body which is ovoid in the latter and much larger than the body of *A. minutus*.

Schulze, 1874, formed the genus Actinolophus for the reception of *A. pedunculatus* a marine form from the Baltic Sea described by him. Penard 1890, described *A. capitatus* from a single individual suggesting its close relationship with the tentacliferous infusoria (Suctoria). Zacharias, 1893, in a brief description, called attention to a new Heliozoan, *Actinosphæridium pedatus* which Schaudinn, 1896, in his monograph of the Heliozoa, placed provisionally in the genus Actinolophus, recognizing for that genus three species, two of which were of doubtful value. Penard, 1904, in his valuable monograph of the fresh water Heliozoa, mentions both *A. capitatus* and *A. pedatus* among forms whose position is doubtful, suggesting possible affinities with Tokophrya and Nuclearia, noting at the same time the desirability for further

* Read before the Ohio State Academy of Science, Nov. 26, 1904.

study. Until a better knowledge is obtained of their affinities however, it seems advisable to consider them under the genus Actinolophus.

The following summarizes our present knowledge of the group and indicates the position of *A. minutus* in respect to the other species

Genus **Actinolophus,** Schulze.

1874 *Actinolophus*, F. E. Schulze, Arch. mikr. Anat. v. 10, p. 392.
?1893 *Actinosphæridium*, O. Zacharias, Forschungber Plon, v. 1, p. 15.
1896 *Actinolophus*, Schaudinn, Das Tierreich, Heliozoa, Berlin.

Body spherical or oval, provided with a pedicle the length of which is usually much greater than the diameter of the body. Body generally (always?) provided with a gelatinous envelope through which the fine pseudopodia are extended. Nucleus excentric, contractile vacuole (?).

The following table will serve to separate the forms:

A^1 Pseudopodia not knobbed at the extremity.
  B^1 Pedicle 3–4μ in diameter, marine forms, *A. pedunculatus*
  B^2 Pedicle not more than 2μ in diameter, fresh water forms,
    C^1 Body ovoid, diameter 18μ, length 23μ, *A. pedatus*
    C^2 Body spherical, diameter 12μ *A. minutus*
A^2 Pseudopodia knobbed at extremity diameter 30μ, fresh water forms, *A. capitatus*

1. **A. pedunculatus,** Schulze, 1874 *A. p.* F. E. Schulze, Arch. mikr. Anat., v. 10 p. 392 f. 1–9. 1896 Schaudinn, Das Tierreich, Heliozoa, Berlin, p. 11.

Length of body, up to 30μ, length of pedicle up to 100μ, diameter of pedicle 3–4μ.

Marine, Baltic Sea.

2. **A. pedatus,** (Zach.) 1893 *Actinosphæridium pedatum*, Zacharias, Forschungber. Biol. Stat. Plon., v. 1 p. 15, f. 9a, 9b. 1896 ? *Actinolophus pedatus*, Schaudinn, Das Tierreich, Heliozoa, Berlin, p. 11. 1904 ? *Actinosphæridium pedatum*, (? *Nuclearia caulescens*), (? *Tokophrya*), Penard, Les Heliozoaires d'eau douce, p. 318.

Length of body 23μ, diameter 18μ, length of pedicle 11–30μ, diameter 1.7μ. Body provided with a thick gelatinous envelope from which extends extremely fine and rather short pseudopodia. Nucleus oval, situated in the inferior part of the body. Contractile vesicle not known. Color pale yellow, individuals occasionally agglomerated by their bodies into colonies.

Fresh water, Germany.

Zacharias placed A. pedatus in a new genus Actinosphæridium on the basis that it differed from Actinolophus by possessing, in the encysted condition, plates covering the body. Schaudinn enumerates it among the doubtful species of Actinolophus, while Penard refers it back to Actinosphæridium, at the same time calling attention to its remarkable similarity to Nuclearia and to Tokophrya.

3. **A. minutus**, n. sp.

Body spherical, diameter 12μ including gelatinous envelope approximately 1μ thick. Length of pedicle 70μ, diameter 1μ. Extremely fine short pseudopodia of about 2μ in length extend beyond the envelope on all sides. Nucleus suboval situated in the inferior part of the body. Contractile vesicle (?). Base of pedicle (in the form studied) imbedded in a gelatinous mass 10–12μ in extent containing small algæ, etc.

Gambier, Ohio, U. S. A.

A single specimen observed Oct. 29, 1904, in sediment from an aquarium jar containing *Hydra fusca*, the entire contents of the jar having been collected Sept. 13, 1904, in the Kokosing River at Gambier and subsequently covered with a glass plate for the purpose of preventing too rapid evaporation. The form was under observation at intervals during a period of four hours.

4. **A. capitatus,** Penard. 1890 A. c. Penard, Jahrb. nassau. Ver., v. 43 p. 16 t. 1 f. 11. 1896 A. c. Schaudinn, Das Tierreich, Heliozoa, Berlin, p. 12. 1901 A. p. Sand, Etude monographique sur le groupe des Infusorres tentaculiferes, Ann. Soc. Belge de Microscopie. 1904 A. c. Penard, Les Heliozoaires d'eau douce, Geneva, p. 316.

Diameter 30μ, length of pedicle 90μ. Nucleus (?). Contractile vesicle, Pseudopodia few in number, knobbed.

In fresh water, Germany.

Penard described this species in 1890 from a single individual referring it to the genus Actinolophus although noting its close relationship with the tentaculiferous infusoria. Sand, 1901, in his study of that group came to the conclusion that *A. capitatus* was nearer related to the Heliozoa than to the Suctoria for the following reasons, (a) the pedicle resembles that of *Clathrulina elegans*, (b) the pedicle does not penetrate into the gelatinous envelope as in *Tokophrya limbata* one of the Suctoria, (c) the nucleus is excentric, (d) the species closely resembles *A. pedunculatus*. Penard, 1904, in his paper on the fresh water Heliozoa, after having examined several more specimens which he remarks are exceedingly rare, insisted on the suctorian nature of the form, maintaining that the points raised by Sand have little value. Penard at the same time suggests the desirability for a further study of the form. Consequently it seems advisable at present to allow it to remain in the genus Actinolophus.

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Kenyon College, Gambier, Ohio.

NOTES FROM THE OHIO STATE HERBARIUM. II.

H. A. Gleason.

An Aronia New To Ohio. *Aronia atropurpurea* was described by Professor N. L. Britton in 1901 from Staten Island, and credited with a range from Nova Scotia to Florida, which is now extended west to this State. It is distinguished from *Aronia nigra* by the tomentose lower surface of the leaves, and from *Aronia arbutifolia* by the dark purple subglobose fruit. Specimens of it are in the State Herbarium from the peat bog on Cranberry Island in Buckeye Lake, Licking County, where it was also collected by Mr. J. F. Clevenger in October, 1904. The color of the fruit is so much like that of *Aronia nigra*, with which it is associated at Buckeye Lake, that the species may be easily overlooked by collectors.

Cassia Medsgeri Shafer. Everyone is familiar with the common Senna, *Cassia marilandica* L., but few would have suspected that the name covered two distinct species. Mr. J. A. Shafer has just described * the species whose name precedes this paragraph and which has been hitherto included with *C. marilandica*, and has shown for it a wide range from Pennsylvania south to Georgia and west to Iowa, Kansas and Arkansas. His descriptions, which are quite detailed, show a number of differences between the species, but one of them, easily distinguishable at flowering time, is so prominent that attention may be called to it here. The ovary of *C. marilandica* is densely pilose with long gray hairs, which stand out at right angles, and give it an apparent diameter of about 3 mm. In *C. medsgeri* the hairs are sparse, much shorter, and ascending or appressed to the ovary. This character alone is sufficient to separate the two species immediately, and can be seen easily in herbarium specimens. The pods of *C. medsgeri* are arcuately curved, and scarcely dehiscent; the seeds about 2 by 4 mm., while those of *C. marilandica* are about 4 by 5 mm. These dimensions are taken from Mr. Shafer's article, as there are no specimens with mature pods in the State Herbarium. No Ohio localities are given in the list by Mr. Shafer but an examination of *C. marilandica* in the State Herbarium shows five sheets referable to the new species, from Ottawa, Franklin, Washington, Stark and Monroe counties. Unfortunately, none of the labels gives any information as to its habitat, but according to Mr. Shafer it grows in dry gravelly situations.

* Torreya 4: 177, December, 1904.

MAT PLANTS.

JOHN H. SCHAFFNER.

Mat plants are plants with numerous prostrate branches which are usually closely crowded and form a more or less circular body a few inches to eight or more feet in diameter. This prostrate discoid body habit is quite characteristic of a small number of plants belonging to various families. Among the most typical mats may be mentioned Amaranthus blitoides Wats., Portulaca oleracea L., Euphorbia maculata L. and Euphorbia serpyllifolia Pers. Mats are usually annual plants either of the ordinary herbaceous type or very fleshy. There are, however, a number of geophilous perennials which form mats, like Verbena bracteosa Mx. The main radiating branches usually give rise to numerous smaller branches and they may or may not strike root. In the more typical cases there are no roots except the main central root. Mats are especially characterized by having a large number of small leaves, seeds, and flowers. These peculiarities, of course, harmonize with the shape and position of the plant.

Like most ecological groups, mat plants intergrade with other types of body habit. On the one hand they pass over into such forms as Malva rotundifolia L., Callirrhoe involucrata (T. and G.) Gr., Citrullus citrulus (L.) Karst., and the typical carpet plants; and on the other, transitions occur between them and tumbleweeds or even normally erect forms. Although it is not intended to give a definition here of carpet plants, yet, since the terms mat and carpet are often used synonymously, it might be stated that typical carpets are perennials with numerous trailing branches or runners which take root at the nodes and develop low tufts of leaves or rosettes, finally forming a close low covering of the ground. Among this type of carpet plants may be mentioned the buffalo-grass, Bulbilis dactyloides (Nutt.) Raf., and the various species of Antennaria.

Mat plants are at home in open and exposed places where there is little or no individual crowding. They are abundant on prairies and appear extensively on newly plowed land. On newly broken prairie they are usually the most characteristic vegetation. They are also prominent on dry or moist sandbars, on salt marshes, and in cultivated fields.

Nearly all typical mats, when growing in shaded places, assume the upright habit. But it is especially interesting to note that normally erect plants may assume the mat habit in a suitable environment. One of the most striking cases is the slender pigweed, Amaranthus hybridus L., which is usually erect and often attains the height of eleven feet. This plant when growing on exposed dry or moist sandbars frequently develops as a mat, without a central stem but with a number of prostrate radiating branches. Sometimes there is a central erect stem a few inches high with long prostrate branches radiating in all directions from the base. The same form has been seen by the writer on sandhills in central Kansas. So peculiar is the appearance that one hardly recognizes the plant in its new form. Eragrostis purshii Schrad. and Diplachne acuminata Nash also form mat-like bodies when growing on sandbars. On exposed broken ground various normally erect, ascending, or decumbent plants also form mats. Noteworthy among these are Echinochloa crus-galli (L.) Scrib., Eragrostis major Host., and Cenchrus tribuloides L. In salt marshes of the interior one meets with fleshy mat plants like Sesuvium sessile Pers. Sesuvium martimum (Walt.) B. S. P is common on the sands of the Atlantic coast. Dondia depressa (Pursh) Britt. is also a fleshy halophyte which commonly assumes the mat form on the salt marshes of Kansas.

It should not be difficult, with suitable physiological experiments, to determine the ecological factors which induce the formation of mats. Intense light and unobstructed space appear to be very important. The wind may have some influence. Water supply appears to have little or no effect. Thus Eclipta alba (L.) Hassk. was observed to form perfect mats on very wet exposed sandbars but in shaded situations a little distance away it grew entirely erect, some plants being three feet high.

The Ohio plants named below are either typical mats or develop as mats under proper conditions. The more typical species are marked with an x.

Echinochloa crus-galli (L.) Beauv.
Chætochloa glauca (L.) Scrib.
Cenchrus tribuloides L.
Eragrostis major Host.
Eragrostis purshii Schrad.
Polygonum aviculare L. x
Polygonum littorale Link. x
Amaranthus hybridus L.
Amaranthus blitoides Wats. x
Mollugo verticillata L. x
Portulaca oleracea L. x
Alsine media L. x
Euphorbia polygonifolia L. x
Euphorbia serpens H. B. K. x
Euphorbia maculata L. x
Euphorbia humistrata Engelm. x
Euphorbia nutans Lag.
Verbena bracteosa Mx.
Spermacoce glabra Mx.
Diodia teres Walt.
Eclipta alba (L.) Hassk.

PLANTS WITH NODDING TIPS.

JOHN H. SCHAFFNER.

In the plant kingdom are to be found many peculiar adaptations. One of the most interesting is the habit which some species have of keeping the growing tip curved downward during the period of development or until the stem has attained its growth for the season. This curving of the tip of the stem appears much like the arch commonly developed in sprouting seedlings but must be for a different purpose.

Fig. 1. Solidago canadensis showing nodding tips.

The nodding of the growing tip is strikingly seen in such plants as Solidgo canadensis (Fig. 1) and Asimina triloba. Some species of a genus may nod while others show no sign of a curve in the stem tip. Thus Gaura parviflora nods very strongly while Gaura biennis, it appears, does not nod at all. In most cases the curve is quite rigid but in some the nodding is merely the result of the flexibility of the stem. A few species have the tips nod at night but become nearly straight in the daytime. Whatever the cause or factor which induces plants to nod, there is probably no doubt but that the habit is a means of protection to the delicate terminal bud.

Species with Rigid Nodding Tips.

Salix cordata Muhl.	Vitis vulpina L.
Ulmus americana L.	Ampelopsis cordata Mx.
Ulmus fulva Mx.	Parthenocissus tricuspidata(S.& Z.)Pl.
Asimina triloba (L.) Dun.	Gaura parviflora Dougl.
Albizzia julibrissin Boiv.	Solidago canadensis L.
Vitis labrusca L.	Erigeron philadelphicus L.

Species with Flexible Tips.

Tsuga canadensis (L.) Carr.	Juniperus communis L.

Species with Tips which Nod at Night.

Cassia chamæcrista L.	Euphorbia nutans Lag.

BRUSH LAKE ALGAE.

Lumina C. Riddle.

The following list of Algæ was identified from material collected at Brush Lake, Champaign Co., O., during the Fall of 1902. In addition to the species included in the lists published by Dr. Kellerman in his "Proposed Algological Survey of Ohio," Ohio Nat. 2: 219–223; by A. J. Pieters in "Plants of Western Lake Erie;" Bull. U. S. Fish Comm. 1901; 57 79; Julia W. Snow, "Plankton Algæ of Lake Erie;" Bull. U. S. Fish Comm. 1902; 369–394; and in the writers' list of "Algæ from Sandusky Bay," Ohio Nat. 3: 317, there were found seven new species for the state. These are indicated by the letter "n" after the name. The nomenclature is that used in DeToni Sylloge Algarum.

RHODOBACTERIACEÆ.

Thiocystis violaceæ Weinogradsky. n.

BEGGIATOACEÆ.

Beggiatoa alba(Vaucher) Trevisson.

CHROOCOCCACEÆ.

Chroococcus turgidus Kuetz. & Næg. n.
Gomphosphæria aponina Kuetz.
Merismopedia glauca (Ehrenb(Næg.
Merismopedia convoluta Breb.

OSCILLATORIACEÆ.

Oscillatoria frœlichii Kg.
Oscillatoria elegans Ag.
Oscillatoria limosa Ag.
Microcoleus lacustris (Rabenh) Farlow. n.

NOSTOCACEÆ.

Nodularia spumigena Mertens.
Anabæna flos-aquæ Breb.

TETRASPORACEÆ.

Botryococcus braunii Kuetz.

CLADOPHORACEÆ.

Cladophora declinata fluitans(Kuetz) Hansg.

VOLVOCACEÆ.

Pandorina morum (Muell) Bory.
Spondylomorum quaternarium Ehrenb.

PLEUROCOCCACEÆ.

Rhapidium aciculare (A Br) Rabenh.
Rhapidium convolutum (Corda) Rabenh.
Scenedesmus bijugatus (Turp) Kuetz.
" quadricauda(Turp) Breb.
Tetrædron enorme(Næg) Hansg.

SORASTRACEÆ.

Cœlastrum microporum Næg.
Cœlastrum cambricum Archer.

HYDRODICTYACEÆ.

Pediastrum boryanum(Turp) Menegh.
Pediastrum tetras (Ehrenb) Ralfs.

DESMIDIACEÆ.

Desmidium aptogonium (Kuetz) Lagerh.
Hyalotheca dissiliens (Smith) Breb.
Closterium acerosum Ehrenb.
" ensis Delph. n.
" lunula (Muell) Nitzsche.
" parvulum Næg.
" moniliferum (Bory) Ehrenb.
Closterium liebleinii Kuetz
Pleurotænium trabecula (Ehrenb) Næg.
Cosmarium nitidulum DeNot.
" margaretiferum (Turp) Menegh.
" botrytis(Bory) Menegh.
" brebissonii Menegh.
" biretum Breb.
Staurastrum incisum Wolle. n.
" leptocladium Nordst. n.
" fusiforme Wolle. n.

KEY TO THE OHIO HICKORIES IN THE WINTER CONDITION

LOUIS H. SCHOLL.

Hicoria Raf. Large trees with hard, heavy and very tough wood; twigs very tough, with alternate leaf scars, not 2-ranked, without stipular and self-pruning scars; bundle scars scattered, sometimes in three areas; terminal bud present, large; bud scales usually numerous and imbricate or valvate and few, but at least 3 exposed, pubescent, sometimes peltate pubescent; axillary buds superposed or apparently single, not clustered at the tip of the twig; pith solid and 5-angled; fruit a nut with a husk.

1. Bud scales valvate, 3–5 exposed, yellow, peltate pubescent; pith brown; bark of trunk close and rough; husk of fruit thin, tardily and irregularly 4–valved, splitting to below the middle; nut smooth, thin shelled, short pointed; seed intensely bitter.
H. minima (Marsh.) Britt. Bitternut (Hickory).

1. Bud scales imbricate, more than 6, unless shed. 2.

2. Terminal bud large, ½–1 inch long; husk of fruit splitting freely to the base; nut angled; seed sweet. 3.

2. Terminal bud small, ¼–½ inch long; husk thin, not splitting freely to the base; nut slightly or not angled. 5.

3. Lower bud scales deciduous; bark close, rough; twigs stellate pubescent; husk not separating quite to the base.
H. alba (L.) Britt. Mockernut (Hickory).

3. Lower bud scales persistent during the winter; bark shaggy, separating in long plates; husk very thick, splitting to the base. 4.

4. Terminal bud of the globose type, densely pubescent; fruit oblong; thick shelled, pointed at both ends.
H. laciniosa (Mx.) Sarg. Shellbark (Hickory).

4. Terminal bud of the ovate type, puberulent; fruit subglobose; nut thin shelled, rounded at the base.
H. ovata (Mill.) Britt. Shagbark (Hickory).

5. Bark close; fruit obovoid; nut thick shelled, angled; seed astringent and bitter, not edible. *H. glabra* (Mill.) Britt. Pignut (Hickory).

5. Bark of old trees separating in strips; fruit nearly globular; nut thin shelled, only slightly or not angled; seed sweet.
H. microcarpa (Nutt.) Britt. Small Pignut (Hickory).

KEY TO OHIO ASHES IN THE WINTER CONDITION

E. C. Cotton.

Fraxinus L. Trees with stout twigs and opposite leaf-scars not meeting but sometimes with connecting ridges; terminal bud present; bud scales 1 to 3 pairs, the outer ones usually not spreading, rough, pubescent and rather dry; lateral buds evident; leaf-scars semi-circular to shield or heart-shaped; bundle scars numerous, contiguous, in a curved line or nearly forming a complete ring; pith cylindrical, solid, rather large and white; twigs gray or greenish- or brownish-gray; lenticels usually numerous but not large or wart-like; bark of trunk corrugated or flaky, ashy gray or brownish; wood of medium weight, hard, tough and elastic; fruit a samara usually one seeded.

1\. Twigs pubescent not with four ridges or wings; bark of trunk corrugated; leaf scars usually shield-shaped. 2.

1\. Twigs somewhat pubescent, with four or more ridges or wings, sometimes persisting until the third or fourth year; connecting ridges between leaf-scars usually present; leaf scars usually crescent shaped; buds pubescent, gray or brownish-gray; bark of trunk ashy gray, thin flaky; fruit linear-oblong or cuneate, winged all around, the body extending more than half way to the apex.
F. quadrangulata Mx., Blue Ash.

1\. Twigs glabrous or nearly so. 3.

2\. Lateral buds large, prominent, projecting, tumid, somewhat spherical, usually exposing four bud scales; twigs usually dark-gray; connecting ridges between leaf-scars usually present; fruit with linear somewhat broadened wing, two or three times as long as the narrowly elliptic, nearly terete body.
F. Biltmoreana Bead. Biltmore Ash.

2\. Lateral bud small, usually pyramidal or rather truncate, not projecting, usually showing but two bud scales; twigs usually showing but two bud scales; twigs usually light greenish gray; connecting ridges between leaf-scars sometimes present; fruit linear, margined above by the decurrent, linear, spatulate wing, and nearly equaling it.
F. pennsylvanica Marsh. Red Ash.

3\. Buds brownish-black or black; fruit winged all around, body flat. 4.

3\. Buds reddish-brown, brownish-gray or gray; fruit spatulate with wing terminal or partly decurrent; bark of trunk corrugated. 5.

4\. Lateral buds usually spherical; twigs light-gray, stout, stiff and brittle; lenticels prominent and usually numerous; bark of trunk ashy gray, flaky; fruit narrow-oblong. *F. nigra* Marsh. Black Ash.

4\. Lateral buds more or less four angled, commonly pyramidal; twigs greenish-gray, somewhat slender; lenticels not prominent and usually few; fruit oblong, cultivated. *F. excelsior* L. European Ash.

5\. Ridges connecting leaf-scars usually present; leaf-scars crescent shaped; twigs generally greenish-gray; wing of fruit not decurrent.
F americana L. White Ash.

5\. Ridges connecting leaf-scars usually absent; twigs gray; leaf-scars usually shield-shaped; wing of fruit decurrent on the sides of the body to below the middle. *F. lanceolata* Borck. Green Ash.

KEY TO OHIO POPLARS IN THE WINTER CONDITION.

JOHN H. SCHAFFNER.

Populus L. Trees with light soft wood; the larger branches usually with greenish-white, greenish, or brownish-gray bark. Twigs with a terminal bud; buds more or less resinous but not spicy-aromatic to the taste or smell; outer bud scales several, glabrous, pubescent, or tomentose; leaf scars alternate, not 2-ranked, more or less heart-shaped; bundle scars 3; stipular scars evident; self-pruning scars present and often very prominent; bark bitter; pith 5-angled, solid.

1. Twigs white or gray tomentose; buds ovoid-conical, short pointed. 2..
1. Twigs glabrous or pubescent, not tomentose. 4.
2. Buds glabrous, or slightly pubescent or tomentose, resinous, large; twigs robust, usually angular; leaf scars large. *P. heterophylla* L. Swamp Poplar
2. Buds tomentose or very pubescent, only slightly resinous, reddish-brown; twigs usually terete and slender; bark of larger branches greenish-gray or greenish-white. 3.
3. Buds very tomentose, small; twigs usually with abundant self-pruning scars which heal very perfectly, showing a dark ring around a central depression; bark often with black, diamond-shaped scars; crown large, spreading, round-topped. *P. alba* L. White Poplar.
3. Buds pubescent, not tomentose, rather large; bark of larger branches greenish-gray; trunk erect with an open, unsymmetrical straggling crown; branches distant, small and crooked. *P. grandidentata* Mx. Large-toothed Aspen.
4. Terminal and lateral buds rounded or only slightly augular, rather short pointed, brown and polished or reddish-brown and pubescent; twigs usually slender and terete. 5.
4. Terminal bud angular, large, rather long pointed; lateral buds long pointed or acuminate, sometimes angular. 6.
5. Buds glabrous or nearly so, brown and polished; bark of larger branches smooth, light green. *P. tremuloides* Mx. American Aspen
5. Buds pubescent and reddish-brown; bark of larger branches smooth, greenish-gray. *P. grandidentata* Mx.
6. Tree spire-like, the branches nearly vertical; lateral buds acuminate, curved, usually spreading. *P. dilatata* Ait. Lombardy Poplar.
6. Tree dome-shaped, the branches spreading. 7.
7. Buds gummy resinous, reddish-brown and large; twigs often more or less pubescent, usually reddish, mostly terete. *P balsamifera* L. (Inc. var. *candicans*). Balsam Poplar
7. Buds resinous but dry, greenish or yellowish-gray; lateral buds acuminate, and usually curved and spreading; twigs glabrous, usually brownish-gray, often angled. *P. deltoides* Marsh. Cottonwood.

HYDROFLUORIC ACID FOR MARKING SLIDES.

Joseph F. Clevenger.

Various methods have been described for labeling slides in a series, or for keeping track of them while staining. The principle of etching glass with hydrofluoric acid has been known for a long time, and use has been made of it in various ways, but it does not seem to have been employed to any extent by biologist for marking slides.

The writer has tried a number of methods recently published for marking slides, but for one reason or another they were not very satisfactory. Generally the mark became so obliterated in passing through the stains and grades of alcohol that they were beyond recognition.

Through a suggestion offered by Miss Lumina C. Riddle it occurred to me that hydrofluoric acid might be suitable for this purpose. Very satisfactory results were obtained by the following method:

Take a thoroughly cleaned slide, dip one end into paraffin and let it cool. Take a needle and make whatever mark is desired, and then with a toothpick, or a similar piece of wood, apply a drop of hydrofluoric acid to the mark. Let this remain from two to five minutes; then melt the paraffin and clean the slide. Any number of slides may be marked at a time and the method is nearly as rapid as that with ink and much more reliable. Ordinary precautions must be taken in handling the hydrofluoric acid.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, Nov. 7, 1904.

The meeting was called to order by the president and the minutes of the previous meeting were read and approved.

Mr. Sanders, the retiring president, read a paper on "The Uses of the Bacteria in the Arts." Prof. Schaffner reported Kuhnistera purpurea (Vent.) MacM. for Columbus. It is a rare plant in Ohio. Prof. Landacre gave some observations on the rate of growth of Vorticella. Mr. J. C. Britton of Washington, D. C., gave an account of a recent trip to Bermuda. Mr. Burgess of the State Agricultural Department, stated that the Elm Leaf Beetle had been found in Dayton this autumn.

The president appointed F. L. Landacre, J. H. Schaffner, and Z. P. Metcalf to act as a committee on nominations to select officers for the coming year.

J. N. Frank, *Sec.*

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REPORT OF PROGRESS ON STUDY OF THE HEMIPTERA OF OHIO AND DESCRIPTION OF NEW SPECIES.*

HERBERT OSBORN.

As a result of collections during the past year quite a number of species have been added to the State list, observations have been made on distribution, habits and life history of others and much additional material gathered for a general catalogue of the Hemiptera of the State. The Trustees kindly assigned a small sum from the MacMillin Research Fund but owing to the pressure of other engagements only a portion of the fund was used this season. I was able, however, to make considerable collections at Cincinnati, Ashtabula and Steubenville as well as in the vicinity of Sandusky where six weeks of the early summer was spent. The collections at Steubenville and Ashtabula were fortunate in disclosing forms new to the State and I hope it will be possible to get additional material from the northeastern part of the State to represent other months.

A number of species have been collected by Mr. Otto H. Swezey, Jas. G. Sanders, and J. S. Hine and I am under special obligations to Mr. Chas. Dury of Cincinnati, and Mr. E. V. Louth of Ashtabula, for assistance in their respective localities.

A brief summary of the most interesting of these species and descriptions of new species will be given here but it is intended to complete a catalogue as early as practicable to include discussion of all known species.

Aradus acutus Say. This species which is common further south and an interesting addition to our state fauna was taken at Chillicothe by Mr. Swezey.

* Presented at meeting of Ohio Acad. Sci., Cleveland, November 26, 1904.

Eucanthus acuminatus Fab. Taken near Sandusky on Sandusky River a number of specimens being secured from an old log and stump where they seemed to congregate.

Pediopsis basalis VanD. Taken at Arcanum on cottonwood by Mr. Swezey.

Deltocephalus configuratus Uhl. Collected at Ashtabula in August.

Goniagnathus palmeri VanD. One specimen of this interesting little species taken at Columbus.

Typhlocyba rubroscuta Gill. Collected at Columbus.

Typhlocyba crevecouri Gill. Columbus, collected by Mr. J. G. Sanders. The specimens agree perfectly with descriptions except that there is a broad black band covering segments 1 to 5 of the abdomen both above and below not mentioned by Gillette who says "all beneath pinkish yellow."

Livia maculipennis Fitch. This interesting little Psyllid was discovered at Ashtabula while collecting near the city with Mr. E. V. Louth. Adults were first swept from the heads of a Juncus identified by Mr. Louth as Juncus acuminatus, closer examination of the heads revealed nymphs enclosed in the swollen glumes in many instances occurring in large numbers so the heads were fully packed. The relation of these nymphs to the adults that had been swept was at once suspected and definitely proven later by breeding.

Platymetopius obscurus n. sp. Head moderately produced, front uniformly dark brown, minutely dotted with yellow, color olivaceous brown above and below, elytra with minute roundish white spots. Length female, 4.5 4.75 mm. Male 4.

Vertex about one and one-half times as long as broad, acutely angled, front narrow tapering gradually to apex, clavus longer than broad, widening slightly at apex, pronotum about as long as vertex, rounded anteriorly nearly truncate behind. Elytra scarcely hyaline, a series of reflexed cross veinlets in the costal area.

Color, dark olivaceous brown, vertex with pair of yellow spots and with minute yellowish lines. Front dark fuscous with yellowish arc near the vertex and numerous minute yellowish dots, larger on the loræ; scutellum and elytra coppery fuscous with indistinct longitudinal lines—five on pronotum, two on scutellum, elytra with rounded white dots on the apical and ante-apical cells and in basal portion of corium. Ramose lines and reflexed costal veinlets blackish.

Genitalia—Last ventral segment of female elongate, rounded behind. Male valve nearly as long as broad, obtusely angled behind; plates elongate triangular, reaching tip of pygofer.

Specimens from Greensburg, Pa., Columbus, O., and Cold Spring Harbor, N. Y.

Thamnotettix furculatus n. sp. Size and general pattern of clitellarius with dorsal spot narrower, more elongate, dark spots at base of antennæ and elongate, forked process on female ventral segment. Length of female, 5 mm.

Vertex slightly longer on middle than at eye, very slightly angulate, intermediate in this respect between clitellarius and exquisitos. Front full, almost tumid, clypeus widening toward tip and broadly rounded, loræ not broad not reaching margins of genæ. Pronotum, lateral margins rounded, nearly twice as wide as long, posterior border almost straight.

Color, dark chocolate to fuscous with bright yellow markings, vertex bright yellow with hind border black or fuscous. The common band of occiput and anterior third of pronotum extending over the posterior part of the eye. Two prominent black spots on the margin between vertex and front, a black spot below the base of each antenna, posterior two-thirds of pronotum bright lemon yellow of same color as discal claval spot, scutellum dark brown with darker spots on either side of median space. Base of part of clavus brown, claval suture and about half the width of elytra dark fuscous to black with a broad fuscous apical band, the costal-half of elytra back to the apical cells hyaline tinged with yellowish, beneath pale yellow to whitish.

Genitalia: The last ventral segment of female deeply emarginate with a prominent tooth at the edge of the emargination extending about one-fourth of the segment beyond the outer margin. A long narrow median process reaching as far back as the hinder tooth and with a deep incision thus forming a narrow elongate fork.

One specimen, female, was secured from Sandusky River about twenty miles above Sandusky, July 2, 1904. It must have been taken in sweeping in woodland or in low vegetation bordering woods. It is very closely related to clitellarius being scarcely larger but the common claval spot narrows to each end, the vertex is slightly more produced, the base of antennæ spotted and above all the genital segment entirely different from any species known to me.

A specimen of what is evidently the male of this species was taken in Columbus, June 20, 1901. The color markings and shape of vertex agree perfectly and the length, 4.5 mm., is in usual proportion for the sexes in this genus. The genitalia differ decidedly from those of clitellarius the valve being long, the hind edge strongly angled; plates broad convexly narrowing to tip, reaching to tip of pygofer, a submarginal dark line, marginal cilia yellow.

Phlepsius collitus Ball. This species has been separated from fulvidorsum, with which it was formerly confused, by Prof. Ball.

As the record for fulvidorsum given in a previous list was based on a specimen from Vinton which proves to be collitus this name should be entered. Specimens of fulvidorsum were taken at Little Mt. by Mr. J. G. Sanders, Aug. 21, '04, so this species will still be included in our state list.

Phlepsius maculatus n. sp. Mottled with black and white with ramose lines on pronotum and elytra forming fairly well defined patches; female segment long, bisinuate, notched at middle. Length to tip of elytra 7.25 mm.

Head barely wider than pronotum Vertex broad, slightly longer at middle than next the eye; anterior edge scarcely acute; ocelli close to the margin of the eye; front broad, sides nearly parallel to below antennal pits then rapidly converging to base of clypeus; clypeus widening slightly to tip; loræ large, broad, extending from half way between antennal pits and clypeus almost to margin of cheek; pronotum short, anterior margin strongly curved; hind margin distinctly concave; elytra large slightly contracted behind clavus, apex slightly flaring.

Color, white or cream, densely mottled or streaked with dark fuscous black; vertex having two quite strong patches on the posterior border, not quite touching the eyes with some faint lines at middle and at anterior margin; the front minutely dotted, with slight indication of regular arcs; clypeus, loræ and cheeks more faintly marked; pronotum with dark confluent lines or spots forming a wavy, irregular band across the middle and another indefinite band on the posterior border; scutellum with two discal points and broken border black; elytra with confluent dots or lines in all of the areoles forming a distinct black spot at middle of claval border and about four on costa; beneath gray, the femora annulated with black, tibiæ with black spots and annulus at apex; last joint of anterior and middle tarsi and apical portions of hind tarsal joints black; body gray with last ventral segment polished black except basal and lateral portion.

Genitalia—last ventral segment of female twice as long as preceding, lateral margins strongly reflected, hind border deeply bisinuate; the central portion somewhat produced with rather deep notch at middle.

This is a large and handsome form only a single specimen of which was taken at Cedar Point, July 30, 1904. It is so distinct from any of the known species of the genus that it seems best to describe it even though but a single specimen is in hand.

KEY TO THE GENERA OF OHIO WOODY PLANTS IN THE WINTER CONDITION.

JOHN H. SCHAFFNER.

The writer has been studying the winter condition of trees and shrubs for the past two years, having been attracted to the subject through observations on self-pruning. Many of the twig characters are exceedingly important and should be given more consideration in specific descriptions and in manuals. Incidentally some keys were constructed. These have been verified to a large extent by use in the class room and it is believed that a twig key can be used with as little difficulty as one based on the usual floral characters. A hand lens is necessary to determine some of the characters included.

1. Foliage leaves persistent and usually evergreen. 2.
1. Foliage leaves deciduous each year. 20.
2. Foliage leaves needle-shaped, subulate, narrowly linear, or scale-like; conifers. 3.
2. Foliage leaves with expanded blades, netted veined. 8.
3. With dwarf branches, each bearing 2–5 foliage leaves. PINUS.
3. Without true dwarf branches. 4.
4. Leaf buds scaly. 5.
4. Leaf buds not scaly, naked. 7.
5. Leaf scar not on a sterigma, prominent, circular; leaves flat. ABIES
5. Leaf scar on a sterigma, the base of the leaf remaining as a scale on the twig. 6.
6. Leaves flat, those on the upper side of the twig much shorter than the lateral ones. TSUGA.
6. Leaves flat, all of about the same length. TAXUS.
6. Leaves more or less 4-sided, spreading in all directions. PICEA.
7. Foliage leaves small, scale-like, appressed, opposite, 4-ranked, closely covering the twigs which are decidedly flattened and fan-like; leaves of two shapes, the dorsal and ventral broader and less acute than the lateral ones; scales of the carpellate cone not peltate. THUJA.
7. Foliage leaves small, scale-like, appressed, opposite, 4-ranked, closely covering the slightly flattened twigs which are not very fan-like; leaves nearly or quite similar; scales of the carpellate cone peltate. CHAMÆCYPARIS.
7. Foliage leaves of two types, scale-like and subulate, opposite or in threes; the scale-like leaves 4-ranked, appressed, causing the twigs to appear quadrangular, the subulate leaves spreading; one or both types of leaves on a plant; carpellate cone developing into a bluish-black berry-like fruit. JUNIPERUS.

—8—

8. Leaves with spines or reduced to spines. 9.
8. Leaves without spines. 10.
9. Leaves compound, with spine-tipped teeth; or leaves of the main twigs usually without a blade and reduced to 1–5 prong-like spines, at length dry. BERBERIS.
9. Leaves simple, with spine-tipped teeth or lobes; twigs grey. ILEX.
10. Leaves opposite or whorled. 11.
10. Leaves alternate. 13.

11. Leaves palmately veined; shrubs with green twigs parasitic on trees; twigs with self-pruning joints. PHORADENDRON.
11. Leaves pinnately veined; plants not parasitic. 12.
12. Leaves oval, the upper perfoliate, glabrous; twining plants. LONICERA.
12. Leaves oblong or oval, coriaceous, not perfoliate; shrubs or trees. KALMIA
12. Leaves obovate or orbicular, hairy, crenulate, not perfoliate; stem trailing. LINNÆA.
13. Leaves serrate, serrulate, crenate, or dentate. 14.
13. Leaves entire. 15.
14. Leaves somewhat hairy; shrubs with thorns or thorn-like spurs. COTONEASTER.
14. Leaves glabrous, very aromatic, oval to obovate, ½ in. long; low slender trailing plant. GAULTHERIA.
14. Leaves glabrous, bitter, white beneath, ¼–½ in. long; slender trailing or ascending plants in bogs. OXYCOCCUS.
14. Leaves with prominent scurfy scales; erect shrubs without thorns. CHAMÆDAPHNE.
15. Leaves glabrous. 16.
15. Leaves pubescent or woolly at least below. 17.
16. Leaves green on both sides, thick, coriaceous, oblong to oblanceolate, 5–10 in. long; winter buds very scaly. RHODODENDRON
16. Leaves green on both sides or glaucous beneath, coriaceous, 2-5 in. long, oval to oval-lanceolate; winter buds naked; erect shrubs. KALMIA.
16. Leaves white beneath, linear-lanceolate, revolute-margined, acid, 1–2½ in. long; a bog shrub. ANDROMEDA.
16. Leaves white beneath, revolute-margined, bitter, ¼–½ in. long; slender trailing or ascending plants in bogs. OXYCOCCUS.
17. Leaves revolute-margined. 18.
17. Leaves not revolute-margined. 19.
18. Leaves with a fragrant odor, densely tomentose beneath; erect resinous shrubs. LEDUM.
18. Leaves 2-ranked, small, oval or ovate, hairy; creeping shrubs. CHIOGENES.
19. Leaves lanceolate, mucronate, not evergreen; buds clustered at the tip of the twig; trees with 5-angled pith. QUERCUS.
19. Leaves oval or nearly orbicular, hirsute beneath; twigs hirsute; prostrate shrubs. EPIGÆA.
19. Leaves spatulate, minutely pubescent, with hairs on the margins; trailing or spreading shrubs. ARCTOSTAPHYLOS.

—20—

20. Climbing monocotyls with scattered vascular bundles, green bark, and two tendrils on the persistent petiole base; often prickly. SMILAX.
20. Not with scattered vascular bundles but with a ring of wood, true bark, and a central pith. 21.
21. Twigs with thick wart-like dwarf branches; conifers. 22.
21. Twigs without true dwarf branches. 23.
22. Young twigs covered with scales. LARIX.
22. Twigs without scales. GINKGO.
23. Twigs with numerous small scattered self-pruning scars, without apparent leaf scars but with minute dry scale leaves. 24.
23. Twigs with evident leaf scars and lateral winter buds. 25.
24. Trees with feather-like dwarf branches, some usually remaining in winter; foliage leaves spreading into two ranks; roots often with knees; a conifer. TAXODIUM.

24. Shrubs with delicate spray-like twigs which are self-pruned; leaves minute. TAMARIX.
25. With tendrils opposite the leaf scars; usually every third leaf node without a tendril; climbing plants self-pruning unripe twigs by means of cleavage planes in the leaf nodes. 26.
25. No tendrils opposite the leaf scars. 27.
26. With woody partitions in the brownish pith at the leaf nodes; lenticels inconspicuous; tendrils without adhering disks; surface of leaf scar irregular. VITIS.
26. Pith continuous, white; lenticels conspicuous; tendrils without adhering disks in our species; leaf scar rather smooth. AMPELOPSIS.
26. Pith continuous, white; lenticels conspicuous; tendrils usually with adhering disks; leaf scars smooth, concave, with small bundle scars scattered or in a ring. PARTHENOCISSUS.

—27—

27. Leaf scars alternate. 28.
27. Leaf scars opposite or whorled. 109.
28. Twigs with distinct and complete stipular ridges or rings at the leaf nodes. 29.
28. Twigs without complete stipular rings. 31.
29. Leaf scar surrounding the axillary bud, terminal bud self-pruned; wood with prominent medullary rays. PLATANUS.
29. Leaf scar not surrounding the axillary bud, terminal bud not self-pruned; buds enclosed in the large connate stipules. 30.
30. Buds glabrous; twigs brown; pith diaphragmed; leaf scars oval or circular; bark spicy-aromatic. LIRIODENDRON.
30. Buds downy, or if glabrous then the twigs red; pith with or without diaphragms; leaf scars U-shaped, oval, or circular; bark usually aromatic. MAGNOLIA.
31. With thorns, prickles, or spines; or with spur-like branches ending in thorns. 32.
31. Without thorns, prickles or spines but some may have thorn-like stunted branches. 42.
32. With leaves reduced to simple or branches spines. BERBERIS.
32. With stipular spines, a pair for each leaf scar. 33.
32. Twigs with typical lateral thorns, without terminal thorns. 34.
32. With thorns at the ends of branches or with spur-like branches ending in thorns, and in addition axillary thorns may be present. 35.
32. Stems or twigs with prickles, some of which may have the appearance of stipular spines. 39.
32. Bud scales tipped with spines; stem twining; leaf scar central. CELASTRUS.
33. Leaf scar covering the two or more superposed axillary buds. ROBINIA.
33. Leaf scar below the axillary buds; buds reddish, pubescent. XANTHOXYLUM.
34. With thorns beside the axillary buds; normally one for each leaf axil, becoming gradually smaller toward the tip of the twig, terminal bud absent. TOXYLON.
34. Thorns axillary, large, rarely branched except on the main trunk; usually with two lateral buds at the base which may develop as twigs; numerous axils without thorns. CRATÆGUS.
34. Thorns commonly branched, situated above the axil of the leaf; leaf scar covering the two or more superposed axillary buds; twigs polished, often zigzag. GLEDITISA.
35. Not with three distinct bundle scars. 36.
35. With three bundle scars. 37.

36. Climbing shrubs with axillary thorns, light gray bark and a prominent central scar. LYCIUM.
36. Erect shrubs with thorns at the ends of twigs or spurs. RHAMNUS.
37. Terminal bud self-pruned; twigs some shade of black, brown, or reddish. PRUNUS.
37. Terminal bud present. 38.
37. Most of the slender branches ending in thorns not showing a terminal bud or self-pruning scar; lateral thorns with one or two large buds at the base. CYDONIA.
38. Buds conical, pungent, pubescent, twigs glabrous or nearly so, mostly yellow-olive; trees with erect growth, the branches not spreading as in most of the apples. PYRUS.
38. Buds downy or pubescent, twigs usually pubescent, if glabrous then dark reddish-brown; trees with rounded crowns and spreading branches. MALUS.
39. Base of the petiole remaining on the stem. RUBUS.
39. Petiole separated close to the stem. 40.
40. Bundle scars numerous; pith large; erect shrubs or trees. ARALIA.
40. Bundle scars 3; low or slender shrubs. 41.
41. Leaf scars very narrow, often a mere line extending half way or more around the stem, not decurrent. ROSA.
41. Leaf scars rather broad, somewhat decurrent; older bark shreddy. RIBES.

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42. Leaf scars quite regularly 2-ranked, that is with the third scar over the first. 43.
42. Leaf scars not 2-ranked. 56.
43. Pith interruptedly diaphragmed, with cavities, small, greenish-white; bundle scars 3. CELTIS.
43. Pith solid, or if with cavities then with a single bundle scar or with several scattered bundle scars. 44.
44. Terminal bud elongated, naked, silky or tomentose. 45.
44. Terminal bud with numerous or several bud scales. 46.
44. Terminal bud absent, the twigs showing a terminal self-pruning scar at the morphological tip. 49.
45. Pith diaphragmed; buds dark silky; lateral buds rounded not stalked; leaf scars U-shaped; bundle scars 5–7, stipular scars none; bark with fetid odor. ASIMINA.
45. Pith not diaphragmed; buds light gray; lateral buds elongated, prominently stalked, tomentose; stipular scars prominent; leaf scars not U-shaped. HAMAMELIS.
46. With 10–20 visible scale leaves; stipular scars and medullary rays very prominent; leaf scar oblique, beside the axillary bud. FAGUS.
46. Visible scales 3–8. 47.
47. Bundle scars several, scattered; pith more or less 5-angled; bark close with rough ridges; stipular scars present. CASTANEA.
47. Bundle scars 3. 48.
48. Trunk and larger branches with papery or leathery bark; catkins in winter; leaf scar oval or semicircular. BETULA.
48. Bark not papery or leathery; no catkins; leaf scar narrow, contracted between the bundle scars. AMELANCHIER.
49. Visible bud scales 1–3. 50.
49. Visible scales more than 3. 52.
50. Bundle scar 1; visible scales 2; twigs brown, pubescent; pith sometimes with cavities. DIOSPYROS.
50. Bundle scars scattered, several. 51.

51. Twigs grayish-brown or reddish, usually zigzag; bark mucilaginous, fibrous; buds rather fleshy, usually bright red; medullary rays prominent when the bark is removed; the winged fruiting panicle often persistent. TILIA.
51. Twigs glabrous or pubescent, reddish or yellowish-brown; pith 5-angled. CASTANEA.
51. Twigs downy, grayish-green; pith white, cylindrical, large; bark very fibrous. BROUSSONETIA.
51. Twigs coarsely glandular pubescent or sparingly hairy, brown; pith brown, cylindrical, small. CORYLUS.
52. Bundle scars scattered; leaf scars oblique; twigs gray or light brownish-gray. MORUS.
52. Bundle scars 3. 53.
53. Twigs dark reddish-brown, speckled, often zigzag; buds reddish-violet, often superposed or clustered; leaf scars not oblique but below the lateral bud. CERCIS.
53. Twigs dark brown, not speckled; buds not superposed; leaf scars oblique. 54.
54. Bark smooth, trunk and larger branches with peculiar fluted or projecting ridges; bud scales brown, finely pubescent; staminate catkins in the bud in winter. CARPINUS.
54. Trunk not with fluted or projecting ridges. 55.
55. Bark in rough ridges; no catkins; twigs and buds in most cases pubescent; some species with characteristic transverse self-pruning scars on the twigs, others with corky ridges. ULMUS.
55. Bark scaly, fine-furrowed, the furrows usually somewhat spiral; bud scales green with brown tips, nearly glabrous; staminate catkins exposed in winter. OSTRYA.
55. Bark of trunk and larger branches separating into papery or leathery sheets; catkins in winter. BETULA.

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56. With 2 or more superposed axillary buds; all except 1 may be very small. 57.
56. Axillary buds single or 2 or more side by side; not superposed. 67.
57. Pith diaphragmed, with air cavities, brown; twigs thick, with large leaf scars and 3 prominent bundle scars; large trees. JUGLANS.
57. Pith solid. 58.
58. Stems twining; leaf scars circular with numerous bundle scars; buds partly hidden. MENISPERMUM.
58. Stems not twining. 59.
59. Buds partly sunken, hardly projecting beyond the surface; terminal bud self-pruned or tips of branches withering. 60.
59. Buds not sunken in the epidermis. 61.
60. Leaf scar not surrounding the axillary buds; pith large, chocolate-colored; twigs robust, polished, mottled white and purplish-brown. GYMNOCLADUS.
60. Leaf scar surrounding the axillary buds, quadrangular. U-shaped; bark with pungent odor; pith white. PTELEA.
60. Leaf scar covering the axillary buds; pith small; twigs brown, polished, often zigzag. GLEDITSIA.
61. Pith cylindrical or nearly so. 62.
61. Pith more or less 5-angled, yellowish or brownish; terminal bud large; bundle scars scattered; trees with tough twigs. HICORIA.
62. Leaf scar surrounding the hairy axillary buds; bundle scars 5–9; terminal bud self-pruned. CLADRASTIS.
62. Leaf scar not surrounding the axillary buds. 63.
63. Bark very spicy-aromatic, fragrant; buds often stalked and clustered. BENZOIN.

63. Bark not spicy-aromatic. 64.
64. Pith diaphragmed but solid; bundle scars definitely 3; trees. NYSSA.
64. Pith not diaphragmed; bundle scar usually central. 65.
65. Leaf scars with the dry stipules rather persistent; bark with strong odor. AMORPHA.
65. Stipules not evident, or minute; bark not with strong odor. 66.
66. Stipular scars or stipules present, stipules minute. ILEX.
66. Stipular-scars and stipules absent; buds small, twigs light gray. ILICIOIDES.

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67. Outer bud scales more than 1. 68.
67. Outer bud scale 1; twigs usually with brittle zones and hence very easily detached; stipular scars present; bundle scars 3. SALIX.
68. Terminal and lateral buds stalked; pith 3-angled; both staminate and carpellate catkins present all winter. ALNUS.
68. Buds sessile or nearly so; pith not 3-angled. 69.
69. Pith more or less 5-angled. 70.
69. Pith cylindrical or nearly so. 74.
70. Buds clustered at the tip of the twig; bundle scars numerous, scattered. QUERCUS.
70. Buds not clustered at the tip. 71.
71. Bundle scars numerous usually scattered. 72.
71. Bundle scars 3. 73.
71. Bundle scar 1; bark green, spicy-aromatic; internodes very unequal SASSAFRAS.
72. Buds small with about 3 outer scales; twigs reddish or yellowish-brown, glabrous or pubescent; terminal bud present or absent; stipular scars prominent. CASTANEA.
72. Terminal bud large with 4 or more visible scales, hairy or peltate pubescent; lateral buds usually superposed; twigs tough. HICORIA.
73. Without stipular or self-pruning scars; crushed buds fragrant, aromatic, not resinous, glabrous. LIQUIDAMBAR.
73. Stipular and self-pruning scars present; crushed buds not fragrant though they may have a resinous odor, resinous or if only slightly so then the twigs pubescent or tomentose. POPULUS.
74. Pith diaphragmed but solid; bundle scars 3; no stipular scars; trees. NYSSA.
74. Pith not diaphragmed or if diaphragmed then not solid. 75.
75. Bud scales tipped with short sharp points; stem twining; buds conical, pungent. CELASTRUS.
75. Bud scales not spiny-tipped; stems not twining. 76.
76. Pith very large, light brown, bark not resinous, ill-smelling; buds spherical or flattened at the apex, often clustered at the tip of the twig, brown and pubescent; bundle scars about 9 along the lower edge of the very large leaf scar which does not surround the axillary bud; large trees. AILANTHUS.
76. Pith small, or if large and brown then the leaf scar surrounding the axillary bud or the bark resinous. 77.
77. Bark with a resinous or sticky milky sap; pith usually large, if rather small then the bark aromatic, or the plants climbing by rootlets. 78.
77. Bark not resinous. 79.
78. Buds clustered at the tip of the twig; bark spicy-fragrant to the smell; base of petiole prominent with several bundle scars; fruiting panicles plumose. COTINUS.

78. Buds not clustered at the tip; bark sometimes aromatic, often very poisonous to the touch; leaf scar in some species surrounding the axillary bud in others only partly surrounding the bud or the bud covered; small trees or shrubs or woody vines climbing by numerous rootlets. RHUS.
79. Leaf scars surrounding the hairy sunken axillary buds; terminal bud self-pruned and thus the twigs with peculiar rings. DIRCA.
79. Leaf scars not surrounding the axillary buds and twigs not with peculiar rings. 80.
80. Base of petiole and stipules persisting, prominent, drying off; small shrubs. 81.
80. Petiole deciduous close to the brak, leaving a definite leaf scar. 82.
81. Bundle scars 3; pith large; bark not shreddy. RUBUS.
81. Bundle scar 1; pith small; stipules sheathing the stem; bark dark brown, shreddy. DASIPHORA.

—82—

82. Bundle scar 1, or if several then closely crowded and confluent, appearing as 1. 83.
82. Bundle scars 3 or more, distinct. 96.
83. Climbing vines, the stems herbaceous above; young twigs gray pubescent. SOLANUM.
83. Stem climbing, woody throughout; bark light gray; buds often clustered. LYCIUM.
83. Stem not climbing, woody throughout. 84.
84. Stipular scars or stipules present. 85.
84. No stipular scars or stipules. 87.
85. Terminal bud present. 86.
85. Terminal bud absent; bud scales dark brown or black. RHAMNUS.
86. Stipules deciduous; low shrubs. CEANOTHUS.
86. Stipules usually persistent, minute; erect shrubs. ILEX.
87. Terminal bud present. 88.
87. Terminal bud absent. 91.
88. Bark of twigs very spicy-aromatic, green; internodes very unequal. SASSAFRAS.
88. Bark not spicy-aromatic. 89.
89. Internodes very unequal; bark brown or gray. AZALEA.
89. Internodes not very unequal. 90.
90. Twigs glabrous, gray or blackish-brown. ILICIOIDES.
90. Twigs pubescent or tomentose, reddish or light-brown. SPIRAEA.
91. Trees with polished, greenish-brown, grayish-yellow, or red twigs; bark sour; leaf scar prominent, semi-oval, with a dark central scar usually in the form of a ring; buds small, not projecting much beyond the epidermis; the large terminal panicled raceme with capsules persisting all winter. OXYDENDRUM.
91. Trees with brown pubescent twigs; or shrubs. 92.
92. Trees with 2 visible scales in the triangular flattened bud; pith often with lenticular cavities; twigs pubescent, zigzag at the tip. DIOSPYROS.
92. Low shrubs with several visible scales in the bud. 93.
93. Twigs finely white-speckled and granulated, green or reddish. VACCINIUM.
93. Twigs not white-speckled. 94.
94. Buds of two kinds, large flower buds with many visible scales and small ones with 2 outer scales. GAYLUSSACIA.
94. Buds all alike, with several scales. 95.
95. Surface of leaf scar rather even; self-pruning scars present; twigs reddish-olive. POLYCODIUM.
95. Surface of leaf scar very uneven; no self-pruning scars; bud scales numerous. SPIRÆA.

— 96 —

96. Terminal bud absent. 97.
96. Terminal bud present. 101.
97. Stipules or stipular scars absent or indistinct. 98.
97. Stipules or stipular scars present. 99.
98. Leaf scar very narrow, almost a line, not decurrent, extending half way around the stem; low shrubs or climbers. ROSA.
98. Leaf scar broad; twigs not glandular dotted; erect shrubs or trees. PRUNUS.
98. Leaf scar broad; young twigs glandular dotted; buds usually clustered at the tip. MYRICA.
99. Twigs glandular, dark, pubescent; buds globular; low shrubs. COMPTONIA.
99. Twigs not glandular 100.
100. Buds and twigs very downy, twigs dark brown or black. CYDONIA
100. Buds and twigs pubescent; twigs light or greenish brown. SORBARIA
100. Buds downy or pubescent; twigs glabrous or pubescent, gray or brown. RHAMNUS.
101. Twigs green or yellowish-green, glabrous; internodes very unequal; lateral buds minute; small trees. CORNUS.
101. Twigs normally red above and green beneath, glabrous; bark very bitter; some axils with 2 or 3 hairy buds of nearly equal size; trees. AMYGDALUS.
101. Twigs not green or red and green unless the plants are low shrubs, but gray, brown, black, or reddish. 102.
102. Bundle scars 5 or more in the broad U-shaped leaf scar; tips of the buds quite downy; small trees. SORBUS.
102. Bundle scars 3. 103.
103. Leaf scars very narrow, often a mere line extending half way or more around the stem, not decurrent; low shrubs. ROSA.
103. Leaf scars rather broad often decurrent. 104.
104. Leaf scars strongly decurrent at the sides and middle; bundle scars close together, the central one large; shrubs with brown twigs. OPULASTER.
104. Leaf scars not decurrent or if so then the bundle scars distinctly separated. 105.
105. Buds elliptic, lanceolate or lance-linear; shrubs. 106.
105. Buds ovate or depressed; mostly trees or tree-like. 107.
106. Older bark shreddy; leaf scars somewhat decurrent at the middle and sides; bud scales very thin, light or dark brown. RIBES.
106. Bark close; buds pale brown or red; leaf scars not decurrent; bud scales rather thick; twigs pubescent. ARONIA.
107. Buds rounded at the apex, often clustered at the tip of the twig; twigs glandular dotted. MYRICA.
107. Buds rounded at the apex; scales thick; twigs often zigzag; plant usually with some thorns, not glandular dotted. CRATÆGUS.
107. Buds pointed; plants sometimes with thorn-like stunted branches, not glandular dotted. 108.
108. Buds glabrous or slightly pubescent; twigs usually glabrous and slender, some shade of black, brown, or reddish, often with 2 or 3 axillary buds; some with self-pruning scars. PRUNUS.
108. Buds downy or strongly pubescent, conical, pungent; twigs glabrous, mostly yellow-olive; trees with erect growth, the branches not spreading as in most of the apples. PYRUS.
108. Buds downy or strongly pubescent; twigs strongly pubescent or if glabrous then dark reddish-brown; trees with rounded or spreading crowns. MALUS.

—109—

109. Pith large, white, with cavities or more or less diaphragmed; twigs robust, gray, with large lenticels; bundle scars in a ring in the large leaf scar; trees. PAULOWNIA.

109. Leaves with tendrils on the persistent petiole which shows 2 leaflet scars at the end; climbing vines with rather large, sometimes hollow pith. BIGNONIA.

109. Pith not diaphragmed nor with lenticular cavities; petioles not with tendrils. 110

110. Axillary buds evident. 112

110. Axillary buds minute and not evident, or covered by the persistent petiole base. 111.

111. Bundle scar forming a curved line; lateral buds sunken in the bark; leaf scars after in threes. CEPHALANTHUS.

111. Bundle scars 3; terminal bud with 2 acuminate visible scales. CORNUS.

111. Bundle scars 3; terminal bud small, dome-shaped; axillary buds bursting through the prominent petiole base; twigs many-angled PHILADELPHUS.

112. Twigs green or greenish, never twining. 113

112. Twigs gray, brown, or red, not green when ripe. 115.

113. Terminal bud self-pruned; stipular scars prominent; bark with strong odor. STAPHYLEA.

113. Terminal bud present. 114.

114. Leaf scars meeting and ending upward in a free appendage; base of petioles in some cases originally covering the axillary buds; bundle scars 3 or more. ACER.

114. Leaf scars not meeting; twigs more or less 4-angled; base of petiole not covering the axillary bud; bundle scar 1. EUONYMUS.

115. Twigs and buds brown-scurfy or stellate-pubescent; bundle scar 1; shrubs. LEPARGYREA.

115. Not brown-scurfy or stellate-pubescent. 116.

116. Bundle scars numerous in an ellipse or a ring; trees with small flat buds or woody vines climbing by rootlets. 117.

116. Bundle scars 1, 3, or 5, or sometimes more but not in a ring. 118.

117. Trees with small flat buds; twigs gray, robust; pith large, white; leaf scars often in threes. CATALPA.

117. Woody vines climbing by rootlets; ends of the twigs usually withering. TECOMA.

118. Pith very large, the soft wood small in proportion; twigs either with cleavage planes in the upper leaf nodes or with brown papery outer bark separating readily from the green inner layer; shrubs with robust twigs. 119.

118. Pith small or if rather large then the plants trees. 120.

119. Lenticels conspicuous; tips of twigs self-pruned in the leaf nodes. SAMBUCUS.

119. Lenticels inconspicuous; twigs not self-pruned; outer papery brown bark easily separated from the inner dark green layer. HYDRANGEA.

—120—

120. Bundle scars 1, or several closely united in a curved line appearing as 1. 121.

120. Bundle scars 3 or more, distinct. 125.

121. Low shrubs with decurrent ridges from the middle of the leaf scar. 122.

121. Trees or erect shrubs without decurrent ridges from the middle of the leaf scar but sometimes with ridges or wings from the ends of the leaf scar. 123.

122\. Low creeping shrubs with delicate erect or ascending twigs. ASCYRUM.
122\. Low erect shrubs; leaf scar close to the bark; fruit a capsule. HYPERICUM.
122\. Low erect shrubs; leaf scar on the prominent petiole base; fruit a berry. SYMPHORICARPOS.
123\. Terminal bud absent, the twig usually ending in a thorn. RHAMNUS.
123\. Terminal bud present; or if absent on some twigs then the end buds large, pointed, angular, and usually green. 124.
124\. Twigs and buds glabrous; buds ovoid-pointed, 4-angled, scales fleshy; fruit a capsule. SYRINGA.
124\. Twigs very pubescent, buds less so; lateral buds rather flat, more or less triangular; bud scales fleshy; leaf scar on the short petiole base; fruit a drupe. LIGUSTRUM.
124\. Twigs and buds pubescent; lateral buds cylindrical or hemispherical; bud scales dry; leaf scar concave, on the short petiole base; lenticels large and conspicuous; fruit a drupe. CHIONANTHUS.
124\. Buds rough or pubescent; twigs glabrous or pubescent, sometimes 4-angled; lateral buds somewhat flattened, obtuse; bud scales rather dry; leaf scar close to the bark; lenticels not large; fruit a samara. FRAXINUS.
125 With a prominent pubescent ridge decurrent from the middle of the line connecting the leaf scars; low shrubs. DIERVILLA.
125\. No pubescent decurrent ridge from the middle of the connecting line, but the ends of the leaf scars may be decurrent. 126.
126\. Terminal bud with 2 long acuminate pubescent outer scales; line connecting the uppermost leaf scars notched. CORNUS.
126\. Terminal bud with several pairs of visible scales, or with 1 large pair and a small pair at the base, or the tips of the twigs withering. 127.
127\. Trees or shrubs with numerous bundle scars, sometimes in 3 areas, in a large heart-shaped leaf scar; pith rather large; terminal bud large, with numerous scales. ÆSCULUS.
127\. Bundle scars 3 or sometimes 5. 128.
128\. Visible scales of the axillary buds 4 or more pairs, or if less, then the outer pair equalling the bud in length and the second pair hairy. 129.
128\. Visible scales of the axillary buds 1–3 pairs, the outer short, or if equalling the bud then the second pair glabrous or glutinous. VIBURNUM.
129\. Upper edge of the leaf scar strongly concave; usually large trees, if shrubs then the first pair of scales equaling the bud. ACER.
129\. Upper edge of the leaf scar nearly straight; shrubs or climbing plants, the pith sometimes hollow, sometimes with hardened pith at the leaf nodes. LONICERA.

NERTHRA STYGICA SAY AND SOME NOTES ON THE FAMILY GELASTOCORIDÆ.

J. R. de la Torre Bueno.

In 1832* in his "*Descriptions of New Species of Hemiptera, Heteroptera of North America*," Thomas Say described his "*Naucoris stygica*" from one mutilated specimen from Georgia. Its structure led him to propose a new genus for it, to be called Nerthra. From that time to the present the real "Nerthra stygica" has been lost to science. It is true that Mononyx stygicus Say is mentioned by Uhler as well as by Comstock in some of their works, but from the description of it given by the first-named author in Kingsley's "Standard Natural History" it is evident that the references are not to Say's bug, but either to Mononyx fuscipes Guerin or to M. nepæformis Fabricius. It is one of these two that Dr. Howard figures in his "Insect Book." In support of this view is the fact that all the American works and papers which have been consulted fail to mention the most striking peculiarity of Nerthra; namely, the hemelytra soldered together and extremely roughened. The genus and species are cited in Stal's "Enumeratio Hemipterorum," while on the other hand, Montandon, in his revision of the subfamily "Monychinæ" doubts its very existence, for he says that to his knowledge it has not again been found in America and, quoting Say's description in extenso, remarks it "would lead one to believe that he (Say) had before him a form near to or identical with Matinus or Peltopterus and in any case differing from Mononyx."

In the absence of Guerin's original generic characterization of Peltopterus, it has been referred to the description of the latter genus in Stal's "Hemiptera Africana" (Vol. III, p. 173), to which genus Nerthra is nearest, on account of the entirely coriaceous character of the hemelytra. It differs, however, in the shape of the body, the apical tubercles of the head and the shape of the thorax and hemelytra. (This last may be a merely specific character.) It becomes, therefore, evident that Say's genus Nerthra stands, and since the very existence of the bug is questioned by no less an authority than the Rumanian Hemipterist and so much misapprehension regarding it seems current I venture to attempt a description from the only specimen I have seen, giving the bibliography and synonymy as far as known to me.

Nerthra Say.

1831 (1832 sec. Uhler)—Description of N. Sp. of Het. Hem. of N. A., p. 808.
1859—Compl. Writ. of T. Say, ed. by Le Conte, Vol. I, p. 364.
1876—Stal, Enum. Hem., V., p. 139.

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* Prof. Uhler in a letter to Mr. G. W. Kirkaldy expresses the opinion that although this paper is dated 1831, it did not appear until March, 1832.

Shape suboval, depressed; head short and broad; scutellum small; hemelytra entirely coriaceous and linearly roughened in prominent points, soldered together along a straight suture indicated by a groove. Rostrum small. Anterior femora basally incrassate; tarsal claws single. Abdomen rounded. Male genital segments laterally deflected.

N. stygica Say. (Fig. 1.)

1831—(1832?)—Naucoris stygica Say. Descr. of N. Sp. Het. Hem. of N. A., p. 808.
1859—Comp. Writ. of T. Say, ed. Le Conte, Vol. I, p. 364.
1876—Nerthra stygica, Say, Stal, Enum. Hem. V, p. 139.
1899—Montandon, Hem. Crypt. S. fam. Mononychinæ, Bull. Soc. Scie., Bucarest, An. VII, No. 4 and 5, p. 4 (separate).

(Not—Mononyx stygicus Uhl., in Kingsley's Nat. Hist. p. 264, 1885; Uhl., Ch. List, p. 27, 1886; Uhl. Proc. Cal. Acad. Sci., 2d ser. IV, p. 290, 1893-'94; Comstock, Introduction, p. 191, 1888; Comstock, Manual, p. 134, 1899; Howard, Insect Bk., pl. XXIX, fig. 16.)

Moderate in size, suboval, depressed; head short and broad with four tubercles in the middle, the outer two less elevated than the middle two; triangular in front and reflexed. Eyes reniform, not very prominent. Ocelli absent. Rostrum short, small and so hidden under the head as to be hardly visible (joints not counted for this reason). Prothorax, sides subparallel; curvedly converging in the cephalad third; base slightly sinuate;

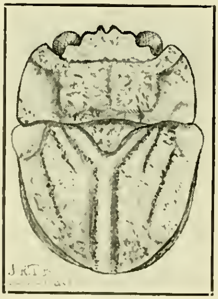

Fig. 1. Nerthra stygica Say X5.

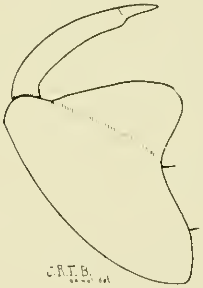

Fig. 2. Nerthra stygica Say; femur and tibia of first pair. X12.

laterally flattened; apex nearly straight except at the eyes; disk much elevated and roughened. Scutellum triangular, sides sinuated, much roughened. Hemelytra slightly flattened and dilated at the humeral angles and gently curvedly sloping to the rounded extremity; entirely coriaceous and linearly roughened in acute elevations along the lines of the sutures; soldered into one piece along a straight sulcate suture extending from the caudal angle of the scutellum to the tip of the hemelytra; apparently soldered to the scutellum as well; not entirely covering the abdomen, the connexival segments being moderately visible beyond the costal margin; extending beyond the end of the abdomen. First pair of legs raptorial. Anterior femoræ incrassate, flattened anteriorly and coming to a point (Fig. 2); coarsely granulate; tarsal claws single. Intermediate and posterior pedes cursorial; femoræ normal with a row of blunt teeth; tibiæ with two rows of stout spines with a sulcus between; tarsi one-jointed in intermediate pedes and provided with double claws (tarsi of posteriors lost in the specimen before me). Mesosternal tubercle rather acute and laterally somewhat flattened, terminated by bristles. Male abdominal segments much compressed in the middle to give room for the large and prominent genital segments which are deflected toward the right. Abdomen rounded with an entire margin.

Color, blackish-brown above, except the flattened prothoracic and hemelytral lobes which are yellowish and translucent. Underside of the abdomen more or less black. First pair of legs entirely black; second and third more or less spotted with lighter color.

Dimensions: Insect—Long., 7.4 mm.; lat., 5.3 mm. Head including eyes—Long., .6 mm.; lat., 3.4 mm. Prothorax—Long., 2.4 mm.; lat., 5 mm. Abdomen—Long., 4.4 mm.; lat., 5.3 mm.

Redescribed from a single specimen in the collection of Mrs. Annie Trumbull Slosson who took it in Florida.

The much roughened upper surface together with the entirely coriaceous hemelytra fused into one will at once distinguish this species from all the other Mononychinæ.

The preceding descriptions will doubtless be found lacking in many respects but dissection being necessary to determine certain anatomical features and characters, such, for instance, as the antennæ, the possession of only one specimen, and that not my own, has made it impossible to supply what is missing.

As Say's description is not accessible to all, I give it hereafter taking it from the Le Conte edition.

"N. stygica—Black, front quadrilineate.

"Inhabits Georgia.

"Body oval, brown-black, rather rough; head crenate on the front so as to form four denticulations; eyes rounded, rather prominent; thorax not emarginate before, with a slightly depressed margin behind; anterior thighs dilated triangualr; hemelytra with oblique lines; they appear united at the suture.

"Length three-tenths of an inch.

"I have but one mutilated specimen which was sent to me by Mr. Oemler. If I am not deceived by this specimen, the species is apterous and the hemelytra are united by a rectilinear suture, which will require the formation of a separate genus which may be named Nerthra."

My sincere thanks are due to Mrs. Slosson for her kindness in granting me the privilege of studying her insect.

The revival of this genus raises the genera of North American Gelastocoridæ (sens. lat.) to four, namely:

Pelogonus Latreille,
Gelastocoris Kirkaldy.=*Galgulus* Latreille,
Mononyx Laporte,
Nerthra Say.

The number of species has heretofore been given for the United States as three only, Pelogonus americanus Uhl., Gelastocoris (Galgulus) oculatus Fabricius, and Mononyx (Nerthra) stygica Say. As a matter of fact, however, their number cannot be fixed with certainty. The recorded species and those known to me are as follows, from the whole of North America.

Family GELASTOCORIDÆ Kirkaldy.

Subfamily *Pelogoninæ.*

Genus *Pelogonus* Latreille.

P. americanus Uhler, Eastern U. S.
P. perbosci Guerin–Mexico, W. Indies.
P. *ænifrons* Champion–Mexico.
P. viridifrons Champion–Guatemala.
P. acutangulus Champion–Guatemala.

Subfamily *Gelastocorinæ.*

Genus *Gelastocoris* Kirkaldy.

G. rotundatus Montandon–Mexico, Guatemala.
G. bufo Herrich-Schæffer–Mexico, Guatemala, Costa Rica.
G. oculatus Fabricius–U. S., Canada, Mexico, Central and South America.
G. vicinus Montandon–U. S., Mexico.
G. variegatus Guerin–S. and W. U. S., Mexico, C. and S. A.

Subfamily *Mononychinæ.*

Genus *Mononyx* Laporte.

M. fuscipes Guerin–W. U. S., Mexico, C. and S. A.
M. nepæformis Fabricius. W. U. S. and Mexico.
M. sp. n. sp. Florida.

Genus *Nerthra* Say.

N. stygica Say, S. E. U. S.

This gives in all three subfamilies and fourteen species for North America.

The preceding list of species is partly taken from Biologia Centrali Americana, partly from Montandon's revision before cited and some localities are from my collection. Guatemala bugs have been included because it is not at all improbable that they may cross the southern border of Mexico and even be found in the Southwestern United States. The Mononyx n. sp. mentioned is an apparently undescribed bug from Florida, in the collection of Mr. Otto Heidemann, of Washington, D. C.

For the species of Mononyx, tables will be found in Montandon's paper; the Mexican and Central American forms of Pelogonus are tabulated in Vol. II, Rhynchota of Biologia Centrali Americana, but there is no work on Gelastorcoris outside of the notes under the species in the last mentioned work to help in separating them.

New York City.

THE HIBERNACULA OF OHIO WATER PLANTS.

Harlan H. York.

Many aquatic plants that root at the bottom of streams and lakes die down in the autumn and pass the winter by means of tubers, bulbs and rhizomes, while others have developed a peculiar type of winter propagative buds at the tips of the stems. These curious buds are found in many of the pond weeds, stoneworts and bladderworts. In the late summer and early autumn the plants turn brown and die except at the tips of the stems which remain alive. The tips of the stems cease to lengthen out and are enclosed with dark green leaves which become crowded and folded so closely as to form egg-shaped bodies. They remain on the stems for some time but finally become detached and sink to the bottom of the water where they escape the cold of winter and are scattered in various directions thus becoming a means for vegetative propagation. These buds are much shortened stems and are termed Hibernacula.

A somewhat careful study was made of the hibernacula of Utricularia vulgaris since they are quite large and easily obtained. They begin to appear in the latter part of August and are formed in the manner already described, the leaves being crowded so closely and overlapping each other as to form green ball-shaped buds that are quite compact. The air spaces in the stems and leaves become much reduced and the cells are packed with starch granules which cause the buds to sink when they are detached from the stems. When the hibernacula first begin to develop, the tips of the stems and leaves secrete a mucilaginous substance, which surrounds and permeates the buds when they are formed.

In the spring when the ice has melted and the sun's rays begin to warm the water, the buds commence to grow. The starch grains that were stored up in the preceding autumn are used in the building of the new stem. Bubbles of gas are set free which are held in the mucilaginous covering and cause the buds to rise to the surface of the water. The hibernacula have changed somewhat in appearance from that in the fall as they are more or less supplied with red coloring matter, probably a result of the low temperatures to which they have been exposed. The buds continue to expand and the enclosed stem becomes an active, growing plant. Later it may become attached in the mud by roots from the basal end.

The bladders are much reduced, or almost entirely absent from the stems bearing the hibernacula, while they are found within the buds in an immature stage. The spaces between the leaves that go to form the hibernacula, contain various algæ, such as Oscillatorias, Desmids, Diatoms and other unicellular forms.

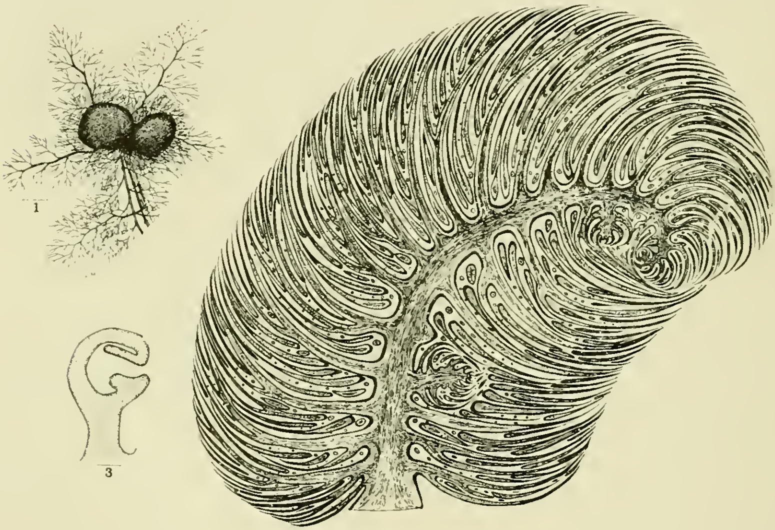

Fig. 1. Two hibernacula of Utricularia vulgaris on a single stem.
Fig. 2. Longitudinal section through the middle of a hibernaculum of Utricularia vulgaris.
Fig. 3. Longitudinal section of an immature bladder.

The hibernacula of the Potamogetons, the Myriophyllums and Philotria canadensis, are usually more elongated and the leaves less crowded than those of Utricularia. The buds do not rise to the surface of the water in the spring but remain in the mud and develop roots and leafy shoots which grow upward toward the surface of the water.

The Lemnas, Wolffias and Spirodela produce pocket shaped buds, which contain the next years' stem, and like those of Utricularia, usually sink to the bottom of the water on the approach of winter and in the spring rise again to the surface and develop into floating plants.

The following named plants, found in Ohio, produce hibernacula:

Lemna cyclostasa (Ell.) Chev.
Lemna minor L.
Lemna triuslca L.
Spirodela polyrhiza(L.) Schleid.
Wolffia columbiana Karst.
Wolffia punctata Gris.
Philotria canadensis (Mx.) Britt.
Zannichellia palustris L.
Potomageton pusillus L.
Potomageton lonchitis Tuckerm.
Potomageton pusillus polyphyllus Morong.
Potomageton zosteræfolius Schum.
Potomageton friesii Ruprecht.
Potomageton vaseyi Robbins.
Utricularia cornuta Mx.
Utricularia gibba L.
Utricularia intermedia Hayne.
Utricularia vulgaris L.
Myriophyllum heterophyllus Mx.
Myriophyllum spicatum L.
Myriophyllum tenellum Bigel.
Myriophyllum verticillatum L.

KEY TO THE OHIO SUMACS IN THE WINTER CONDITION.

Mabel Schaffner.

Rhus L. Small trees, shrubs, or woody vines climbing by rootlets, with a milky or acrid resinous sap; pith more or less cylindrical, often large, white, brown, or yellowish; leaf scars alternate, not two-ranked; bundle scars several; stipular scars none; terminal bud present or absent; axillary buds single, not clustered at the tip of the twig, sometimes surrounded by or hidden under the leaf scar; bud scales several; sap of some species poisonous to most people when touched.

1. Leaf scar surrounding the axillary bud; pith very large, brown; erect shrubs or small trees. 2.
1. Leaf scar not completely surrounding the axillary bud; pith medium; erect shrubs, small trees, or woody vines climbing by rootlets. 3.
1. Leaf scar on the short petiole base which covers the axillary bud; pith small; bark glabrous, aromatic; low, ascending or diffuse shrub. *R. aromatica* Ait. Fragrant Sumac.
2. Twigs glabrous, somewhat glaucous. *R. glabra* L. Smooth Sumac.
2. Twigs velvety-hairy. *R. hirta* (L.) Sudw. Staghorn Sumac.
3. Bark velvety pubescent, brown; buds short, rounded; erect shrub or small tree. *R. copallina* L. Dwarf Sumac.
3. Bark glabrous or nearly so, or if pubescent then with aerial rootlets, gray or brownish-gray; buds projecting; bark and wood poisonous to most people when touched. 4.
4. Leaf scars heart-shaped; bundle scars numerous, scattered; erect shrub or small tree in swamps. *R. vernix* L. Poison Sumac.
4 Leaf scars U-shaped; bundle scars numerous, scattered or arranged in a curve; woody vine climbing by aerial rootlets, sometimes shrubby or tree-like. *R. radicans* L. Poison Ivy.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, Dec. 5, 1904.

The club was called to order by the president, Mr. Sanders. The minutes of the previous meeting were read and corrected. The first business to come before the club was the report of the nominating committee as follows: for president, Prof. J. S. Hine; for vice president, Miss L. C. Riddle; for secretary-treasurer, F. M. Surface. On the motion of Prof. Schaffner the secretary was instructed to cast the unanimous ballot of the club for these officers. Prof. Hine being absent Miss Riddle took the chair.

The major paper of the evening was by Mr. H. A. Gleason on the Sand Dunes of Central Illinois. In this region the vegetation is a coarse bunch grass prairie and scrub oak timber, but it is developing in the direction of typical Illinois woods and prairie. Prominent in the physiography are large excavations formed by the wind and known as blow outs. The flora presents little similarity with that of the nearby dunes along Lake Michigan, but shows a close relationship with the sand-hill region of Nebraska. In the discussion Prof. Schaffner spoke of the sand hills of Kansas and Nebraska.

Prof. Hine now took the chair. Prof. Osborn spoke of the first day's meeting of the Ohio State Academy of Science at Cleveland. He spoke especially of Prof. Moseley's presidential address on the "Formation of Sandusky Bay." Especially interesting was the account of the formation of Cedar Point. Other papers presented on the first day were Prof. Halsted's paper on "Mathematics in Biology," Prof. Miller's lecture on "Radium," and in the evening Prof. Herrick's "Bird Studies."

Prof. Landacre then reported the second day's meeting of the Academy. The scientific papers were presented in the forenoon and the afternoon was taken for the business session. The matter of a midwinter meeting with the Ohio Educational Society was taken up and it was agreed that there should be at least a round table meeting at that time.

Prof. Hine then reported on the financial condition of the Ohio Naturalist. The Naturalist is upon a firmer basis than ever before and its prospects for the future are bright.

The following persons were elected to membership: J. F. Clevenger, C. H. Flory, L. H. Scholl, H. A. Gleason.

The hour being late the president declared the club adjourned until the first Monday in January after the holiday vacation.

F. M. Surface, Sec.

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ECOLOGICAL NOTES ON OHIO PTERIDOPHYTES.

ALMA H. WACKER.

Of the one hundred and nineteen Pteridophytes which Britton has listed for the Northeastern United States and of the two hundred and seventy-two recorded by Underwood for North America north of Mexico, at least sixty have been found in Ohio. This number includes the ferns, horsetails, Lycopods, Selagnellas and Azolla.

When looking for Pteridophytes it is well to remember that they grow under widely diverse conditions; from exposed rocks and sandy soil, meadows and rich woods to swamps and standing water

Besides the reproduction by spores other means of propagation are present in most species. Rhizone propagation is one of the most common means. The rhizomes or underground stems may be upright as in Ophioglossum, or horizontal as in most of the ordinary ferns. They may be smooth or scaly, branched or unbranched; or they may be found creeping upon the ground and sending roots into the earth as in some of the Lycopods.

In some species vegetative propagation by special gemmæ or brood-buds is present as in Filix bulbifera, while in Lycopodium lucidulum there are peculiar modified buds. These drop to the ground and give rise to new plants.

A few ferns have leaf propagation; the tip of the leaf takes root and develops a new plant. This occurs in Camptosorus rhizophyllus, Asplenium pinnatifidum, A. platyneuron, and A. ebenoides. There is another kind of propagation which may be mentioned here. Nephrolepis exaltata, a cultivated species, sends out runners, which often take root at the end and thus form a new plant.

Only two of our Pteridophytes are annuals, Selaginella apus and Azolla caroliniana. The rest are perennial; of these a large number are evergreen, the aerial portion persisting and remaining green throughout the winter. The following list includes the Pteridophytes which belong to the evergreen class:

Polypodium vulgare.
" polypodioides.
Pellæa atropurpurea.
Asplenium pinnatifidum.
" ebenoides.
" platyneuron.
" trichomanes.
" ruta-muraria.
" montanum.
Camptosorus rhizophyllus.
Polystichum acrostichoides.
Dryopteris cristata.
" " clintoniana.
" marginalis.
" spinulosa.
Dryopteris spinulosa intermedia
" " dilatata.
Woodsia obtusa.
Equisetum robustum.
" hyemale.
" lævigatum.
" variegatum.
" scirpoides.
Lycopodium lucidulum.
" inundatum.
" obscurum.
" annotnium.
" clavatum.
" complanatum.
Selaginella rupestris.

Classifying the Ohio Pteridophytes according to habitat, we have the following list:

1. Those growing in wet marshes or swamps with or without abundant shade.

Botrychium matricariæfolium.
" lanceolatum.
Osmunda cinnamomea.
" regalis.
" claytoniana.
Woodwardia virginica.
Dryopetris noveboracensis.
" cristata.
" spinulosa intermedia.
" " dilatata.

2. Those growing on the ground in rich woods and thickets more or less moist:

Ophioglossum vulgatum.
Botrychium matricariæfolium.
" lanceolatum.
Adiantum pedatum.
Asplenium platyneuron.
Athyrium thelypteris.
" filix-fœmina.
Dryopteris noveboracensis.
" goldieana.
" marginalis.
" spinulosa.
Phegopteris phegopteris.
" hexagonoptera.
" dryopteris.
Filix fragilis.
Woodsia obtusa.
Equisetum scirpoides.
Lycopodium lucidulum.
" obscurum.
" annotinum.
" clavatum.
" complanatum.

3. Those growing in moist rocky ravines or rocky places are:

Botrychium virginianum.
Woodsia obtusa.
Filix bulbifera.
" fragilis.
Dryopteris marginalis.
Asplenium angustifolium.
Phegopteris phegopteris.
" dryopteris.

4. Those found on rocks either limestone or sandstone are:

Polypodium vulgare.
" polypodioides.
Pellæa atropurpurea.
Asplenium pinnatifidum.
" ebenoides.
" trichomanes.
" ruta-muraria.
Asplenium montanum.
" parvulum.
Camptosorus rhizophyllus.
Filix bulbifera.
Woodsia ilvensis.
Selaginella rupestris.

5. A very few may be found growing in sandy soil. Among these we find:

Equisetum arvense.
" pratense.
Equisetum sylvaticum.

6. The following are found growing under varying conditions in many localities:

Botrychium obliquum.
" dissectum.
" lunaria.
" virginianum.
Onoclea sensibilis.
Matteucia struthiopteris.
Dennstædtia punctilobula.
Dryopteris thelypteris.
Polystichum acrostichoides.
Asplenium angustifolium.
Pteridium aquilinum.

7. In addition to what has been mentioned above, Osmunda regalis is occasionally found in standing water, and Azolla caroliniana floating on still water.

KEY TO THE OHIO MAPLES IN THE WINTER CONDITION.

Charles H. Flory.

Acer, L. Trees or shrubs with fibrous roots; twigs slender or sometimes robust, usually glabrous, green, gray, brown or red, with or without lenticular corky ridges; lenticels sometimes prominent; pith solid, rather small; leaf scars opposite, contiguous or connected by a ridge, sometimes meeting in a free point, either U or V shaped; stipular scars none; bundle scars 3–5; buds short-stalked or sessile; terminal bud present; lateral buds prominent, often three side by side; scales either dry or fleshy, glabrous or pubescent, brown, gray, green or red; bark close or exfoliating, gray, brown or black; wood light colored, usually hard, heavy, strong, stiff and tough, of fine texture or frequently wavy grained; fruit a 2-winged, 2- seeded samara.

1. Twigs green or purplish green, glaucous; axillary buds originally covered by the petioles; buds hairy, not stalked; leaf scars meeting in a free point. *Acer negundo* L Boxelder.
1. Twigs green, brownish, or reddish, with narrow, white, longitudinal lines; buds large, glabrous, stalked; a shrub or small tree. . . . . *Acer pennsylvanicum* L. Striped Maple.
1. Axillary buds not covered by the petiole base; twigs not striped. 2.
2. Older twigs with prominent, longitudinal, corky ridges; cultivated, from Europe. *Acer campestre* L. English Maple.
2. Twigs without corky ridges. 3.

3. Terminal buds large, angular, more or less pointed, glabrous except at the margins of the scales; bud scales very fleshy; twigs robust; not red. 4.
3. Terminal buds rather small, pointed or obtuse, pubescent, not very angular; scales dry or if rather fleshy then the twigs red or reddish; twigs usually slender. 5.
4. Twigs slender, brownish or grayish, not glaucous; leaf scars meeting in a free point; buds large, fleshy, slightly greenish to dark red; outer surface of 4–6 inner scales chestnut brown; cultivated. *Acer platanoides* L. Norway Maple.
4. Twigs stout, greenish brown to gray, glaucous; leaf scars usually not contiguous; buds large, fleshy, green or slightly tinged with red; outer surface of inner scales not chestnut brown; twigs with self-pruning scars; cultivated. *Acer pseudo-platanus* L. Sycamore Maple.
5. Twigs closely gray pubescent; buds small, evidently stalked; shrubs or rarely small trees. *Acer spicatum* Lam. Mountain Maple.
5. Twigs glabrous; buds short-stalked or sessile; large trees. 6.
6. Buds rounded, robust, fleshy, reddish in color; visible scales 2–8; leaf scars rarely contiguous; twigs with self-pruning scars. 7.
6. Buds slender, pointed, dry, brownish to brownish gray, sometimes nearly black at tip; visible scales 6–16; leaf scars contiguous or nearly so; twigs without self-pruning scars. 8
7. Twigs glabrous, brownish to red; bark gray, falling away in large, thin flakes on old trees. *Acer saccharinum* L. Silver Maple.
7. Twigs glabrous, reddish to red; bark light gray, rough on old trees, but not falling away in large pieces. *Acer rubrum* L. Red Maple.
8. Twigs reddish brown or buff, mostly glossy; buds conical, acute, gray, pubescent; limb of leaf scars less prominent because of the absence of stipules; ridge connecting leaf scars only slightly pubescent; bark of trunk dark gray or gray, somewhat spreading. *Acer saccharum* Marsh. Sugar Maple.
8. Twigs greenish to gray buff, dull; buds ovoid, conical, often obtuse; limb of leaf scars more prominent because of the presence of stipules; ridge connecting leaf scars prominently pubescent; lenticels prominent and usually many; bark of trunk black, rather close. *Acer nigrum* Michx. Black Maple.

THE CLASSIFICATION OF PLANTS, I.

John H. Schaffner.

It is the intention of the writer to give from time to time, for the use of students, a series of notes on the classification of plants. The disposition made of the plant kingdom will represent the writer's own views although much has been borrowed from various sources.

The classification of the plant kingdom should be an expression of its evolutionary history so far as known or it should at least be an attempt at such an expression. It should be based on the doctrine of descent. A natural arrangement should take account of the progressive advancement of plants from the lowest to the highest types as well as of the segregation of great branches or groups and the origin of large numbers of species belonging to the same general level. In other words, the scheme should include the recognition of both vertical and horizontal developments. In a general way the morphological characters which represent the progress from unicellular to the most complex multicellular forms are of very great importance in placing any group of organisms in the scale. But of still greater importance is the character of the life cycle.

If all types of plants evolved in the past had remained to the present day, it would be possible to devise a scheme which would show the natural relationships of all species and larger groups by very close connecting links. But in the evolutionary process plants passed through critical stages where it was hardly possible for them to tarry. The species must either remain below the critical condition or else advance farther in order to meet the requirements of the newly acquired structures, habits, or functions. The changing conditions of the earth's surface have had a profound effect as well as the mere fact of a great diversity of conditions. One of the most important factors in the problem of classification arises out of the changing environments to which plants were subjected during the geological history of the earth. In finding a basis for the determination of evolutionary advancement or retrogression, therefore, the ecological factor also becomes one of great importance. The change of functions and activities in passing from one set of conditions to another is sometimes considerable. As one would expect, then, there are breaks in the continuity of plant groups and these breaks frequently mark the transition to life in a different environment.

There are two very important gaps which divide the entire plant kingdom, as we have it at present, into three distinct groups. Each succeeding group is in all essentials more highly developed than the preceding and shows no very close relationship to it, the intermediate forms having been lost. These three groups may be called series and we can then say that the plant kingdom is divided into three series.

The first great hiatus occurs at the point where plants adapted to a water habitat passed out to aerial conditions. It represents the grand transition from water to aerial moist ground plants. This transition must, however, not be confused with those cases where plants having a body adapted to a water condition, typically filamentous in form, merely changed sufficiently to *endure* an aerial habitat.

The second great hiatus marks the boundary line between those plants, on the one hand, which are still dependent on considerable moisture for one generation and on the presence of free water to accomplish fertilization and the plants, on the other hand, which have been practically weaned from the necessity of free water during any period of their life cycle. In these highest dryland plants the water taken from the soil into the body of the plant is sufficient for carrying on all the essential processes of life.

From certain morphological characteristics the three great groups or series have been called THALLOPHYTA, ARCHEGONIATA, and SPERMATOPHYTA, or in English, Thallophytes, Archegoniates, and Spermatophytes or Seed Plants. It must not be supposed, however, that all plants live in the habitat to which they seem to have been adapted originally. The great majority of Thallophytes now live in the air, many Archegoniates are found in very dry places, while great numbers of Seed Plants have returned to the water.

The general progress of the history of the earth's surface has been from an aqueous condition to a dry land condition. Plants originated in the water and since islands and continents arose from the primordial ocean they have been stranded on the shores and crowded from water to aerial conditions by the drying of swamps and seas. When drier conditions began to prevail on the enlarging islands and continents, the lack of free water was met by the development of seeds. The progressive advancement of the general mass of the plant kingdom has plainly been along the lines of the earth's physiographic history. It must not be concluded however, that the evolution of plants was entirely or even to a considerable extent due to environment but only that the evolutionary process has kept pace with physiographic changes on the earth. The evolutionary processes are primarily the result of protoplasmic properties and functions. Organisms in the past were as well adapted to live in their environment as organisms are at present; and from a geological point of view it becomes evident that evolution has been making its way through the conditions of environment from the beginning. Generalized or archaic types are usually as rare in fossil groups as among living forms. As for example in various groups of gymnosperms, the first known forms are as highly specialized as any which come later. It is probably safe to say that the conditions of environment may and do act as determinative factors in the evolutionary process but they are not the cause of the process.

The three series of plants may be characterized as follows:

A. THALLOPHYTA. Thallophytes. 60,000 known living species.

The lowest plants; typically water plants but the majority now without chlorophyll and living as parasites or saprophytes in aerial conditions; plant body a thallus, unicellular, cœnobioid, or multicellular, usually filamentous, very minute to gigantic in size; all gradations from the lowest nonsexual plants to plants with complete sexuality and often with an alternation of generations but the sporophyte or nonsexual generation always small and not typically developed, the gametophyte being *the* plant; oosphere when present never produced in an archegonium but in a simple oogonium.

B. Archegoniata. Archegoniates. 15,000 known living species.

The intermediate plants; normally aerial plants but moisture-loving; always with an alternation of generations, the gametophyte comparatively large and often hermaphrodite in the lower forms but minute and always unisexual in the highest; the sporophyte small and without vascular tissue and permanently parasitic in the lower forms but large and with vascular tissue and becoming independent when mature in the higher; either homosporous or heterosporous, eusporangiate or leptosporangiate, never seed-producing; growing point commonly with a definite, two- or three-sided apical cell; stems sometimes having secondary thickening by means of a more or less perfect cambium or by division in the cortical cells; oosphere produced in an ovary of definite character called an archegonium and always cutting off a ventral canal cell; fertilization asiphonogamic, the spermatozoids swimming through water.

C. Spermatophyta. Seed Plants. 125,000 known living species.

The highest plants; normally dry land plants; always with an alternation of generations; sporophyte large, heterosporous and eusporangiate, the spores not discharged; the gametophytes usually minute, developing in the sporangia and thus parasitic on the sporophyte; female gametophyte, with an archegonium which develops an oosphere and ventral canal cell or with only a rudimentary ovary, retained permanently in the megasporangium (ovule); male gametophytes (pollengrains) at length discharged from the microsporangium (pollensac) but having a second period of parasitic growth by the formation of a pollentube, hence fertilization always siphonogamic; male cells usually nonciliated but in the lowest classes developing into multiciliate, motile spermatozoids; plants producing seeds, the sporophyte embryo passing into a resting stage intervening between its intra- and extra-seminal development; stems without true apical cells, but more commonly with a cambium zone from which secondary thickening takes place.

LYCOPODIUM POROPHILUM IN OHIO.

John H. Schaffner.

The Rock Lycopod, *Lycopodium porophilum* Lloyd and Underw., is a plant holding an intermediate position between *L. selago* L. and *L. lucidulum* Mx. In examining some of my herbarium material recently I recognized a fine specimen of this species, which Mr. O. E. Jennings had collected for me for class use over a year ago. The collection was made near Lancaster, Fairfield Co. It probably has a considerable range in the state and should be looked for wherever sandstone cliffs abound. It has a rather stiff appearance and can be easily recognized form the description as given in Britton's Manual. The prostrate portion of the stem is short and has abundant roots. After several dichotomous branchings the vertical stems form a rather dense tuft 6—12 cm. high. The plant has abundant brood buds. The leaves are nearly linear, acuminate, and nearly entire. They are considerably smaller than those of *L. lucidulum* and differ from *L. selago* in having the bases flattened.

THE STRUGGLE FOR LIFE ON A CERTAIN SANDBAR.

JOHN H. SCHAFFNER.

In the year 1900, the Republican River which flows through Clay County, Kansas, was very low for a long time. This gave an opportunity for the development of a thick growth of vegetation on the wide sandbars common along this stream.

The writer was much impressed by the remarkable development of young trees on some of these bars and made a careful study of one of them to ascertain what seedlings were growing under the conditions present. The picture given below (Fig. 1)

was taken from near the water's edge and shows the river bank in the background, covered with a solid belt of the Sandbar Willow (Salix fluviatilis Nutt.) This bar had been nearly barren the previous year but now it was covered with little trees. The only seedlings present, except here and there some herbaceous plant, were Cottonwoods (Populus deltoides Marsh.), Peachleaf Willows (Salix amygdaloides And.), and Sandbar Willows (Salix fluviatilis Nutt.) In some places the three species were about equally mixed, in others nearly all of the plantlets were of a single species. Near the outer margin where there was a thinner stand, as shown in the foreground of the picture, eighty Cottonwood plants from twelve to eighteen inches high were counted per square foot. But among these eighty survivors were numerous smaller dead and decaying individuals. Going a little farther toward the centre of the field, two hundred plants (Cottonwoods, Peachleaf Willows, and Sandbar Willows) were counted on an accurately measured square foot! Many, however, were losing in the struggle for space and light and were either sickly in appearance or in a dying condition. A few were already dead. The smaller ones were hopelessly shaded. A great destruction was taking place among these immature or juvenile individuals long before the normal conditions of adult life were possible. All had apparently sprouted at about the same time and the struggle for existence was among more or less similar individuals of a very few species. These possessed the ground so completely that there was practically no opportunity for an intruder to gain a foothold at this stage of the process.

But suppose that this society were to continue its development for a number of years or until the trees had grown to maturity. In three years there would be about one tree for each square foot. Such examples are numerous on old sandbars. Of the two hundred plants one hundred and ninety-nine would have no room and must inevitably perish. But in this way space is again made available for other plants to sprout among the survivors. Thus the original struggle among those of like nature makes an opportunity for plants of other species to invade the territory. Some of these can endure the shade and other imposed conditions already present and the result is more and more of a mixed society. The struggle for life is now between diverse species under all gradations of favorable and unfavorable conditions. The struggle among the original possessors of the soil is, however, not yet at an end. As the trees grow larger more and more must give way to their more powerful or fortunate neighbors. In twenty-five years there would be at most but one large Cottonwood or Willow for each fifty square feet. Nine thousand nine hundred and ninety-nine little Cottonwoods and Willows will have been over-reached and over-shadowed and the one solitary giant will stand as the sole survivor of a conquered multitude.

Not a single plant of this particular society, however, was thus fortunate. For two years later a high flood washed over the entire bar and removed every vestige of the thriving young plant society. Accidental destruction put an end to the process of the elimination of the unfit. At present the struggle for existence is again going on as vigorously among the members of a new society as it did among those which had occupied the soil before; and it is evident that without the destruction of the previous society the later generation would not even have had an opportunity to try the experiment of the juvenile stage.

NOTES ON THE MORPHOLOGY OF PHILOTRIA.

LUMINA C. RIDDLE.

The study of Philotria canadensis was begun by the writer in July, 1902, with the expectation of making a careful investigation of its morphological characters.

On account of difficulty in obtaining a complete series the work was delayed and in the meantime a preliminary report on the same subject was presented at the St. Louis meeting of the American Association for the Advancement of Science by R. B. Wylie and later the paper was printed in full, Bot. Gaz. **37**: 1-22. So carefully has he worked out nearly every detail that there seems little to add to the subject except in the way of verification. Yet it is thought advisable to make a note of some of the most important points.

Material for study was collected from Sandusky Bay, Lake Erie where the plant grows more or less abundantly but blooms rather uncertainly. None of the material obtained gave satisfactory stages beyond fertilization. The staminate flowers were found on the opposite side of the Bay from the carpellate colony.

The staminate flowers were uniformly of nine extrorse bisporangiate stamens, the three center ones being more or less united by the filaments and in some cases these extended above so as to form a resemblance to a stigma. Staminodia were found also in the carpellate flowers, but these showed no traces of sporangia.

Measurements of flowers which gave the archesporial cell stage were about 4 mm. long. Opened flowers varied in length according to the distance of the stem at their origin from the surface of the water. The average length was about 100 mm. or 4 inches.

The single archesporial cell cuts off one parietal cell usually. The primary sporogenous cell is always much the larger and divides into four megaspores the lowest being the functional one. The upper one was often quite long and was usually the last to succumb to the rapidly enlarging embryo sac. The widening of the embryo sac was great in only one plane and was not very marked when sections were cut at right angles to that plane. The pouch-like form of the antipodal region was very noticeable. Miss Burr found a similar pouch in Vallisneria, Ohio Nat. **4**: 439–443. In every case three pale vescicular nuclei could be found deep in the pouch. In some cases a large brightly stained nucleus was found just above the antipodals but careful examination showed that it was either the lower polar nucleus in a typical eight celled embryo sac or else the evidence was that there had been a division of the definitive nucleus and one of the first daughter nuclei had travelled to the antipodal region just as Schaffner finds to be the case in Sagittaria, Bot. Gaz. **23**: 252–272, and Miss Burr in Vallisneria. In the case of Philotria however, no definite wall was found cutting this nucleus off from the rest of the embryo sac. While Wylie seems to indicate in Pl. II, figs. 35-36 that there is fusion of the second sperm nucleus with the definitive nucleus it seems difficult to account for the extra nucleus in the antipodal region unless there had already been a division of the defiinitve nucleus or the polar nuclei had failed to conjugate, for in the slides which the writer examined the polar nuclei were in close contact long before fertilization and the antipodals were too vescicular to indicate the possibility of any further activity.

The synergidæ stained quite characteristically so that they were easily distinguished from the other nuclei in the embryo sac.

The pollen grains showed distinctly the tube nucleus and the crescentic sperm nuclei connected by a slender filament of cytoplasm while the four members of the tetrad still remained in close contact.

OHIO PLANTS WITH TENDRILS.

Opal I. Tillman.

Tendril plants are for the greater part, plants of the tropics, where the vegetation is so dense that the plants have developed such organs by means of which they are brought to a more favorable position with respect to light. The tendrils attach themselves to supports and thus bring the plant to an upright position or aid it in climbing over various objects. In the different species the tendrils morphologically represent different parts of the plant and this furnishes a basis of classification. Some tendrils attach themselves by twining entirely around the support, others as the Virginia Creeper, attach themselves by means of little discs with adhesive surfaces developed at the tips of the tendril. The tendril usually grows straight until the tip touches some object of support around which it hooks to secure a firm hold, then it shortens usually by coiling in a double spiral.

All tendril plants may be divided into two main divisions: first the leaf climbers, and second the shoot or branch climbers. Each of these main divisions may be subdivided depending upon the degree of development.

In the leaf tendrils the entire leaf, terminal leaflet, petiole, or petiolule or other parts may be modified into the tendril. There are five families in Ohio which have plants belonging to this group with twenty-three species.

In the Smilaceæ the two tendrils are located on either side of the base of the petiole, which presists, the blade being cast off beyond the tendril. They are simple and coil in the usual manner. In case of Smilax bona-nox there is a decided widening at the base of the tendril; S. ecirrhata is usually without tendrils.

The following greenbriers occur in Ohio:

1. Smilax herbacea L.	5. Smilax hispida Muhl.
2. " ecirrhata (Engelm) Wats.	6. " pseudo-China L.
3. " glauca Walt.	7. " bona-nox L.
4. " rotundifolia L.	

In our RANUNCULACEÆ the leaves are the climbing organs, the petiole or petiolule is the sensitive part. In Clematis virginiana there are cases showing the transition from leaf to tendril. The leaflets drop off and leave the petiole presistent. There are two species in Ohio:

8. Clematis virginiana L. 9. Clematis viorna L.

One of the PAPAVERACEÆ has modified leaves which act as tendrils. The petiolule is the sensitive part. The leaflets are very much reduced often showing a transition from ordinary leaf parts to tendril. Our species is:

10. Adlumia fungosa (Ait) Greene.

The FABACEÆ which have tendrils belong to the pea tribe, Vicieæ. The ends of the leaves develop into tendrils which have from two to five branches, except Lathyrus ochroleucus in which the tendril is simple. The Ohio species are:

11. Vicia cracca L.	17. Vicia angustifolia Roth.
12. " americana Muhl.	18. Lathyrus maritimus (L.) Bigel.
13. " carolina Walt.	19. " venosus Muhl.
14. " tetrasperma (L.) Mœnch.	20. " palustris L.
15. " hirsuta (L.) Koch.	21. " myrtifolius Muhl.
16. " sativa (L.)	22. " ochroleucus Hook.

In our species belonging to the BIGNONIACEÆ there are two leaflets and one branched tendril coming from the end of the presistent petiole.

23. Bignonia crucigera L.

The twig or shoot tendrils may represent ordinary branches or modified parts of a flower cluster and as in the leaf tendrils they may be either simple or branched. In Ohio are found four families with seventeen species belonging to this division or group.

In the climbing SAPINDACEÆ two tendrils occur at the base of the flower cluster. Our only species is the introduced:

24. Cardiospermum halicacabum L.

In the VITACEÆ the tendrils appear on the twig opposite the leaf. They are usually branched several times. In some cases one of the branches of the tendril develops a rudimentary bunch of grapes, or there may be a well developed bunch of grapes with a rudimentary tendril. In Ampelopsis cordata and most other species of this family every third leaf node is without a tendril. The Ohio species are:

25. Vitis labrusca L.
26. " æstivalis Michx.
27. " bicolor Le Conte.
28. " vulpina L.
29. Vitis cordifolia Michx.
30. Ampelopsis cordata Michx.
31. Parthenocissus quinquefolia (L.) Planch.

In our species belonging to the PASSIFLORACEÆ there is a single unbranched tendril coming from the axil of the leaf. It coils in the usual manner.

32. Passiflora lutea L.

The tendrils in the CUCURBITACEÆ represent modified shoots; part of the tendril being stem and part leaf. They are from two to five branched, all the branches coming from the same point. They usually appear beside the leaf. The Ohio species are:

33. Micrampelis lobata (Michx) Greene.
34. Sicyos angulatus L.
35. Cucurbita pepo L.
36. " pepo ovifera L.
37. Cucurbita maxima L.
38. Citrullus citrullus (L.) Karst.
39. Cucumis melo L.
40. " sativus L.

KEY TO OHIO WALNUTS BASED ON TWIG CHARACTERS.

JOHN H. SCHAFFNER.

Juglans L. Trees with valuable often very dark-colored wood, spreading branches, and fragrant bark; twigs with terminal buds and superposed axillary buds and with dark brown bark; leaf scars alternate, large, heart-shaped, not 2-ranked; bundle scars 3 or in 3 areas; stipular scars none; end of twig often showing a self-pruning scar caused by the falling away of the carpellate peduncle; pith diaphragmed, with cavities.

1. Bark of twigs very pubescent. 2.
1. Bark of twigs glabrous; terminal bud and most of the lateral buds hemispheric or very short-pointed, but some may be cone-shaped; cultivated. *J. regia* L. English Walnut
2. Axil of leaf scar with a hairy cushion below the buds; terminal bud light-colored, usually truncate, with long scales; lateral buds usually spherical. *J. cinerea* L. Butternut
2. Axil of leaf scar without a hairy cushion; terminal bud dark-colored, usually pointed, with short scales; lateral buds ovoid-conic. *J. nigra* L. Black Walnut

The Nature Study Review, published in New York under the editorship of Prof. M. E. Bigelow of Columbia and with a very distinguished list of associates is undertaking to develop the nature study movement along lines which will doubtless command the support of the better class of naturalists.

There has been of late years so much of a tendency to run the nature study idea into such extremely popular and superficial lines that the real purpose and intent of the originators has been endangered. That there is abundant place for every agency that will tend to extend the knowledge of nature while at the same time avoiding the running of nature study into a mere fad of nature romance, will doubtless be agreed by all true naturalists.

Readers of the NATURALIST will find much of interest in the numbers of the Review so far published and doubtless future numbers will be of equal interest and value. H. O.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, Jan. 9, 1905

The meeting was called to order by the Vice-President, Miss Riddle. The minutes of the previous meeting were read and approved. The first speaker of the evening was Prof. W. C. Mills, whose subject was "The Ainu of Japan." Prof. Mills came into personal contact with the Ainu at the St. Louis Exposition, and was able to illustrate his talk with several photographs and with specimens of their handiwork. The Ainu are one of the primitive peoples of Japan and at present inhabit the northern islands, principally Yezo. At present there are about 17,000 Ainu and about 900,000 Japanese on this island. The nine Ainu who were brought to St. Louis were the first to leave their native land in 1400 years. The men all wear long beards and the women tattoo their faces to represent a beard. This tattooing is begun at about the age of nine and is done by cutting the flesh and rubbing in the wounds soot from the bottom of their cooking vessels. The average height of the men is about 5 ft. 4 in. Their eyes are horizontal; the skin is white, and their features resemble those of many of the white races of Europe. The women weave a kind of cloth called Artus, made from the fibers of the Elm and from this they make much of their clothing. This clothing is usually decorated with certain entirely original, spiral patterns. Their religious customs are very peculiar. The bear plays an important part in their religion and the bear hunt and feast is one of their singular customs.

Prof. Osborn then gave an account of the recent meeting of the American Association for the Advancement of Science and of some of its affiliated societies. Prof. Lazenby also spoke of some of the affiliated societies, especially the Society of Agriculturists and the Society of Horticulturists.

Prof. Landacre gave a short account of the meeting of the Ohio Educational Society and the mid-winter meeting of the Ohio Academy.

On the motion of Prof. Schaffner the following were elected to membership: E. C. Cotton, G. F. Lamb, J. P. Pratt and T. P. White.

The club then adjourned until the first Monday in February.

F. M. SURFACE, *Secretary.*

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ODONATA, ASTACIDAE AND UNIONIDAE COLLECTED ALONG THE ROCKCASTLE RIVER AT LIVINGSTON, KENTUCKY.

E. B. WILLIAMSON.

The few following records of two days collecting in Rockcastle County, Kentucky, near the headwaters of the Cumberland River on June 23 and 24, 1904, may be of interest. Since collecting along the Cumberland at Nashville, Tennessee, I have been desirous of following the same river among the hills of eastern Kentucky where I expected to find the Rockcastle a rapid mountain stream with waterfalls, deep pools and long, swift rapids. Such is far from its nature. Its bed in the soft rocks is nearly made and, resting from former labors, the stream flows so slowly under the overhanging branches of birch trees that its motion is almost imperceptible. Shaded by trees and hills, steep-banked, cold and motionless, it offers few of those attractions to dragonflies which I had hoped ot find. There are no gorges and only an occasional low, short ripple (locally shoal) relieves the monotony of long stretches of canal like tranquility. The perfume of flowering laurels on the verdure-clothed banks saturate an atmosphere in which sound and motion would be as sacrilegious as in the chamber of death. Doubtless at seasons there is greater activity. On the dates above mentioned (June 23 and 24) only nine species of dragonflies were taken. I believe collecting three weeks earlier would have revealed a greater number of species and individuals, and possibly a great many Gomphines might have been found at the ripples at this time.

DRAGONFLIES.

1. *Calopteryx angustipennis.* Not rare, frequenting willow-herb at ripples. This species was taken by Mr. Chas. Dury along Little Blue River, Crawford County, Indiana, May 27, 1904. This lost species, rediscovered in 1899 in Pennsylvania and Ohio, seems to have unaccountably escaped collectors for a long period.

2. *Argia tibialis.* This species was found abundantly along Sycamore Creek, a tributary of the Cumberland, near Nashville, Tenn., during the spring of 1901.

3. *Enallagma exsulans.* This is the river *Enallagma* of the Ohio River system.

4. *Progomphus obscurus.* This common gomphine was not rare along the Rockcastle.

5. *Dromogomphus spinosus.* What has been said of *Progomphus obscurus* applies to this species.

6. *Gomphus dilatatus.* Two males, resting on boulders in mid-stream in a ripple, were taken.

7. *Lanthus albistylus.* Observed in the afternoon resting on boulders and pebbles about a wide slow ripple. The nymph, described by Hagen from Kentucky as possibly *Tachopteryx thoreyi* and referred by Needham to *Lanthus parvulus*, in all probability is this species.

8. *Hagenius brevistylus.* Recently emerged individuals of both sexes were taken.

9. *Macromia illinoiensis.* Several males taken flying along the river.

CRAYFISHES FROM KENTUCKY.

Notes and determinations by Dr. A. E. Ortmann.

1. *Cambarus bartoni* (F.) 3 males (second form), 1 female. Rostrum more tapering and narrower than in typical specimens from eastern Pennsylvania; but a similar form of rostrum is found in (chiefly young) individuals from western Pennsylvania. Tubercles of inner margin of hand more strongly developed, with slight indications of a second row.

Small streams tribuatry to Rockcastle River, Livingston, Rock Castle Co., Ky. E. B. Williamson.

2. *Cambarus extraneus* Hag. 2 males (second form), 2 females. Hagen, Ill. Cat. Mus. Harvard. 3. 1870 p. 73. Faxon, Mem. Mus. Harvard. 10. 1885 p. 84. Faxon, Pr. U. S. Mus. 20. 1898 p. 650.

Areola slightly longer than half of anterior section of carapace; fingers of chelae elongated (characters of *girardianus*). Lateral spine of carapace well developed; external orbital spine comparatively small; distal upper end of meropodite of cheliped with two spines (in one specimen with three, the third anterior to the others, and small).

The specimens thus agree apparently with those mentioned by Faxon (1898) from Big Cahawba River, central Alabama, (Alabama River drainage), which are said to be intermediate bewteen *extraneus* and *girardianus*. The typical *extraneus* is reported from Etowah River, Rome, Floyd Co., Ga. (Alabama River drainage); the var. *girardianus* Fax. is known from Cypress Creek, Lauderdale Co., Ala., and from Eastanaula Creek, near Athens, McMinn Co., Tenn. (both belonging to the Tennessee River drainage). The new locality belongs to the Cumberland River, and it is remarkable that instead of finding here *girardianus*, we have a transitional form, which rather resembles *extraneus*.

Rock Castle River, Livingston, Rock Castle Co., Ky. E. B. Williamson.

3. *Cambarus putnami* Fax. 2 males (second form), 1 female. Agree well with description. This species is positively known from the following localities only: Kentucky, Grayson Springs, Grayson Co.; Green River, near Mammoth Cave; Cumberland Gap.

Rock Castle River, Livingston, Rock Castle Co., Ky. E. B. Williamson.

FRESH-WATER MUSSELS.

My specimens were kindly determined by Dr. Dall and a complete set has been placed in the National Museum. The following arrangement and nomenclature are those of Simpson's Synopsis from which work I have copied the distribution of each species.

1. *Lampsilis ventricosus* Barnes. Entire Mississippi drainage; St. Lawrence system; Nelson River and tributaries.
2. *Lampsilis multiradiatus* Lea. Entire Ohio River drainage; southern Michigan.
3. *Lampsilis taeniatus* Conrad. Tennessee and Cumberland River systems.
4. *Lampsilis rectus* Lamarck. Entire Mississippi drainage; Alabama River drainage; Red River of the North; St. Lawrence system.
5. *Lampsilis trabalis* Conrad. Kentucky and streams of Tennessee; Clinch River, Virginia.
6. *Lampsilis glaus* Lea. Ohio River drainage; Warsaw, Indiana; (probably St. Lawrence drainage) southern Michigan; White River, Carroll County, Arkansas.
7. *Medionidus acutissimus* Lea. Alabama River system.
8. *Medionidus subtentus* Say. Tennessee and Cumberland River systems.
9. *Tritogonia tuberculata* Barnes. Mississippi drainage generally; streams falling into the Gulf of Mexico from the Alabama system west to Central Texas.

10. *Ptychobranchus phaseolus* Hildreth. Ohio, Tennessee and Cumberland River systems; peninsula of Michigan; Kansas; Arkansas; Indian Territory; Louisiana.

11. *Strophitus edentulus* Say. Entire Mississippi drainage; St. Lawrence system and south in streams draining into the Atlantic to North Carolina; north in the British possessions to Lake Winnipeg; southwest to central Texas; Tyner, Alabama.

12. *Pegias fabula* Lea. Cumberland and Tennessee river systems.

13. *Alasmidonta truncata* B. H. Wright. Upper Mississippi drainage; Ohio, Cumberland and Tennessee River systems; Michigan; Upper St. Lawrence drainage.

14. *Unio gibbosus* Barnes. Entire Missippissi drainage; St. Lawrence and its tributaries; Alabama River system; southeast into Florida; southwest to the Guadalupe River, Texas.

15. *Pleurabema clava* Lamarck. Ohio, Cumberland and Tennessee River systems.

16. *Quadrula coccinea* Conrad. Entire upper Mississippi drainage; St. Lawrence basin in various localities.

KEY TO THE LIVERWORTS RECOGNIZED IN THE SIXTH EDITION OF GRAY'S MANUAL OF BOTANY.

Edo Claassen.

This key was prepared for the purpose of making the work of determining the liverworts described in Gray's Manual more easy than it has been heretofore. Other characters have been added to the description of the perianth, here and there, that in case the perianth is wanting, it may be possible to find the name of the genus of the specimen in hand.

In the archegonial "flower" of the foliose liverworts the pedicel together with the capsule is usually surrounded by three envelopes—the involucre, the perianth, and the calyptra.

The external envelope, called the involucre, is formed by the uppermost leaves which surround the base of the perianth. They usually differ from the lower leaves by their size and shape and are sometimes more or less connate with the perianth.

The perianth, surrounded by the involucral leaves, is a sac-like envelope of oval or cylindrical form. It may be compressed or angular, smooth or folded and its orifice may be either entire or lobed, dentate or ciliate. Although usually present it is wanting in Gymnomitrium and most of the frondose liverworts.

After fertilization the capsule is formed in the interior of the archegonium and while developing ruptures the upper part of the same by the lengthening of its pedicel. The archegonium thus modified and remaining at the bottom of the perianth represents the calyptra. It is soft and hyaline and in most cases shorter than the perianth and not connate with it.

It may be added that any suggestions in regard to the improvement of this key will be thankfully received.

All liverworts are usually divided into two artificial groups, the foliose and frondose, which are then subdivided as follows:

Plant–body a leafy axis (Jungermanniaceae). 1
Plant–body a thallus. 30.

1. Leaves incubous. 2.
Leaves succubous. 13.
2. Leaves complicate-bilobed or with a small lower lobe. 3.
Leaves not complicate-bilobed or with a small lower lobe. 7.
3. Lower lobe incurved-ventricose or saccate, seldom expanded. 4.
Lower lobe quadrate or roundish. 6.
4. Lower lobe incurved, more or less ventricose. *Lejeunia.*
Lower lobe saccate, seldom expanded. 5.
5. Branches intra-axillary, the leaves on either side free. *Frullania.*
Branches lateral, a basal leaf borne partly on the stem, partly on the branch. *Jubula.*
6. Lower leaf-lobe quadrate. *Radula.*
Lower leaf-lobe roundish. *Porella.*
7. Leaf-divisions numerous and capillary. 8.
Leaf-divisions not numerous and capillary. 9.
8. Leaves bilobed, lobes subdivided and with ciliate margins. Perianth present, terminating short branches, smooth, obovate, mouth connivent, plicate-denticulate. *Ptilidium.*
Leaves 4-5-divided, divisions setaceously multifid and fringed. Perianth none or rather forming together with the calyptra and involucre a terminal or axillary, fleshy and hairy torus. *Trichocolea.*
9. Leaves deeply bilobed and 3-ranked (underleaves being similar to leaves. *Herberta.*
Leaves not bilobed and 3-ranked. 10.
10. Leaves entire (sometimes retuse) or 2-3-toothed. 11.
Leaves 2-4-cleft or parted. 12.
11. Leaves entire (sometimes retuse). *Kantia.*
Leaves 2-3-toothed. *Bazzania.*
12. Leaves 3-(or seldom 4) parted; divisions capillary, formed by one row of cells. *Blepharostoma.*
Leaves palmately 2-4-cleft or -parted; divisions formed by more than one row of cells. *Lepidozia.*
13. Capsule opening irregularly into 4 irregular or dentate valves; plant-body pseudofoliaceous. *Fossombronia.*
Capsule opening regularly into 4 regular valves; plant body foliaceous. 14.
14. Perianth absent; leaves closely imbricate and 2-ranked on short julaceous stems. *Gymnomitrium.*
Perianth present. 15.
15. Perianth connate to the middle or more with the involucral leaves. 16.
Perianth free or connate with calyptra. 17.
16. Perianth connate to near the summit; leaves complicate-bilobed. *Marsupella.*
Perianth connate to the middle; leaves entire or nearly so. *Nardia.*
17. Perianth pendant, saccate; leaves bilobed, extending horizontally and at right angles from the stem; underleaves 2-cleft. *Geocalyx.*
Perianth upright; underleaves none or ovate-lanceolate or 2-4-cleft. 18.

18. Leaves complicate-bilobed. 19.
 Leaves not complicate-bilobed. 20.
19. Perianth oval, scarcely or not compressed, plicate; mouth denticulate. *Diplophyllum.*
 Perianth dorsally compressed, mouth truncate, bilabiate, decurved. *Scapania.*
20. Underleaves present (Plagiochila and Cephalozia may be sought here). 21.
 Underleaves none or usually none. (Odontoschisma may be sought here). 26.
21. Leaves bilobed, bidentate or emarginate. 22.
 Leaves entire (sometimes retuse). 25.
22. Leaves emarginate; perianth connate with the calyptra. *Harpanthus.*
 Leaves bilobed or bidentate; perianth free. 23.
23. Underleaves 2-4-cleft or parted. *Lophocolea.*
 Underleaves entire or nearly so. 24.
24. Involucral leaves 2, connate at base, entire. Stems without runners. Leaf-cells roundish, 5-7-angular, cell walls much thickened, each cell appearing as if surrounded by about 6 smaller, 3 (or more)-angular ones. *Mylia.*
 Involucral leaves 3-ranked, bifid or bilobed. Stems with runners. Leaf cells round, surrounded by much thickened walls. *Odontoschisma.*
25. Underleaves 2-4-parted. *Chiloscyphus.*
 Underleaves subulate, fugacious. *Jungermannia.*
26. Leaves bifid or bilobed. 27.
 Leaves entire (sometimes retuse) or spinulose-dentate. 28.
27. Perianth triangular ,prismatic, the contracted mouth dentate. *Cephalozia.*
 Perianth oval-oblong, plicate, mouth denticulate. *Jungermannia.*
28. Leaves entire (sometimes retuse). 29.
 Leaves spuinlose-dentate, rarely entire, the dorsal margin reflexed; perianth compressed. *Plagiochila.*
29. Perianth cylindrical, wider above, truncate, depressed, with orifice prominently umbilicate, ciliolate. *Liochlaena.*
 Perianth compressed or terete, usually carinate, mouth entire or toothed. *Jungermannia.*
30. Capsule splitting into 4 regular valves (Jungermanniaceae). 31.
 Capsule not splitting into 4 regular valves. 35.
31. Thallus with distinct costa. 32.
 Thallus with indistinct costa or none. 34.
32. Thallus villous throughout or hairy (ciliate) on marign and midrib beneath. *Metzgeria.*
 Thallus smooth. 33.
33. Perianth long tubular; thallus mostly simple with sinuate or undulate margins, transparent, without inside cavities. *Pallavicinia.*
 Perianth none; thallus dichotomous or radiate with pinnatifid margins, opaque, with inside cavities filled with green cells. *Blasia.*
34. Thallus mostly simple or forked, with thick margin. Sporogonium rising from the underside near margin. Elaters persistent on tip of valves. *Aneura.*
 Thallus mostly palmatifid or pinnately lobed with thin margin (one layer of cells). Sporogonium rising from the upper surface. Elaters persistent in the centre of the capsule. *Pellia.*
35. Capsules solitary, more or less perfectly 2-valved (sometimes rupturing irregularly), linear (Anthocerotaceae). 36.
 Capsules aggregate, pendant from the underside of a peduncled disk or cruciately arranged in 4 horizontal segments or sessile on the thallus or immersed in it. 37.

36. Capsule narrowly linear, pedicelled, 2-valved. Elaters present. *Anthoceros.*
Capsule very short, sessile, not valved below middle. No elaters. *Notothylas.*
37. Capsule pendent from the underside of a peduncled disk or cruciately arranged into 4 horizontal segments (Marchantiaceae). 38.
Capsule sessile on the thallus or immersed in it (Ricciaceae). 45.
38. Thallus barely costate or ecostate. *Dumortiera.*
Thallus plainly costate. 39.
39. Gemmae present on sterile stems. 40.
Gemmae none. 41.
40. Gemmae in cup-shaped receptacles. Fertile receptacle 7-11-rayed. *Marchantia.*
Gemmae in crescent-shaped receptacles. Fertile receptacles cruciform. *Lunularia.*
41. Perianth present. 42.
Perianth none. 43.
42. Perianth scarcely exserted, 4-5-lobed. Receptacle 2-4-lobed with as many alternate rib-like rays. *Preissia.*
Perianth exserted half its length and cleft into 8-16 fringe-like segments. Receptacle 4-lobed. *Fimbriaria.*
43. Thallus large, very indistinctly porose, scaleless below. Receptacle hemispherical, acutely 4-8-lobed. *Asterella.*
Thallus small or very large, porose. 44.
44. Thallus very large, without scales below. Receptacle conical, membraneous. *Conocephalus.*
Thallus small with purple scales below. Receptacle conic, hemispherical, truncately 3-4-lobed. *Grimaldia.*
45. Capsule sessile on the thallus; involucre inflated-pyriform. *Sphaerocephalus.*
Capsule immersed in the thallus; involucre none. *Riccia.*

KEY TO THE OHIO ELMS IN THE WINTER CONDITION.

Lindley M. Smith.

Ulmus L. Trees with medium heavy and medium hard wood and rough flaky bark in ridges; twigs brown, the terminal bud self-pruned; visible bud scales several, dry; leaf scars semi-oval, 2-ranked, oblique; bundle scars 3; stipular scars prominent; pith small, cylindrical, solid; some with corky ridges on the twigs, others with abundant self-pruning scars either in the annual nodes or at the base of the twig.

1. Twigs very rough pubescent; inner bark mucilaginous, pleasant to the taste; buds very hairy at the tips; twigs never self-pruned; buds shed abundantly. U. *fulva* Michx. Slippery Elm
1. Twigs glabrous or slightly pubescent; not mucilaginous or slightly so, rather bitter; buds glabrous or if hairy rather small and pointed. 2.
2. Buds ovate short pointed, bud scales quite hairy; twigs without self-pruning joints in the annual nodes; none of the branches corky winged; cultivated. U. *campestris* L. English Elm
2. Buds ovate-conic with long points, bud scales glabrous or somewhat pubescent; twigs with self-pruning joints in the annual nodes, often leaving peculiar stumps; native. 3.
3. None of the branches corky-winged; buds pointed but rather elliptical, glabrous or nearly so. U. *americana* L. White Elm
3. Some or many of the branches corky-winged; buds very much pointed, somewhat pubescent. U. *racemosa* Thomas. Cork Elm

NOTES FROM THE OHIO STATE HERBARIUM. III.

H. A. Gleason.

The genus Bidens in Ohio. The species of the genus as represented in Ohio fall naturally into four well distinguished groups, the first including the simple leaved forms with or without rays, the second the rayless species with divided leaves, the third the Coreopsis-like species with conspicuous rays, and the fourth the single species *Bidens bipinnata*, distinguished by its linear achenes and dissected leaves. The latter is our only representative of the section Psilocarpae of DeCandolle; the others with flat achenes belong to the section Platycarpae.

The species of the northeastern United States have been confused in the recent floras, and this has led to a misunderstanding of the local forms. The keys and descriptions in this paper include only the Ohio species, and it is hoped that they will be of service to Ohio botanists in studying this interesting genus of Composites.

A number of species now included in *Bidens* are in Gray's Manual and other earlier works referred to *Coreopsis*. Dr. Britton (Bull. Torr. Club **20**:280, 281. 1893.) first pointed out their closer relationship with *Bidens*, including in that genus all forms with a pappus of upwardly or downwardly barbed awns, and limiting *Coreopsis* to those species in which the pappus consists of two short teeth, a mere border, or is entirely absent. The aquatic species known as *Bidens beckii* differs in many significant features from typical *Bidens*, and has been proposed by Professor E. L. Greene as the type of the new genus *Megalodonta*. The name of the Ohio species becomes accordingly *Megalodonta beckii* (Torr.) Greene.

The most important recent literature on the genus is by K. M. Wiegand (Bull. Torr. Club **26**:399–422. 1899.), who gives keys and full descriptions of most of the species of Platycarpae, and by E. L. Greene (Pittonia **4**:242–284. 1901.), who discusses the nomenclatorial history of the genus and describes many new species.

Key to the Ohio Species.

1. Achenes linear, not flattened. (Psilocarpae DC.) 1. *B. bipinnata.*
1. Achenes cuneate to obovate, flattened. (Platycarpae DC.) 2.
2. Leaves simple, serrate or somewhat pinnatifid. 3.
2. Leaves pinnately parted or compound. 6.
3. Heads nodding on erect peduncles after flowering. 4.
3. Heads persistently erect. 5.
4. Leaves oblong, 6-10 cm. long, little or not at all narrowed at the base. 2. *B. cernua.*
4. Leaves elliptical, 10-18 cm. long, narrowed at the base. 3. *B. elliptica.*
5. Outer bracts scarcely exceeding the disk, not more than 15 mm. long. 4. *B. connata.*

5. Some of the outer bracts twice as long as the disk or longer, the longest 20-75 mm. long. 5. *B. comosa.*
6. Rays none or very short. 7.
6. Rays large and conspicuous, bright yellow. 8.
7. Outer involucral bracts 4, achenes about 5 mm. long. 6. *B. discoidea.*
7. Outer bracts 6–8, achenes 6–8 mm. long. 7. *B. frondosa.*
7. Outer bracts 10–16, achenes 7–10 mm. long. 8. *B. vulgata.*
8. Achenes cuneate, the short awns narrowly triangular, upwardly hispid. 9. *B. trichosperma.*
8. Achenes cuneate to obovate, the slender awns two-thirds the length of the achene or more, barbed. 10. *B. aristosa.*

1. *Bidens bipinnata* L. Stem much branched, 3–8 dm. high. Leaves slender petioled, ovate, 1-3-pinnately parted, segments ovate, deeply toothed or lobed. Heads long peduncled, 10-20-flowered, involucre oblong, 7–10 mm. high; achenes linear, four-sided, narrowed above, 7–15 mm. long, exclusive of the usually four downwardly barbed awns.

In shaded places throughout the state.

2. *Bidens cernua* L. Stem sparingly branching above or sometimes from the base, 2.5–4.5 dm. high. Leaves oblong, about 1 cm. wide, acuminate, finely and regularly serrate except at the apex and base, cordate-clasping or connate. Heads few to several, erect in flower, nodding in fruit, about 8 mm. high, outer bracts equalling or exceeding the disk; achenes four-angled, cuneate, 4–5 mm. long, awns four, 2–3 mm. long, retrorsely barbed.

Specimens are in the State Herbarium from Cuyahoga, Geauga, Lucas, Madison, Mercer, Perry and Wayne Counties.

3. **Bidens elliptica.** (Wiegand). *Bidens cernua elliptica* Wiegand, Bull. Torr. Club **26**:417. 1899. Stem erect, usually freely branching above or sometimes from the base, 3–8 dm. high. Leaves elliptical, typically 12–15 cm. long by 2–3 cm. wide, sharply serrate along the middle, long acuminate and conspicuously narrowed toward the sessile or barely connate base. Heads very numerous, nodding in fruit, outer bracts exceeding the disk, ray flowers usually present and conspicuous; achenes cuneate, 5-6 mm. long, awns four, retrorsely barbed.

Abundant in wet places along streams, apparently throughout the state.

Bidens elliptica is one of the commonest members of the genus occurring in Ohio. However, it has never before been definitely reported from the state, probably because it is not described in the current manuals, where it is included under *Bidens cernua*. When its identity has been recognized it has been frequently confused with *Bidens laevis*, a coastal plain species with persistently erect heads, not found farther inland than central New York. Although originally described by Wiegand as a variety of *Bidens cernua*, its stouter and branching habit, the numerous heads, the brighter green and larger leaves with their characteristic elliptical shape and tapering base easily distinguish it from that species and warrant its elevation to specific rank.

4. *Bidens connata* Muhl. Stem erect, branching above, 4–10 dm. high. Leaves lanceolate, sharply serrate, long acuminate at base and apex. Heads numerous, about 6 mm. high, rays none; outer bracts of the involucre about 5, 1–1.5 times as long as the disk, lanceolate-oblong, entire or minutely toothed; corollas 5-lobed; achenes cuneate, 5 mm. long, awns 2 mm. long, retrorsely barbed.

There is but one specimen in the State Herbarium, from Wyandot County.

5. *Bidens comosa* (Gray) Wiegand. Stem diffusely branching from the base, or with short branches above, 2–7 dm. high. Leaves elliptic, lanceolate, or narrowly ovate-lanceolate, coarsely toothed, acute or acuminate, tapering at the base into a winged petiole. Heads usually numerous, about 1 cm. high in flower, in fruit becoming 2 cm. high and 3 cm. in diameter, outer bracts 6–8, oblong to oblanceolate, foliaceous, serrate, twice as long as the disk or longer and reaching a length of 8 cm.; corollas 4-lobed; achenes 7–10 mm. long, awns three, the longest 4–6 mm.

Abundant in wet places, probably throughout.

6, *Bidens discoidea* (T. & G.) Britton. Stem freely branched, 5–15 dm. high. Leaves 3-divided, on slender petioles, leaflets lanceolate or narrowly ovate-lanceolate, sharply serrate, acute at the base, long acuminate at the apex. Heads numerous, 5 mm. high in flower, outer bracts 4, narrowly spatulate, exceeding the disk; achenes cuneate, about 5 mm. long, the two awns about 2 mm. in length.

One specimen from Cedar Point, Erie County.

7. *Bidens frondosa* L. Sparingly branched with spreading branches, 6–10 dm. high. Leaves 3-divided, usually thin, on slender petioles 3-5 cm. long, leaflets ovate-lanceolate, acute or rounded at the base, acute or short-acuminate at the apex, 5–8 cm. long. Heads relatively few, 5 mm. high in flower, much larger in fruit, outer bracts 6–8, narrowly spatulate, conspicuously exceeding the disk, naked or sparingly ciliate at the base; achenes oblong or cuneate, dark brown to black, 6–8 mm. long, awns two, 4 mm. long.

The three specimens in the State Herbarium, from Holmes, Meigs and Vinton counties, have been confused with *Bidens discoidea*. The two species are at once separated by the more numerous outer bracts and the much larger achenes of *Bidens frondosa*, as well as by the laxer habit of branching in the latter species. According to Wiegand the leaves are sometimes 5-divided, but this was not observed in any Ohio specimens.

8. *Bidens vulgata* Greene. Stem stout, erect and branching, 5–16 dm. high. Leaves pinnately 3-5-divided, on long petioles, leaflets lanceolate, acuminate, coarsely and sharply serrate or almost incised, 5–12 cm. long. Heads comparatively few, mostly on long stout peduncles, the largest becoming 2 cm. high and 3 cm. across in fruit, outer bracts 10–16, spatulate oblong, unequal and conspicuously exceeding the disk, ciliate at base; achenes brown, obovate, flat, 7–10 mm. long, the two awns 4–6 mm. long.

Abundant in moist soil throughout the state. It has long been confused with *Bidens frondosa*, and under that name has been included in Gray's Manual and the Illustrated Flora. It is distinguished from *Bidens frondosa* by the larger heads, the coarser leaves, the more ascending branches, and the large broad achenes. The bracts, which are ciliate in *Bidens vulgata*, may possibly serve also as a distinguishing character.

9. *Bidens trichosperma* (Michx.) Britton. Tall and freely branched above in the usual form, although in peat bogs it may bloom when but 2–3 dm. high. Leaves petioled, 1-2-pinnately parted, segments 3–10, narrowly linear-lanceolate or linear, acuminate at base and apex, sharply serrate along the middle or almost entire. Heads numerous and showy, outer bracts linear-spatulate, about equalling the disk; achenes cuneate, 5–6 mm. long, awns 2–3 mm. long, narrowly triangular, upwardly hispid or becoming smooth.

Throughout the state, except possibly the extreme southern part, but especially common at the north. Widely variable in size and especially in the shape of the leaf-segments, which in specimens from peat-bogs are sometimes linear-spatulate, entire and rounded at the apex. From this extreme there is every gradation to the typical linear-lanceolate shape. The variety *tenuiloba* has been reported from the state and is undoubtedly included in the preceding description, but there is no valid reason for separating two forms in the Ohio material at hand.

10. *Bidens aristosa* (Michx.) Britton. Stems erect, freely branching, 4–10 dm. high. Leaves petioled, pinnately divided, segments 3–7, lanceolate, sharply serrate, acuminate at both ends. Heads very numerous, with conspicuous rays, outer bracts oblong or oblong-spatulate, equalling or shorter than the disk; achenes broadly obovate, 4 mm. long, with two slender barbed awns 3–4 mm. long.

This western species has so far been reported only from the western part of the state. Three specimens are in the State Herbarium, from Champaign, Clark, and Madison Counties. Although in general habit it resembles *Bidens trichosperma*, it is easily and certainly distinguished from it by the broad achenes with their long slender awns.

DEVELOPMENT OF THE EMBRYO SAC AND EMBRYO OF STAPHYLEA TRIFOLIATA.*

Lumina C. Riddle.

Material for the study of Staphylea trifoliata, L. was collected along the banks of the Olentangy River during several Springs, killed in chrome-acetic acid and imbedded in paraffin. The sections prepared varied in thickness from 8–15 microns. Analin safranin and gentian violet, and iron-alum haematoxylin were used in staining, both giving good results although the latter stain was too dense for pollen grains.

Staphylea trifoliata belongs to the Family Staphyleaceae and to the Order Sapindales and is thus allied to the Hippocastanaceae, Aceraceae, Celastraceae, and Sapindaceae. Scarcely any morphological work seems to have been done on this Order so that very little comparison can be made between Staphylea and nearly related plants. Mottier, Bot. Gaz. **18**:375–377, has reported on the development of the embryo-sac of Acer rubrum and some points of comparison will be noted later. Strasburger also made observations on Staphylea pinnata and Acer in "Zellbildung and Zelltheilung" Jena, 1880; and "Neue Untersuchungen ueber den Befruchtungsvorgang bei den Phanerogamen" Jena 1884.

As a general rule the flowers were quite normal in the number of parts the only variation being four carpels instead of three in the gynoecium. The number of ovules in each carpel may be as high as eight but very rarely more than one matured in each cavity and often only one in the entire capsule. The ovules are anatropous and the best sections were those cut across the ovulary. As soon as the ovules were large enough they were removed from the capsule before killing. The integuments become too woody to make microtome sections long before the embryo is mature. There are two integuments on the ovule but no aril.

The hypodermal archesporial cell (Pl. 19, Fig. 1) appears before there are any traces of integuments. In one case a three celled archesporium (Fig. 2) was found. The single archesporial cell cuts off a primary parietal cell (Fig. 3) which divides to form from three to five tapetal cells (Figs. 4–7) forcing the megasporocyte deep into the tissue of the nucellus. The megasporocyte then divides into four megaspores (Fig. 8) and the lowest becomes functional destroying the others as it enlarges and divides (Figs. 9–10).

* Contributions from the Botanical Laboratory of the Ohio State University, XIX.

The embryo sac widens slightly as it develops to the eight celled stage (Figs. 11–13) and the nuclei arrange themselves in the normal positions, three at the top becoming the synergidae and egg cell, the three lowest settle into a pocket and gradually disintegrate while the two polar nuclei approach each other and finally come to rest in contact.

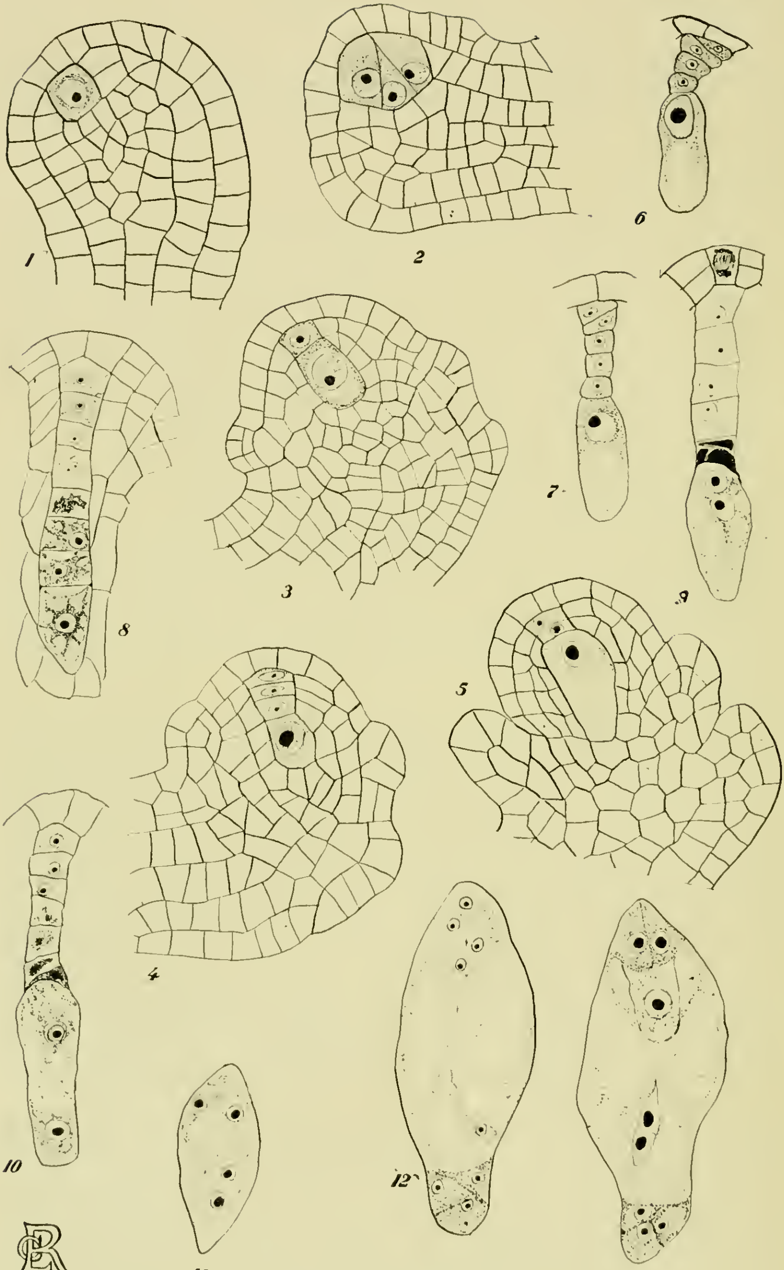
Sections which showed the archesporial cells showed the microspores fully developed and the tapetal layer already breaking down (Fig. 14). Older flowers gave thick-walled pollen grains having two nuclei, the pollen tube nucleus and the generative nucleus. This pollen grain (Fig. 15) resembles those of Acer rubrum (Mottier) and Staphylea pinnata (Strasburger). The latter reports the division of the generative cell into the two sperm cells after the formation of the pollen tube. The generative cell stains quite dark and is apparently enclosed by a wall, making the entire pollen grain very similar to that of the staminate flower of Acer rubrum.

In the formation of the definitive nucleus two polars usually unite (Fig. 13) but in several instances three exactly similar nuclei were found fusing (Fig. 17). In one case, however, there was found what seems to be the union of one of the sperm nuclei with the polars (Fig. 16). This third nucleus is surrounded by a small amount of cytoplasm which stains distinctly darker than that of the polars and the nucleus contains a single small dark nucleolus.

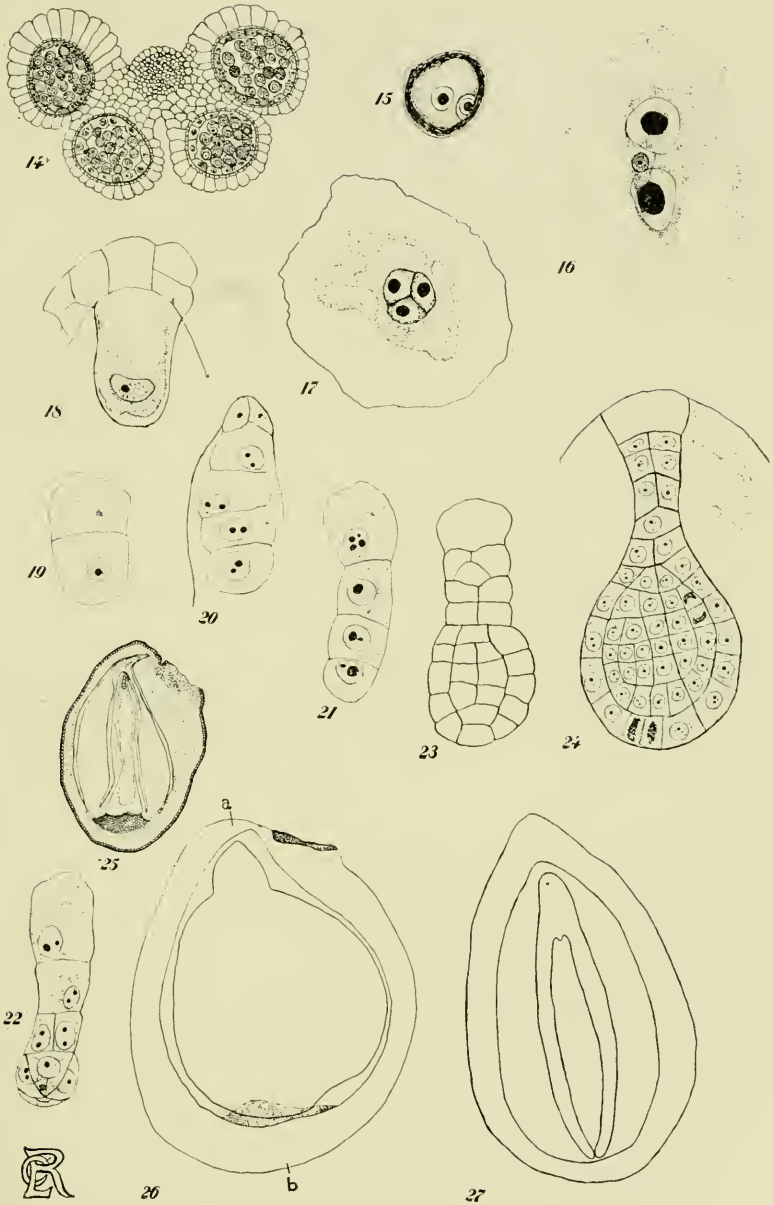
After fertilization the embryo sac enlarges, the formation of endosperm occurs rapidly and the ovule increases greatly in size. The endosperm forms a large loose single layered lining for the entire embryo sac before any division of the one celled embryo occurs. The ovules are about one-fourth the mature size before anything larger than a one-celled embryo is found (Fig. 18). The two-celled (Fig. 19), and four-celled stages (Figs. 20,21 and 25), were found in half grown ovules. Seeds which were full size but still not too hard to section contained embryos still too young to show the development of the cotyledons (Figs. 22–24). Capsules which contained these full sized ovules had attained their normal bladdery inflation. The endosperm was abundant but the nuclei had not begun the formation of walls so that the multinucleate cells which Strasburger finds in Staphylea pinnata were not observed.

The synergidae have usually disappeared or are completely obscured by the abundant endosperm before the one celled embryo divides but in a few cases traces of them were seen with a four-celled embryo (Fig. 20). No traces of the antipodals were evident after division of the endosperm nuclei became rapid.

Division of the suspensor occurs with the formation of the quadrant and seems to retrogress towards the basal cell but the



RIDDLE on "Staphylea trifoliata.



RIDDLE on "Staphylea trifoliata.

latter was not seen divided and its nucleus was quite vescicular even in rather young embryos (Figs. 23-24). The abundant endosperm completely surrounds the young embryo which at first develops very slowly. The outer integument becomes very hard, the inner one and the nucellus remaining very spongy and giving way to the growing endosperm. Ovules which contained mature embryos were found in the capsules of the previous year. Hand sections showed a flat straight embryo with two cotyledons (Figs. 26-27). There was no endosperm layer between the cotyledons. The hardening of the outer integument agrees with the observations of Guerin on Staphylea in his study of the seed integuments of some Sapindales. He also notes abundant "albumen" in both Staphylea and Melianthus.

I wish to acknowledge my great indebtedness to Professor J. H. Schaffner for his invaluable assistance, and to express my hearty appreciation of his kindness.

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Explanation of Plates.

For the figures 1–15 a Leitz microscope with No. 6 ocular and No. 7 objective for all but Figure 14 which was drawn with a lower power. A Bausch and Lomb instrument was used for all the other drawings. For Figure 16 the 1-2 ocular and 1-12 oil immersion were used. For Figure 17 the 1-in. ocular and 1-12 objective; for Figures 18–22 the 1-in. ocular and 1-6 objective; for Figures 23–24 a 2-in. ocular and 1-6 objective and for Figures 25–27 the 2-in. ocular and the upper lens of the 2-3 objective.

PLATE XIX.

Fig. 1. Archesporial cell.

Fig. 2. Three celled archesporium.

Fig. 3. Primary parietal cell and megasporocyte. Integuments beginning to develop.

Fig. 4. Three tapetal cells and megasporocyte.

Fig. 5. Two tapetal cells; megasporocyte enlarging.

Figs. 6-7. Four and five tapetal cells.

Fig. 8. Four tapetal cells and four megaspores.

Fig. 9. Four tapetal cells, two celled embryo-sac and disintegrating megaspores.

Fig. 10. Two celled embryo-sac beginning to destroy tapetum.

Fig. 11. Four celled embryo-sac.

Fig. 12. Eight celled embryo-sac showing antipodals already settled in pocket.

Fig. 13. Egg apparatus, conjugating polar nuclei and antipodals.

PLATE XX.

Fig. 14. Stamen showing pollen sacs and pollen grains.

Fig. 15. Older pollen grain with thickened wall.

Fig. 16. Polar nuclei and a sperm nucleus.

Fig. 17. Three nuclei fusing to form definitive nucleus.

Fig. 18. One celled embryo.

Fig. 19. Two celled embryo.

Figs. 20-21. Four celled embryos.

Figs. 22, 23-24. Older embryos.

Fig. 25. Half grown ovule showing four celled embryo, endosperm lining, nucellus and inner integument shrivelling, and outer integument developing hard tissue.

Fig. 26. Flat section of mature seed showing hard integument a-b and outline of embryo imbedded in endosperm.

Fig. 27. Longitudinal section of a mature ovule through a-b showing cotyledons and plumule. Endosperm around but not between cotyledons.

A NEW ASPIDIOTUS FROM AESCULUS GLABRA.

Harlan H. York.

Aspidiotus (*Diaspidiotus*) *ohioensis* n. sp. Female scale circular, slightly convex, margin irregular, 1–2 mm. in diameter, dark or dirty gray, exuviae orange red, sub-central and covered with dark excretion. When removed from the bark, the scale leaves a conspicuous white patch.

Female: Median lobes broad, notched on lateral margin near apex and sometimes notched near the apex on the mesal margin. Second lobes rudimentary, slightly developed on inner-angle, often not present. First interlobular incision shallow, broader than deep, chitinous processes usually fused into a solid process, occasionally furrowed. Second interlobular incision similar to the first, only smaller, the chitinous process seldom furrowed. Sometimes there is a very small incision laterad of the second incision. There is usually a small chitinous process at the inner base of each median lobe. A simple and a forked plate, sometimes two to three forked plates laterad of median lobe, one to three forked plates between the first and second incisions and usually one simple and one to three forked plates laterad of second incision. Spines prominent, longer than the plates. On the dorsal surface, one spine at the base of the outer margin of each median lobe, one on each of the rudimentary lobes, one about one-third of the distance from the median lobe to penultimate segment and one about the same distance from the penultimate segment. The spines on the ventral surface are shorter than those of the dorsal surface, a spine slightly laterad of each corresponding dorsal spine, except the one at the base of the median lobe.

There are five groups of circumgenital glands. Median group 3 to 7, generally 4 to 5 arranged in a single row, sometimes grouped together, anterior lateral 12 to 15; posterior lateral 7 to 11. Dorsal pores numerous and quite prominent.

Fig. 1. Pygidium of female.
Fig. 2. Dorsal marign of the pygidium of female.

This species was found on Aesculus glabra on Ohio State University campus, March 24, 1905. While it resembles A. ancylus, it is distinguished from this species by the shape and character of the incisions and chitinous processes, the number and arrangement of the median gland orifices, by the number of spines and by the absence of the spine-like extensions of the margin between the third and fourth pairs of spines.

Aspidiotus ohioensis is close to A. aesculi and A. aesculus sub. sp. solus. The spines are more numerous, the incisions are not alike, and the median gland orifices more abundant.

This is one of the several forms that may prove to be varieties of *Aspidiotus ancylus* on a more exhaustive study. A large number of mounts were made and the points mentioned were observed many times.

The author is very grateful to Prof. Herbert Osborn for his valuable suggestions in the above description and drawings.

THE RATE OF GROWTH IN EPISTYLIS FLAVICANS.

F. L. Landacre.

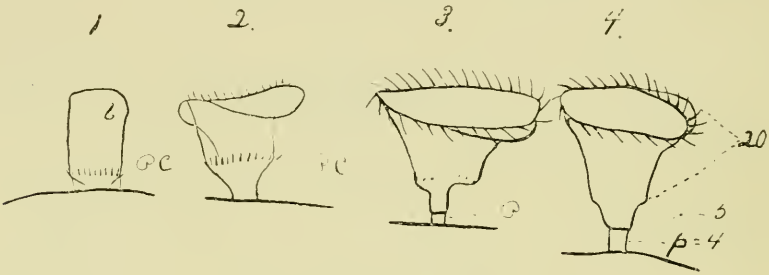
The writer recently had an opportunity to observe the rate of growth in one of our common stalked Protozoa, *Epistylis flavicans Ehr.*, and the changes in form of the animalcule which accompany this growth.

A good deal of interest attaches to the rate of growth of the pedicle in stalked forms on account of the fact that two species frequently otherwise similar may be differentiated by the length of pedicle. A form with branched pedicle, which in its adult condition may be easily differentiated by the pedicle, is with difficulty separated from other species if its pedicle is still simple as it is in the earlier stages of growth. Each form having a branched stalk passes through a stage in which its stalk is simple and it is then sometimes with difficulty separated from the forms with unbranched pedicles.

The frequency with which these immature forms are met with depends of course upon the time required for a detached zooid to acquire a pedicle characteristic of the adult form. If this is done uqickly, for instance, in a few hours, comparatively few immature forms would be encountered. If the period of growth is longer, for instance, several days or a week, one ought to find immature forms rather frequently. During the three summers spent in work on Protozoa at Sandusky no case of growth except the present instance was observed that could be measured. This may be due to the fact that work was commenced about the first of June each year which would be after the period of maximum growth among the Protozoa, this period coming earlier in the spring.

In the present case the attachment of the free swimming form was not observed. But in mounting a slide for observation a large colony of *Epistylis flavicans* was found many of whose zooids were detached and swimming about. Within a short time one was found attached and its rate of growth observed. It could have been attached only a short time for it still had the typical cylindrical shape characteristic of free swimming forms (Fig. 1). The posterior circle of cilia was vibrating rapidly and there was only a faint movement of the cilia visible in the region of the gullet.

In three minutes it had assumed the form of Fig. 2. The posterior cilia were vibrating a little less rapidly. There was a cone shaped extension at the posterior end of the body equalling one-third of the total body length and extending proximally from the posterior circlet of cilia. The body had begun to assume the normal shape the adoral cilia were vibrating and the total width of the peristome was about two-thirds of the adult form. In two minutes more it had assumed the form shown in Fig. 3, the posterior end had narrowed considerably and while the constriction extending from the posterior ciliary wreath was still one-third the total length of the body its attached end had assumed the appearance of the adult pedicle. The lengthening of this pedicle had every appearance of growth and not of metamorphosis of body into pedicle. The body while producing the pedicle was actually larger than before, and although the form was feeding rapidly it is hardly conceivable that assimilation and growth could take place at the rate at which the pedicle appeared.



DESCRIPTION OF PLATE.

Fig. 1. Four stages in the growth of the pedicle of *Ephistylis flavicans* Ehr. p. c.—posterior circlet of cilia. p.—pedicle appearing first in Fig. 3.

At the end of five minutes more (Fig. 4) the body of the animalcule was nearly normal in every respect except that the slight elevation on which the posterior circlet of cilia had been situated could still be observed although the cilia had been retracted. The pedicle at this time was one-sixth the length of the body and the animalcule was feeding actively. From this point on only the relative rate of growth in the pedicle will be given as no opportunity offered to note any other histological changes than those pertaining to the lenghtening of the pedicle.

At the end of five minutes more or a total of fifteen minutes in all the pedicle was equal to one-fourth the length of the body; in twenty minutes one-third; at twenty-five minutes one-half; at thirty minutes, thirteen-twentieths; at thirty-five minutes, four-fifths, and at the end of forty minutes equaled the body in length.

It was not observed again for a period of forty-five minutes during which time the pedicle had attained a length equal to three times that of the body. This is somewhat under the normal, the unbranched pedicle usually being four to five times that of the body. So that a period of one hour and a half was sufficient to produce a pedicle nearly equal to the unbranched portion of the adult colony stalk. Of course to make this observation complete the rate of division in the zooid should be observed and also the rate of production of the branched portion of the pedicle.

At the end of one hour and thirty-five minutes the posterior circlet of cilia began to appear and in an hour and fifty-five minutes the animalcule became detached and swam away.

The presence of the cover glass, the lack of oxygen and food all three probably prevented the completion of the growth and probably retarded the later stages of it but otherwise it seems normal and furnishes some idea of the rate at which the single stalked and branched stalked forms of Protozoa produce their pedicles.

The rapid rate of growth also accounts for the rarity with which one finds immature forms especially those with compound pedicles and yet they do occur frequently enough to render the difficulty of identifying these forms very great.

These observations were made in August and the rate of growth may be quite different from that occurring earlier in the summer during the period of greatest activity among the Protozoa.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, Feb. 6, 1905.

The vice-president, Miss Riddle, called the club to order. The minutes of the previous meeting were read and approved. Prof. Schaffner spoke of a short letter which he had received from Prof. Kellerman. The party in Central America were enjoying the trip very much but were too busy to write.

The first paper of the evening was by Mr. L. H. Scholl on "Cotton and its By-products." Cotton has been raised in Texas since the Anglo-Saxon settlement and now the state produces one-fourth of all the cotton in the U. S. The Cotton Boll Wevil introduced from Mexico about 1892 has threatened the cotton interests of the state. But it has been found that by increased and better cultivation, change of crops, clearing the ground, etc., cotton can be raised in spite of the wevil. Formerly the cotton seeds were thrown into the rivers or burned, but recently science has shown that this perhaps is not the least valuable part of the crop. The products are used chiefly for feeding cattle but the meal is also used for fertilizer. Cotton seed oil is used in place of olive oil, for salad oils, butter oils and is used to adulterate many other oils as linseed. The lint from the seeds is made into cotton batting, paper, etc. The stalks yield a good fiber. The honey taken by the bees from the glands on leaves, stems and flowers is also valuable. Mr. Scholl exhibited a fine line of sample of the various by-products of cotton seed.

Mr. Dresbach presented a paper on the "Form and Structure of the Red Blood Corpuscle." Weidenreich of Strassburg contends that the mammalian erythrocytes are not biconcave but bell-shaped. His conclusions are based: (1) upon the fact that when the corpuscles are fixed with osmic acid, immediately upon escaping from the blood vessels,the great majority have the bell form; (2) the corpuscles have this form in isotonic solutions as a .65% NaCl solution for mammalian corpuscles; (3) Weidenreich claims to have seen the bell-shaped cells in the circulating blood of the rabbit. He concludes that the biconcave form is due to the extreme sensitiveness of the corpuscle and is produced by slight increase of the density above the normal. As to the structure of the corpuscles, Weidenreich thinks that they consist of a distinct cell wall which encloses the haemoglobin and other constituents. The behavior of the cells in such fluids as water, salt solutions, tannic acid solutions, etc., points to the presence of a cell wall. No stroma or framework exists. Mr. Dresbach also reported that an extended study of the case of elliptical human red corpuscles, which he described last year has confirmed his opinion that the extraordinary shape was normal in the subject and not due to any known disease. It was probably of embryonic origin or possibly congenital.

Mr. Metcalf reported the probable occurence of the Swamp Sparrow in Ashland County in the latter part of December. He also reported the Kildeer, Canvas Back Duck and Horned Grebe observed at the same time as unusually late.

The club adjourned to meet the first Monday in March.

F. M. SURFACE, *Sec.*

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THE NATURE OF THE REDUCTION DIVISION AND RELATED PHENOMENA.

JOHN H. SCHAFFNER.

It is generally conceded that the primitive plants and animals were nonsexual. In the primordial life of the earth no conjugation of any kind took place. Some organisms have come through all the geological ages in this primitive condition but the great majority even of the lowest forms have acquired some type of sexuality and retained it while a considerable number have no doubt fallen back from a sexual to a nonsexual condition. If the process of sexual conjugation of cells is then not a primitive property or function of protoplasm various questions naturally suggest themselves.

1. What caused the original nonsexual forms to develop the sexual process?

2. What disturbances were introduced in the life cycle of the organism and in the cell activity?

3. In what ways were the new life cycles established?

4. How do the life cycles of plants compare with those of animals?

5. What significance does the reduction division have in the higher forms?

In most plants conjugation takes place between two naked gametes, and it is probable that such specialized types of sexuality as are present in the Conjugatae and Phycomycetes originated from the more typical gamete conjugations. We can readily believe that all the Archeophyta were naked cells and that the cell wall was developed as a protective covering. When these primitive cells were in process of division there could be an interchange of food from the one to the other so long as the protoplasmic connection was not completely cut. After complete separation the two daughter cells, still lying in contact, could exchange food by osmosis, the one having a less amount of food taking from the one having a greater supply. After the two cells had separated they might exchange food in the same way on coming in contact for any length of time by accident. In this way sexual evolution may have had its beginning as well as parasitism in all of its forms. After the process of temporary or permanent conjugation was once established it would be of advantage to the species under many adverse conditions. A set of starved or weak organisms meeting with a well nourished lot could conjugate either temporarily or permanently, greatly to their advantage, without doing the stronger individuals any special harm. Such is apparently the behavior of various lower organisms at the present time. Furthermore a swarm of unicellular organisms or zoospores in a given area is, by conjugation, reduced to just half the previous number. The mere reduction in the number of units might be a very important factor in the immediate welfare of the species especially when the further delay of reproduction incident to the process of conjugation is taken into account. In many of the lower plants the arrival of adverse conditions is the stimulus to the formation of resting zygospores or oospores by means of which the organism is preserved until a more favorable environment is again at hand. Rejuvenescence, using the term in its broadest sense seems at least a very plausible cause of the origin of sexuality if it is once admitted that conjugation is not one of the fundamental properties of the protoplasm of primordial organisms. Other means of rejuvenescence should serve the same purpose as the stimulus and reaction which one mass of protoplasm must exert on another during conjugation, leaving out of consideration the fact of the reduced space occupied by the two united organisms and consequently the less surface in contact with the surrounding medium. A tree may be rejuvenated by placing a fertilizer about its roots. So organisms which naturally rejuvenate only through conjugation may be rejuvenated through a favorable change of food or other factors of environment, thus actually delaying the necessity of a conjugation for a long period of time.

Whether conjugation was long or short in its evolution is of no special importance in the discussion of the remaining questions formulated above. The first time that nucleated cells conjugated so completely as to act in cell division as a single cell a disturbance was present not operative in the race previously. The two nuclei having fused contained twice the amount of chromatin as before and from two sources, therefore with somewhat different hereditary tendencies. Evidently a fusion or mixing and doubling of nuclei generation after generation is impossible, especially if the chromatin is organized into definite chromosomes. A reduction division of some kind is the inevitable accompanyment of a conjugation process in the life cycle. This fact being recognized we may proceed to find out in what ways the life cycle may be established. Theoretically a number of possible modes may be developed and the reduction division established at three points in the life cycle.

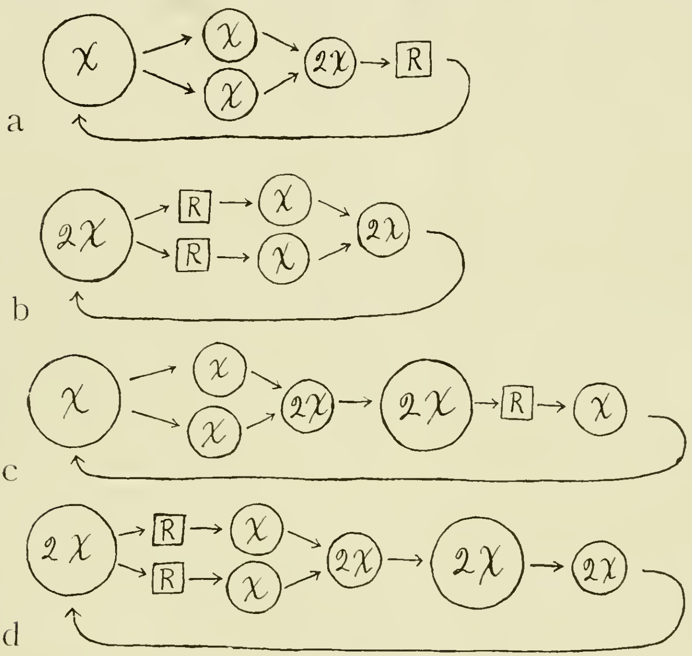


Fig. 1. Diagrams of various types of life cycles

1. Suppose an organism with x chromosomes to give rise to zoospores which conjugate completely; the resulting zygote would have $2x$ chromosomes. If, however, reduction takes place at the first division or germination of the zygote, the new organism would have the reduced or x number of chromosomes. The double number of chromosomes exists only in the resting stage of the zygote and the result is a simple sexual cycle, the gametes being produced without a reduction division (Fig. 1a).

2. If an organism with x chromosomes gives rise to conjugating zoospores, the zygote will contain $2x$ chromosomes.

Suppose that this spore, on germination, fails to reduce the chromosomes. The resulting individual will have the double number in each cell. Now if, when reduction takes place, the cells reduce the chromosomes and the resulting cells are gametes, a new condition arises in which a "$2x$" sexual generation originated from an "x" nonsexual type gives rise to gametes as the result of a reduction division. A simple sexual cycle is established with a "$2x$" sexual generation producting gametes as the result of reduction (Fig. 1 b). Such plants as Fucus must have established their life cycle in this way. The Fucus plant is a $2x$ sexual generation which develops ovaries and spermaries. A cell in the ovary undergoes the reduction division and by further divisions usually produces eight eggs with x chromosomes each. In the spermaries a cell also undergoes reduction and by subsequent divisions a number of spermatozoids are produced having the x number of chromosomes.

3. The third point at which the reduction division may be established is after the sporophyte stage in connection with an alternation of generations. Suppose a nonsexual organism develops zoospores which conjugate and the zygote fails to reduce the chormosomes at the first division. An individual is produced with $2x$ chromosomes. When zoospores are produced as the result of a reduction division they come out not as gametes but as nonsexual spores which give rise to an x generation. This generation being similar to the original generation produces gametes without reduction which have the x number of chromosomes. This is the process in the plants with a true, antithetic alternation of generations. A gametophyte generation is followed by a sporophyte generation which reduces the chormosomes before the development of nonsexual spores (Fig. 1 c).

Other life cycles might be and perhaps are developed. A sporophyte coming from the zygote might develop spores without reduction and these might develop into gametophytes with the $2x$ chromosomes, and the gametes would then be produced as the result of a reduction division (Fig. 1 d). It will be seen, therefore, that there are two types of sexual or gamete-producing generations, one with the $2x$ chromosomes giving rise to gametes through reduction, the other with x chromosomes giving rise to gametes directly without reduction.

Now in the higher plants the life cycle is invariably established, unless in abnormal cases, with an alternation of generations, a gametophyte generation with x chromosomes is followed by a sporophyte generation with $2x$ chromosomes. The reduction division takes place in special cells, sporocytes, and usually by two successive divisions. The resulting spores have the reduced number of chromosomes and represent the first cell of the gametophyte generation (Fig. 2). There is no more reason for saying, as some do, that the gametophyte generation begins with the sporocyte than it would be to insist that the first stage of the sporophyte consists of the egg and sperm before conjugation. The gametophyte is, of course, the sexual generation and the sporophyte the nonsexual generation, both from the morphological and physiological points of view. In the higher plants the gametophytes are very much reduced and some have insisted in retaining the old misapplied sex terms for the sporophyte. But this leads merely to a confuison of terms and ideas. To compare pollination, the growth of the pollentube, and the other processes connected with the development of the gametophytes of higher plants with fertilization, as it exists in the sexual generations of plants and animals, is only comparing things that are not even analogous and giving such diverse meanings to sex terms that they lose their real significance entirely.

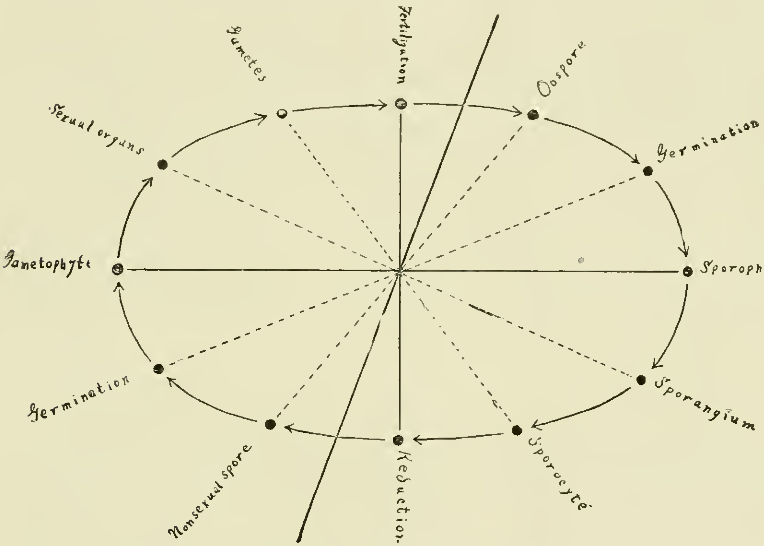


Fig. 2. Diagram showing principal stages in the life cycle of the higher plants.

In the higher animals we appear to have a condition similar to that in Fucus, a "$2x$" gamete-producing organism in which reduction takes place before the formation of gametes. The egg with its polar bodies represents four original eggs comparable to the four spermatozoids developed from the spermatocyte. It is interesting to note that in some of the Brown Algae part of the eight eggs which are produced after reduction also degenerate. Furthermore, the eggs of the Fucaceae are discharged while in all

OHIO NATURALIST. *Plate XXI.*

ADIANTUM	Homosporous Sporophyte	Sporocyte	Reduction	Spore	Hermaphrodite Gametophyte	— —	— —	Spermatozoid Oosphere	Fertilization	Oospore in Ovary	Parasitic Embryo	—
ANGIOSPERM	Heterosporous Sporophyte	Microsporocyte Megasporocyte	Reduction	Microspore Megaspore	Pollengrain (Male) Embryo-sac (Female)	— —	— —	Sperm cell Oosphere	Fertilization	Oospore in Female Gametophyte in Ovule	Intraseminal Embryo	Sprouting
MAMMAL	—	—	—	—	Male Female	Spermatocyte Oocyte	Reduction	Spermatozoon Ovum	Fertilization	Fertilized Egg in Uterus	Intrauterine Embryo	Birth
FUCUS	—	—	—	—	Hermaphrodite or Male and Female Individuals	Reduction cell in Antheridium Reduction cell in Oogonium	Reduction	Spermatozoid Oosphere	Fertilization	Oospore in Water	—	—

Comparison of the life cycles of plants and animals.

gametophytes with a true alternation of generations they are retained in the ovary. The plant life cycles together with a typical animal are compared in Plate XXI.

Among the interesting things which have recently come to light and which appear to have their basis in the phenomena of the reduction division is Mendel's law of heredity in hybrids. The operation of this law can be explained on the hypothesis of pure sex cells. In 1897 the writer worked out in detail the reduction division which takes place in the ovule of Lilium philadelphicum. Although the development and subsequent division of the chromosome was followed out in considerable detail in this work, the facts presented were not accepted by a number of botanists, as admitted by Strasburger, because of supposed authority in the opposite direction. So soon, however, as Mendel's law was rediscovered it became self-evident that belief in a qualitative or true reduction division of some kind was necessary if the whole chromatin hypothesis was not to fall to the ground. Accordingly a re-investigation by some of the foremost cytologists, among them Strasburger and Farmer, resulted in a confirmation and acceptance of the propositions presented in my papers on Lilium and Erythronium, as also of similar work done previously by a number of zoologists.

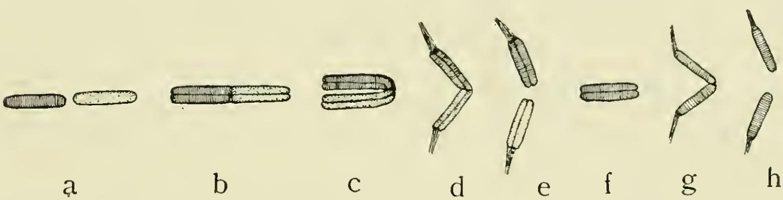


Fig. 3. Diagramatic representation of the transverse division of a chromosome.

If then a transverse division of the chromosomes occurs during the reduction karyokinesis each of the chromosomes resulting from the process of pseudo-reduction may be regarded theoretically to be made up of a pair of chromosomes, one being a male chromosome and the other a female chromosome, joined end to end. There are also some obrsevations which appear to indicate that this actually takes place. In such cases then as in Lilium and Erythronium the formation and nature of the twisted loop can be diagramatically represented as in Fig. 3, a-e. In the following division in which a longitudinal splitting occurs the daughter halves of the chromosomes formed early in the previous division become separated (Fig. 3, f-h).

Mendel's law of heredity, so far as it has a direct bearing on the nature of the reduction division, may be briefly stated as follows: When two organisms differing in some character are crossed it frequently occurs that the resulting hybrids exhibit the character from one parent only. The character which appears is said to be *dominant* while the corresponding character from the other parent not in evidence is called *recessive*. But if these hybrids are bred among themselves they give rise to offspring of two types, some showing the dominant character and some the recessive, and these usually appear in the proportion of 3:1. By further trial it is found that about one-third of the dominant individuals are pure and two-thirds of mixed nature.

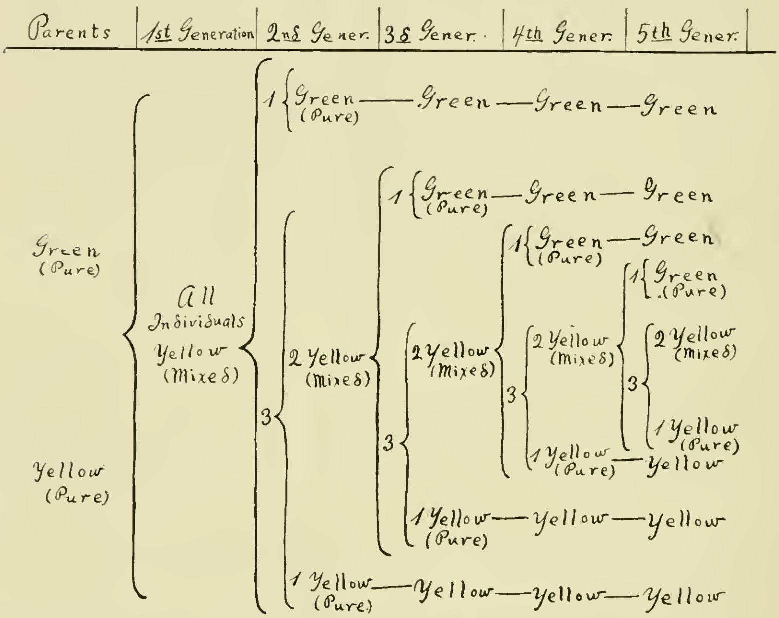
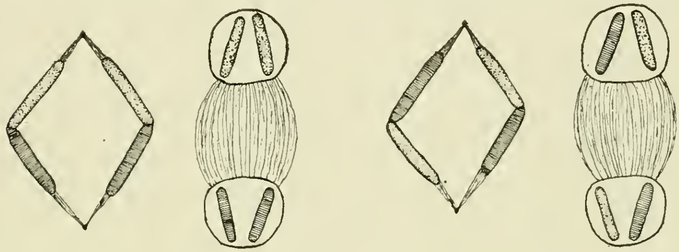


Fig. 4. Diagram showing the operation of Mendel's law with peas having yellow and green cotyledons.

These latter will again produce offspring of both types the same as the original hybrids, and so on for many generations. The first instance discovered by Mendel related to the color of the cotyledons in peas. The yellow color of cotyledons was found to be dominant over green. The operation of Mendel's law as regards the yellow and green colors of cotyledons is shown in Fig. 4. Albinism among animals also furnishes a familiar example of the operation of Mendel's law. If albino mice are mated with gray mice the offspring are gray, but in the following generation one-fourth will again be albinoes. The gray is the dominant and the albino the recessive character.

As stated above, Mendel's law can be explained on the theory of pure sex cells. In working out the peculiar activities of the chromatin during cell division, cytologists have come to look upon the chromosomes as special bearers of hereditary tendencies although other parts of the protoplasm may also have something to do with the transmission of heredity. Now if a transverse division occurs and the chromosomes are pure the daughter nuclei could then be organized as pure having only chromosomes derived from the egg or sperm (Fig. 5, a-b). No difference how many subsequent, longitudinal splittings take place before the formation of gametes, the gametes would always be pure cells.



a b c d

Fig. 5. Diagram of transverse division showing possible production of pure and mixed cells.

In conjugation there is twice the chance for a mixed oospore to be formed as a pure one and hence the splitting of the hybrid race in the proportions given by Mendel's law. But suppose that the chromosomes were joined in pairs and arranged in the mother star in such a way that half of the male chromosomes were on one side and half on the other and the same for the female chromosomes then the transverse splitting would always result in mixed cells and no splitting of the race could occur (Fig. 5, c-d). The daughter nuclei would be mixed even if the chromosomes making up the pair were pure. Other arrangements are possible, and in case the chromosomes are not reorganized as pure bodies the cells resulting from reduction could of course not be pure. But whatever the facts may be it appears that all cases of hybrids that follow Mendel's law as well as those which do not can be accounted for on the theory of pure chromosomes and a qualitative reduction division. This would not prove however that the chromosomes are organized as pure bodies or that there is a transverse splitting of chromosomes. These facts must be worked out from a study of nuclear division, and this is the important and difficult problem to be solved. Anyone can compare the results of cytology and plant and animal breeding after the facts have been ascertained. But to work out these problems is a slow and difficult process as the writer has discovered from experience.

Finally a word may be added as to the significance of reduction and conjugation in the origin of species. The mixing of protoplasms with diverse hereditary characters must cause a great disturbance in the hereditary apparatus. We may think of a struggle of two characters one against the other, the one becoming dominant and the other unable to reassert itself. We may picture to ourselves the powerful stimulus of the one on the other and the reaction and rearrangement of the material mosaic which may result in the evolution of a monstrosity or a new species. But crossing must after all tend to uniformity. It is the origin of sexual barriers and the barriers induced by the activity of one hereditary tendency over another which has led to diversity in plant and animal life so far as this has any relation to the sexual process. Variation and diversity of type is just as prominent a characteristic of nonsexual as of sexual organisms. The new forms resulting from near or distant crosses must be regarded as merely incidental in the great process of the evolution of the diverse life of the earth, the real and fundamental cause lying in the nature of protoplasm itself whether of sexual or nonsexual organisms. Variation is a property of protoplasm and reproduction is primarily a matter of assimilation and growth. If sexuality were the primary cause of variation we would logically have to suppose a multitude of sexual races in the beginning rather than a simple nonsexual and uniform group of organisms which has evolved and segregated into new types without any special reference as to whether the units in the process have acquired sexuality or having acquired it once have lost it again in ages past.

A LIST OF OHIO PLANTS WITH COMPOUND LEAVES.

Walter Fischer.

In making out a list of plants having compound leaves, a few words on this subject and on the light relation of plants in general may not be out of place.

From what is known of the function of leaves it is evident that with the exception of plants in xerophytic conditions, the greater the surface exposed and provided this is done in such a way as not to handicap the plant in other ways, the better will that plant be enabled to survive in its struggle for existence.

Plants may secure a better exposure to light and air in any of the following ways:

1. By motile leaves and stems.

2. By increase in height or length, thus providing room for a greater number of leaves, as in trees, vines and ivies.

3. By leaf arrangement in which the plant secures the best possible light relation by arranging the material on hand to its best advantage. Here we have rosettes, mosaics, etc.

4. By an increase in the size of the leaf blade or the lengthening of its petiole. When the petiole is lengthened it is only to place the leaf in a better position, so this phase of leaf enlargement would more properly come under No. 3. When an enlargement of the blade takes place it must be in such a manner that nothing will be sacrificed to light or strength and it is evidently for this reason that we get the great variety of forms which gradually lead up to the compound leaf.

In our common Monocotyls leaf enlargement takes the form of increase in length only; this being necessary on account of the parallel system of venation which could not prevent the leaves from becoming shredded when exposed to wind and rain, something which does take place in a great many palms. Some of the palms which have pinnately compound leaves and the aroids present quite an exception to this statement however, as their leaves are usually quite large and expanded. Our common Arisaemas are very distinctly palmately compound.

Among Ferns and Dicotyls we have the greatest variety of forms ranging from those that are but slightly toothed or lobed to those which are deeply lobed, cleft or divided, until finally the division is so marked that we have a compound leaf apparently made up of separate leaves on a common axis and petiole. That these compound leaves are a gradual development from simple ones may be readily observed by comparing the leaves of different species in the same families or genera; those of different individuals in the same species and finally the older and later leaves on a single individual. Leaves that are pinnately veined will give rise to pinnately compound ones, while those which are palmately veined will give rise to leaves that are palmately compound. Of the ferns, Botrychium affords the best example of compound leaf development from the simpler forms like B. lunaria to the highly complex leaf of B. virginianum. In different species of Ranunculus all transition forms are also easily observed. Often another feature is added here. In some forms the plants have the rosette habit while young and when leaves are few; later the leaves become compound and thus avoid shading the older ones. The writer has before him a seedling of Robinia, in which the first true leaf is a simple one; the second and third are each composed of three leaflets; the fourth, fifth and sixth each of five; and the seventh and eighth each of seven leaflets.

Thus in the history of species as well as in the history of individuals, the simple leaf is the first to appear and may usually be regarded as the more primitive form. Although the acquirement of compound leaf forms is a higher development it is not necessarily restricted to the higher groups. Some of the best types of such forms are found in the lowest leaf bearing plants like ferns, cycads and buttercups and are nearly absent in the Compositae. They seem to have been acquired independently as a parallel development as is shown by their presence in widely separated groups and in isolated genera and species. In some families as in Leguminosae, Juglandaceae and Umbelliferae, the character is already fixed; in others as in Ranunculus, Geum, and Potentilla, it seems to be a more recent development; while others again show no indications whatever of a tendency to develop higher types of leaves.

Before concluding a few words might be said on the advantage accruing to plants which possess a higher type of foliage. Plants which grow in the shade and where vegetation is dense could present a greater surface without additional shading. It would obviate the necessity of lengthening the petioles of the lower leaves or of decreasing the size of upper leaves and would thus be a distinct gain to the plant. This arrangement is especially marked in some of the climbers. In ferns which are plants usually growing in the shade, a compound leaf seems almost a necessity as the stems are as a rule underground and they must depend entirely upon their leaves for exposure to air and light. Plants which grow in exposed situations would be greatly benefitted as they could increase their foliage surface enormously without exposing themselves to injury by wind, rain or hail. This would be most likely to occur in trees. In our common Kentucky coffee tree the leaf stalk has taken the place of the smaller twigs and its branches present a very naked condition in winter, causing them to expose but a small surface to winter storms. This would certainly be of great advantage to the tree.

It seems as though no definite conclusion could be drawn as to when, where and why plants develop a more complex leaf system, especially as so many plants develop it in connection with some of the other features that enable it to reach the light. A closer study of the question seems to present more problems than solutions. This is undoubtedly because plants are continually shifting from place to place and from one condition into another. So that if certain characters are developed and become fixed when the plant lives in one condition they need not be lost if the plant is forced to migrate or if this condition is changed, as they might not necessarily be a disadvantage to it. Until then, the entire geological history of the different groups is known it would be impossible to tell why plants with similar habits and growing under similar conditions should develop such a great variety of leaf forms.

The following is a list principally by families and genera of Ohio plants possessing leaves that are compound or nearly so. Since it is often difficult however, to distinguish between leaves that are truly compound and those deeply divided, the more typical forms have been put under separate heads with a large list of unclassified ones by themselves. The finely segmented immersed forms are not included in the list.

With pinnate leaves:

Osmunda, Woodsia, Dicksonia, Cystopteris, Dryopteris, Phegopteris, Woodwardia, Asplenium, Pteris, Juglans, Hickoria, Potentilla (3 species), Comarum, Agrimonia, Sanguisorba, Rosa, Sorbus, Cassia, Amorpha, Kuhnistera, Cracca, Robinia, Astragalus, Phaca, Vicia, Lathyrus, Apios, Xanthoxylum, Ailanthus, Floerkia, Rhus (all but one species), Acer negundo, Aralia, Fraxinus, Cuscuta indecora, Polemonium, Tecoma, Sambucus, Valeriana sylvatica.

With bipinnate leaves:

Osmunda regalis, Gymnocladus dioica, Gleditsia triacanthos, Acuan illinoensis.

With trifoliate leaves:

Arisaema triphyllum, Coptis, Polanisia, Proteranthus, Rubus, Fragaria, Waldsteinia, Baptisia, Stylosanthes, Meibomia, Lespedeza, Falcata, Phaseolus, Strophostyles, Oxalis, Ptelia, Rhus radicans, Staphylea, Cuscuta epithymum, Valeriana pauciflora.

With palmately compound leaves:

Arisaema dracontium, Cannabis sativa, Potentilla (2 species), Lupinus perennis, Medicago, Melilotus, Trifolium, Lotus Psoralia, Aesculus, Parthenocyssus, Panox.

With dichotomously decompound leaves:

Adiantum pedatum.

With ternately compound or decompound leaves:

Isopyrum, Cimicifuga, Aquilegia, Anemone, Syndesmon, Clematis, Thalictrum, Caulophyllum, Bicuculla, Adlumia, Capnoides, Dentaria, Cardiospermum.

With leaves more or less cleft, divided, compound or decompound and not otherwise classified.

Onoclea, Pellaea, Helleborus, Trollius, Actaea, Delphinium, Aconitum, Ranunculus, Jeffersonia, Papaver, Stylophorum, Argemone, Chelidonium, Fumaria, Lepidium, Sinapis, Brassica, Rhaphanus, Barbarea, Iodanthus, Roripa, Cardamine, Sophia, Arabis, Reseda, Aruncus, Potentilla, Geum, Ulmaria, Agrimonia, Geranium, Erodium, Malva, Hibiscus, Umbelliferae (all but 4 genera), Hydrophyllum, Ambrosia, Silphium, Rudbeckia, Ratibida, Coreopsis, Bidens, Dysodia, Achillea, Anthemis, Matricaria, Tanacetum, Artemesia, Carduus.

THE AGAR-AGAR AND PARAFFIN METHOD FOR IMBEDDING PLANT TISSUES.

Harlan H. York.

In the Journal of Applied Microscopy and Laboratory Methods 6: 2591–2, 1903, the writer gave an account of a method for killing and imbedding plant tissues in a hot solution of agar-agar. While this method is applicable for most histological work, sections cannot always be obtained as thin as are sometimes desired. Recently a method for imbedding and sectioning plant tissues in paraffin after they had been killed and imbedded in a hot agar-agar solution was tried.

The following are some of the sections made by the agar-agar and paraffin method: Sections of leaf of date palm; sections of leaf of Ficus elastica; sections of stem of Begonia; sections of stem of Equisetum arvense; sections of leaf of beech; sections of a Uromyces on Sparganium eurycarpum; sections of a Phyllachora on Panicum; sections of a rust on Scirpus.

The tissues were first killed and imbedded in a 2 per cent and 5 per cent solutions of agar-agar and then imbedded in paraffin in the usual way.

The 2 per cent solution of agar-agar can be made as follows: Take 10 grams of agar-agar to 500 c. c. of distilled water and boil for two hours. An ordinary oat-meal cooker can be used for boiling this mixture. Filter the agar-agar through a cheese cloth into a glass jar before it is allowed to cool and add formalin in the proportion of one part of formalin to nine parts by volume of the agar-agar.

The 5 per cent solution is made in the same way as the 2 per cent solution, only 25 grams of agar-agar to 500 c. c. of distilled water are taken. Formalin should be added in the same manner and proportion as in the 2 per cent solution. Large quantities of the agar-agar solutions can be prepared and preserved in air tight vessels to prevent evaporation.

The tissues were first put into the 2 per cent agar-agar solution. Put a small quantity of the 2 per cent agar-agar into a test tube or small wide mouth bottle and place with contents into a vessel of boiling water until the agar-agar is melted. After the agar-agar is melted it should be kept at a temperature of 70° C. The tissues are placed directly into the hot 2 per cent solution for two hours. Then they are transferred into the 5 per cent solution, which has been melted in the same manner as the 2 per cent solution and allowed to remain for an hour or more. The tissues are imbedded in the 5 per cent agar-agar. Take a small wooden block or a plate of glass and with a camel's hair brush put a layer of the hot agar-agar on one end of the block, let it cool for a few seconds and place one of the pieces of material on the block and cover with more agar-agar. Allow it to cool for a few minutes, when it is removed from the block and placed in 70 per cent alcohol and passed thro the different grades of alcohol to paraffin and imbedded. The tissues should remain for two or more hours in each of the different grades of alcohol.

No albumen fixative is necessary to attach the sections to the slides and the sections can be stained as any other paraffin sections. Delafield's haemotoxylin and Safranin and gentian violet are favorable stains. The agar-agar surrounding the sections stains in Delafield's haemotoxylin but it takes only a slight stain in Safranin and gentian violet.

It seems that this method will be very valuable for sectioning tissues that would be easily torn by the ordinary paraffin method, and especially applicable in the study of rusts and other parasitic fungi. The layer of agar-agar around the tissues becomes very tough when passed thro the alcohols and forms a firm medium which prevents the tissue from being torn when sectioned.

The Phyllachora mentioned above, was dried and kept in the herbarium. The material was firmly pressed and thoroughly dry and in spite of these facts, the perithecia were sectioned without any injury and the hyphae could be seen in the adjacent tissues of the leaf. The Uromyces was collected in October, 1904, and the tissues of the leaf were entirely dead. The sections showed the delicate teleutosorus and spores in fine condition. The parts sectioned were cut into small pieces and placed in hot water at about 70° C. for an hour and then transfered to a 10 per cent solution of hydro-fluoric acid for twelve hours to remove the silicon which would otherwise interfere with the sectioning. The material was washed and imbedded in the manner already described. The stem of Equisetum was also herbarium material and was treated in the same manner as the Phyllachora and Uromyces. The sections obtained were in good condition for such material. The beech leaf was from alcoholic material and the sections showed the different parts of the leaf in excellent form. This method can be used to the best advantage where a histological study of the plant tissue is desired.

It is much shorter than the oridnary paraffin method as the aqueous solutions of agar-agar penetrate the tissues without any preliminary dehydration. Serial sections were cut as thin as 10μ.

A few scale insects found on a palm were also imbedded and sectioned and fairly good sections were obtained. This method will perhaps be useful in the study of insects.

LIFE HISTORY NOTES ON APION NIGRUM.

E. C. Cotton.

The genus *Apion*, family *Curculionidae*, contains several serious pests among which are two or three that do considerable damage to the clover plant. Two members of the genus *A. nigrum* and *A. rostrum* belong to the fauna of the black locust (*Robinia pseudacacia*). Our knowledge of the habits and life history of these two species is incomplete. It has long been known that the adults of *A. nigrum* feed upon the black locust, eating holes in the leaves and it has been supposed that the larvae, as the larvae of nearly related species, "develop within the seeds of this tree" (Insect Life, **5**:338). However, the seeds of the black locust are but little larger than the adult curculio so that this could hardly be true, and some observations made during the past summer disprove this supposition.

While engaged as Assistant Nursery and Orchard Inspector the writer visited Marietta on May 22, 1904, and found many adults of *A. nigrum* working upon the unopened flower buds of the black locust trees west of that town. On closer observation it was noted that the females were puncturing the buds and ovipositing in the holes thus made. On a second visit to this locality, on May 26, the insects were as numerous as before and it was noted that many of the buds had ceased to develop and were falling to the ground where they remained fresh for some time. Many of the fallen buds had the pedicle still attached, but a larger part did not. An examination showed that nearly all of the prematurely falling buds had been punctured in one or more places, and upon opening them, all stages of the insect were found, i. e., eggs, larvae, pupae and adults. Usually only one stage of the insect was found in a single bud and normally but one develops in a given bud yet there may be two or more. From some of these buds the adults had emerged by eating a round hole, generally through the base of the bud but some ate their way out at about two-thirds of the distance to the tip.

One raceme upon which twelve adults were observed feeding and ovipositing, was found to contain thirty buds, twenty-five of which had been punctured in sixty-three separate places. The highest number of punctures in any one bud was seven. From thirty of these wounds a viscid, gummy substance was exuding. About fifty of these buds were collected from the ground and placed in a glass jar, on May 26th, and on June 5th, twenty adult curculios, one pupa and four larvae were taken out, and on June 11th, seven more adults were removed.

Specimens reared in this jar were identified as *A. nigrum* by Mr. E. A. Schwarz, of the Bureau of Entomology, Washington, D. C.

The trees were again visited on September 18th and although they had been full of bloom in May, diligent searching failed to reveal a single seed pod that had matured, so thorough had been the work of the insects.

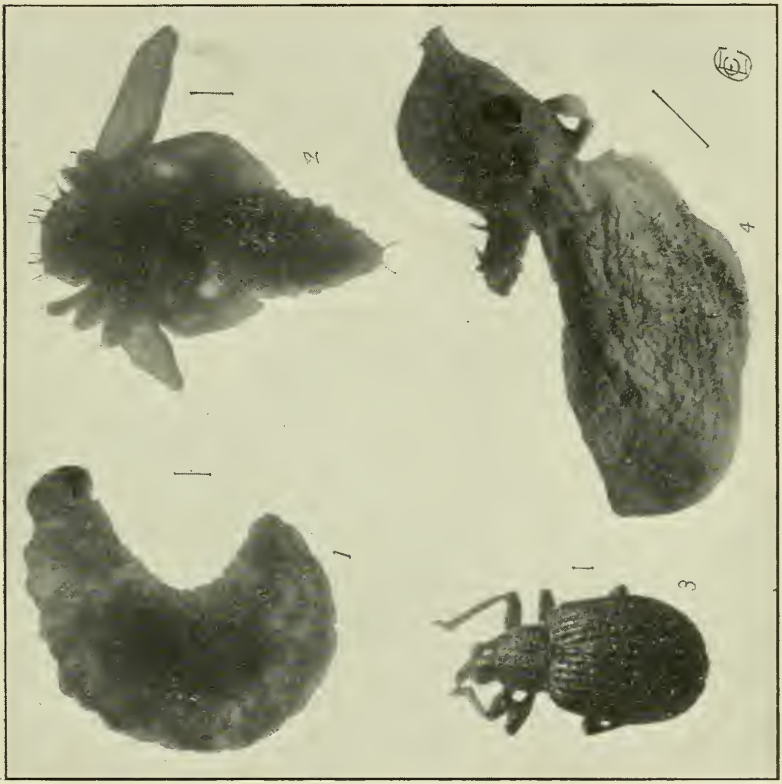


Fig. 1. Larva, full-grown.
Fig. 2. Pupa, ventral view.
Fig. 3. Adult.
Fig. 4. Unopened bud showing opening through which adult emerged.

At McArthur, Vinton County, the curculio while not as plentiful as at Marietta was found on nearly every black locust tree, generally but one or two in a place, however. On June 2d a female was observed busily engaged drilling a hole in the gall-like, rolled up edge of a locust leaf, probably produced by the yellow locust midge (*Cecidomyia robiniae*), and after a little waiting the writer was rewarded by witnessing the oviposition of an egg in the hole thus made. This leaf was collected and preserved but the egg failed to hatch.

Mr. O. H. Sweezy* reports having found the nearly full grown larva of this beetle in similarly rolled up leaves of the black locust at East Cleveland, and further says "they were in a sort of a cocoon." which was not the case with those developing in the locust buds at Marietta. He collected a few leaves containing the larvae and "on July 6, two adult beetles appeared." It is hardly probable that this is a second brood of this insect, because the seasonal differences between the southern and northern portions of the state should account for about one-half of the month's time between the appearance of the adults at Marietta and East Cleveland. The other two weeks may easily be accounted for in the straggling of the brood, which is often noticed even in insects that appear distinctly in broods. It will require at least another season's observations to make sure of this point.

This curculio occupies a position between those, the larva of which, feed wholly upon the leaves, and those which develop in the seeds. This adaptation to a bud feeding larva is peculiar in that it shows a very remarkable acceleration in the larval development, and one that is somewhat unusual. The entire development, from egg to adult, must be accomplished within three weeks and possibly in a shorter time. This may mean a corresponding long life period for the adult insects as they may be found at any time from early in May until the middle of September, and must pass the winter in this stage.

In the same buds were also found a large number, of sometimes as high as forty or fifty, small yellow larvae, probably dipterous, which did not develop to adults and which are still undetermined.

Description of larva: The larva is a small white footless grub, about one-fifth inch in length as it lies in a curved position in the bud; head about one-third of the diameter of the body, brownish in color with a few scattered spines or hairs; body thick, tapering abruptly to a blunt point at the posterior end; a few scattered hairs on the three thoracic segments.

Pupa. White or yellowish-white ,one-fourth inch long, slenderer than larva; head slightly darker in color than body, and with ten spines on top and front; snout folded along under side of body; two pairs of spines on dorsal side of the third thoracic segment, and two spines on posterior end of abdomen, also one at the end of the femur of each leg.

Note—This work was undertaken as part of a thesis for graduation in the College of Agriculture, on the "Insects of the black locust," and is under the direction of Prof. Herbert Osborn.

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* Unpublished notes made during summer of 1904.

A FEW OHIO DESMIDS.

Joseph A. Cushman.

During the spring of 1904 Mr. Charles B. Ames kindly made a few collections containing desmids and sent them to me for identification. These were from bodies of still water about Youngstown, Ohio. Although there is but one undescribed species and the total number of species small, the collection showed a few points of decided interest. It considerably extends our knowledge of the range of several species and varieties, certain of which are not generally known in America. It also adds to the desmid records for the state of Ohio. The following were identified from the collections:

Netrium Digitus (Ehrenb.) Itzigs & Rothe.
Length 260μ: breadth 68μ: breadth at apex 28μ. Common.
In all characters the specimens of this species were typical.

Netrium Nagelii (Bréb.) W. & G. S. West.
Length 142μ: breadth 34μ: breadth at apex 14μ. Occasional.
The only other record for this species in North America is that of the writer, from the White Mountain Region of New Hampshire.

Penium margaritaceum (Ehrenb.) Bréb. var. **obesum** var. nov.
Length 57μ: breadth 22μ. Occasional.
This has the usual characters for this species but is very much shorter and stouter than typical specimens.

Closterium striolatum Ehrenb.
Length 305μ: breadth 44μ: breadth at apex 11μ. Frequent.

Closterium Dianae Ehrenb., var. **arcuatum** (Bréb.) Rabenh.
Distance between apices 110μ: breadth 18μ. Occasional.

Closterium moniliferum (Bory) Ehrenb.
Length 250μ: breadth 37μ: breadth at apex 8μ.
A somewhat small form but the size is constant through the species as represented in this collection.

Closterium Lunula (Mull.) Nitzsch.
Length 540μ: breadth 96μ. Occasional.
Specimens of this species were of the typical form.

Closterium decorum Bréb.
Length 345μ: breadth 25μ: breadth at apex 5μ. Frequent.
Specimens of this species, like those of *C. moniliferum*, of less than the usual size although in other ways they were typical.

Pleurotaenium coronatum (Bréb.) Rabenh., var. **nodulosum** (Bréb,) West.
Length 527–560μ: breadth at base 47–65μ: breadth at apex 25–46μ.
Common. Specimens of this variety were longer than those usually met with and they vary considerably in size, in breadth of apex and in the number of the crenulations.

Pleurotaenium Trabecula (Ehrenb.) Nag., forma **clavata** (Kutz.) West.
Length 288μ: breadth at base 34μ: breadth at apex 19μ
Common in the collections.

var. **rectum** (Delp.) West.
Length 280μ: breadth at base 18μ: breadth at apex 13μ. Common.
Cell wall smooth.

Tetmemorus laevis (Kutz.) Ralfs. Forma.

Length 210μ: breadth 34μ. Frequent.

Although from the measurements given for this species it would seem to be either nearer *T. Brebissonii* or *T. granulatus*, the form is decidedly nearer that of *T. laevis* and the cell wall is smooth or very finely punctate.

Euastrum verrucosum Ehrenb.

Length 72μ: breadth 68μ: breadth of apical lobe 28μ: isthums 15μ. Very common, a somewhat compressed form of the species.

Micrasterias Americana (Ehrenb.) Ralfs. Forma.

Length 149μ: breadth 127μ: breadth of apical lobe 59μ: breadth of isthusm 27μ. Common.

This is a peculiar form with the apical lobe spreading rapidly with its base deep sunken in the median portion of the semicell and with a peculiar arrangement of the teeth of the end lobe. The variations were constant in all specimens seen and the typical form did not appear.

Cosmarium pseudopyramidatum Lund.

Length 37μ: breadth 28μ: breadth of isthmus 6.5μ. Common.

Cosmarium cyclicum Lund.

Length 45μ: breadth=length: breadth of isthmus 12.5μ.

This species is not included by Wolle in his work and is reported by Johnson among his rarities. It seems however, to be a fairly common species in this country as it has turned up in several widely separated localities in material I have examined. In every way the specimens from Youngstown were typical.

Cosmarium Turpinii Bréb.

Length 53–58μ: breadth 47–53μ: breadth of isthmus 12.5–14μ: thickness 34μ. Very common at this locality. Wolle speaks of this species as "not rare." It has not yet been recorded from New England, however.

Cosmarium Broomei Thwaites.

Length 32μ: breadth 28μ: breadth of isthmus 9μ. Fairly common.

Cosmarium Amesii sp. nov.

Length 47μ: breadth 53μ: breadth of isthmus 15μ. Common.

A *Cosmarium* of the group represented by *C. binum* Nordst., *C. speciosum* Lund., etc. End broadly truncated, slightly retuse. Sides of each semicell with ten granules arranged in pairs as are also the granules of the end. From the border these pairs are repeated inward three or four times. The central basal portion of the side of each semi-cell composed of a roughly circular series of granules arranged in seven vertical rows: the central one, the longest, with six granules, at each side of this a series of four and the outer four rows each with five granules. The basal angles of the semi-cells are broadly rounded. This species is named for the collector, Mr. Charles B. Ames.

Staurastrum punctulatum Bréb.

Length 29μ: breadth 28μ: breadth of isthmus 7.5μ. Common.

Staurastrum muticum Bréb.

Breadth 34μ. Occasional.

In all, twenty-one varieties and forms were noted in the collection.

Boston Society of Natural History.

MEMORIAL OF THE OHIO ACADEMY OF SCIENCE ON THE DEATH OF PROF. A. A. WRIGHT.

The Executive Committee of the Ohio Academy of Science adopted the following memorial, prepared at its request by Prof. Lynds Jones, in respect to the death of Prof. A. A. Wright, of Oberlin, a member and former president of the Academy.

HERBERT OSBORN, *Pres.*
L. B. WALTON, *Sec.*

Albert Allen Wright died at his home in Oberlin on April 2d, 1905, of acute peritonitis after an illness of scarcely twenty-four hours. Prof. Wright was graduated from Oberlin College, in 1865, received the degree of A. M. from Oberlin in 1868, the degree of Ph. B. from the School of Mines, Columbia College, 1875, was Prof. of Mathematics and Natural Science, Berea College, Kentucky, 1870–1873, and was called to the chair of Geology and Natural History of Oberlin College in 1874. With the change of title to Professor of Geology and Zoology his service at Oberlin has been continuous since his first appointment.

Prof. Wright was born in Oberlin in 1846. He served as 100 day man during the closing days of the Rebellion, and received his baccalaureate degree the following year at the age of nineteen. He began early to develop his natural taste for science, and soon became recognized as a safe scientific thinker and investigator. He was one who never rushed to conclusions however enticing the facts discovered appeared, but took time to look into every possible avenue of approach to the subject, being satisfied only when his conclusions rested upon a foundation that could not be shaken. Consequently he was not a prolific writer. Indeed, he gave himself so unreservedly to his teaching and his students that research work was possible only during his brief vacations and at odd hours.

Prof. Wright was a modest, retiring man, always shrinking from publicity, yet his service to the community and the state becomes conspicuous in his absence. Oberlin's unrivalled water and sewer systems are largely due to his hard study and keen insight. To him is almost wholly due the inception of the topographical survey of Ohio. In this he was at first defeated, but by untiring efforts and dogged determination saw the issue to a successful finish. He was also among the charter members of the Ohio State Academy of Science, which he served as President.

Probably among his most conspicuous contributions to science was his correction of Dr. Newberry's error in the true arrangement of the ventral armor of Dinicthys. While the publications over his own name were relatively few, his inspiration to others and his constant interest and unfailing kindness in spending himself for others who worked under him will continue long to be a potent factor in the advancement of science.

Professor Wright was a Fellow of the American Association for the Advancement of Science, a Fellow of the Geological Society of America, and a member of the Ohio State Academy of Science.

LYNDS JONES

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, March 6, 1905.

The Club was called to order by the Vice-President, Miss Riddle. The minutes of the previous meeting were read and approved. A letter from Prof. Hine in Guatemala was read. Prof. Hine reported his work there as successful for the most part. The party was enjoying the trip very much.

Mr. Surface was asked to take the chair. The first paper was by Miss Riddle on the "Embryology of Staphylea and of Philotria." The species studied were Staphylea trifoliata and Philotria canadensis. Before the work on Philotria was completed R. B. Wylie, of the University of Chicago published a paper on the same subject. In the discussion Prof. Schaffner called attention to the fact that in Gray's Manual Philotria and Vallisneria are placed near the Orchids while this kind of a relationship is evidently impossible from the detailed study thus shown.

Mr. York next presented a paper on Hibernacula. Mr. York spent his available time this summer at Sandusky studying the water plants in the coves of the bay. Most water plants live over winter by means of tubers, blubs, etc., but in some there is a modification of the tip of the stem. These stems are much shortened and form bud-like structures called hibernacula.

Mr. Morris next read a paper on "Great Climatic Changes." He dealt only with geological changes. By means of the fossil remains and vegetable deposits in different strata the climate of the various regions in past times can be determined. Below the Cambrian there are no fossils but glacial evidence gives some idea of the climate. Several theories with regard to causes of climatic changes were given, prominent among which was Dr. Chamberlain's theory of the varying amount of CO_2 in the atmosphere.

In the discussion, Mr. Gleason, Mr. Hyde, Mr. Metcalf, Prof. Schaffner and Prof. Landacre spoke.

The following were elected to membership: M. E. Hendriksen, W. C. Morse, C. A. Miner and E. P. Durrant.

The club then adjourned.

F. M. SURFACE, *Sec.*

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DEVELOPMENT OF THE EMBRYO SAC AND EMBRYO OF BATRACHIUM LONGIROSTRIS.*

LUMINA COTTON RIDDLE.

Batrachium longirostris (Godr.) F. Schultz is one of the white water Ranunculaceae. By many authorities it is included in the genus Ranunculus but Britton in his Manual separates them into two genera on the character of the achene, that of Batrachium being transversely wrinkled. He distinguishes B. longirostris from B. divaricatum and B. trichophyllum with which the first is often confused, by the length of the beak of the achene. Prantl in his classification of the Ranunculaceae in the "Pflanzenfamilien" includes Batrachium in the Genus Ranunculus but divides the genus into seven sub-genera placing Batrachium in the third, Marsypadenium. This sub-genus he further divides into five super-species of which the first is Batrachium and the second Xanthobatrachium. Under this he places Ranunculus delphinifolius Torr. (R. multifidus Pursh) making the following distinctions:

Batrachium, Honigbl. weisze, Nektarium in einer Grube; Fr. runzelig.

Xanthobatrachium, Honigbl. gelb, Nektarium oefters mit seitlichen Lappen; Fr. nicht runzelig.

The writer had the privilege of studying three dozen excellently prepared and carefully selected slides of Ranunculus delphinifolius and some close resemblances were noted to Batrachium longirostris which will be referred to later in the discussion.

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* Contributions from the Botanical Laboratory of the Ohio State University, XX.

The subject has proved very interesting because of the large number of closely related plants which have already been studied and the accumulated literature which was easy of access either in the original publications or through brief reviews and abstracts. The writer became thoroughly familiar with her own material before making any comparisons in order to avoid having preconceived ideas of what ought to be expected.

Material for study was collected at Licking Reservoir in 1901 by Professor J. H. Schaffner and at Sandusky Bay, Lake Erie in the summers of 1902–1903 by the writer. The usual methods of killing, imbedding, sectioning and staining were employed. Thickness of the sections varied from 8–20 microns the older material being cut thickest.

The development of the carpel is almost identical with that of Ranunculus abortivus as described by E. A. Bessey (1). The rounded pyramid of the receptacle first appears from which numerous conelike projections arise (Fig. 1). Those nearest the base develop into the stamens. Near the summit of the receptacle the arrangement of parts is spiral but approaches the cyclic among the outer stamens. The number of stamens found by actual count varied from 17–21 while the number of carpels was approximately half as great. A lamina or flap develops from the distal side of the young carpel enveloping the inner portion which begins to grow away from the receptacle (Fig. 2). This lamina thins out as it meets the axillary placenta and traces of the integuments can be seen (Fig. 3). As the nucellus develops it describes an angle of 180° and when the gynoecium is mature the tip of the nucellus is directed downward while the opening of the micropyle is towards the receptacle. (Fig. 4). Only a single integument develops. The outer cells of the integument nearest the placenta are large and glandular and seem to function in conducting the pollen tube to the micropyle (Fig. 5). After the closing of the carpel an elongated style develops having finger like, glandular cells on the stigma which afford a lodging place for the pollen.

The microsporangium develops a plate of four or five hypodermal archesporial cells which divide by periclinal walls to form primary wall and primary sporogenous cells (Fig. 6). The primary wall cells then divide and the inner cells develop into the tapetal layer (Fig. 7). The outer cells may divide once or twice forming two or three distinct layers between the epidermis and the tapetum (Fig. 8). The layer next to the epidermis forms the endothecium with thickenings in the angles of the walls, exactly as were found in the endothecium of R. delphinifolius. Further divisions by anticlinal walls occur in both tapetal and wall layers and later the tapetum becomes binucleate by karyokinesis, without forming walls, instead of by fragmentation of the nucleus (Fig. 10–11).

The primary sporogenous cells continue to divide and apparently give rise to the axial layer of tapetal cells. The origin of the peripheral layer from the wall cells and the axial layer from the sporogenous, seems to accord with their origin in R. delphinifolius, both from examination of the slides and from the observations recorded in Coulter's Life History of Ranunculus (3). This refers the origin of the tapetum to the primary archesporium instead of referring the axial layer to the inner tissue of the androecium. Frequently a splitting was observed between the sterile wall layers and the tapetum but quite as often it could be seen between the tapetum and the sporogenous tissue (Fig. 9), and sometimes seemed separated from both. As the stamen matures the cells are forced past each other and misplaced, making it extremely difficult to determine the origin of the tapetum unless a careful study of a series of stages has been made.

The primary sporogenous cells then divide a number of times so that a central cross section shows sometimes as many as twelve microsporocytes (Fig. 8), while a longitudinal section shows from three to four rows (Fig. 11). The tapetal layer does not disintegrate early but is still quite well organized after the separation of the tetrads.

The microsporocyte divides to form four microspores (Fig. 12–13). No cases of more were found as has been reported in Ficaria (4) and other Ranunculaceae but in some cases the separation is incomplete. This is shown in one of the pollen grains in Fig. 25. In many cases the microspore never germinates (Fig. 14), in fact scarcely one to four. The tube nucleus and the generative nucleus lie close together. Just before pollination the generative cell becomes lenticular and divides to form the sperm nuclei (Fig. 15). These are not readily seen because of the abundant starch granules, the deep color which the pollen grain takes, and the crowding of the three nuclei. In the slides of R. delphinifolius there were found similar cases of two male nuclei before the germination of the pollen tube.

Before the lamina has entirely enclosed the nucellus, the archesporium can be distinguished (Fig. 16–17). The occurrence of two or more archesporial cells is not at all unusual and in many cases the struggle for supremacy results disastrously for all concerned. The remains of other archesporial cells can almost always be seen around the megasporocyte. There is no evidence of the cutting off of any primary parietal cell but the reduction division occurs at once. The lower of the two cells divides first and in many cases the division of the upper seemed never to pass beyond the formation of the spindle (Fig. 18–19). This is not unlike the development of the megaspores as reported by Mottier (8). In a few cases there seemed to be two complete sets of megaspores but the writer did not observe any twin embryo sacs though it is quite reasonable to expect to find them where the archesporium is so commonly multicellular. But in Batrachium, or at least in the material collected for study, the number of megaspores which divide and the number of embryo sacs that develop embryos seem very few. In many cases only a few of the ovules matured, perhaps two or three, as was seen in the ripened carpels and also in the material sectioned.

The functional megaspore passes through the two, four and eight celled stages and the nuclei arrange themselves normally (Fig. 20–23). The two synergidae stain much darker than the egg cell and the antipodals than the polar nuclei. After the conjugation of the polar nuclei the resulting definitive nucleus was very readily distinguished by its enormous size (Fig. 24). While the polar nuclei are approaching each other the antipodals enlarge and seem to take on definite walls, and the embryo sac begins to widen below. At the time of fertilization the antipodals are situated in an elevated crater-like pouch (Fig. 24). The lengthening of the embryo sac is greater on the distal than on the proximal side and extends beyond the chalaza near where the antipodal pouch is situated. The antipodals are typically those of Ranunculaceae resembling almost exactly those of R. delphinifolius. The nuclei sometimes divide (Fig. 27) but usually only three were present. They persist for a long time staining quite deeply and can be distinguished even in quite mature ovules (Figs. 31 and 33).

The entrance of the pollen tube into the embryo sac and the actual phenomenon of fertilization was not observed in Batrachium. The pollen tube was traced well down into the stigmatic tissue, found emerging in the cavity of the ovulary and again seen among the glandular cells of the shorter integument and traced into the micropyle. One might expect anything since Overton (10) reported parthenogenesis in Thalictrum purpurascens, Coulter (3) found the second sperm cell much disorganized at the time of its discharge in Ranunculus septentrionalis and Miss Thomas (14) discovered double fertilization occurring in Caltha palustris. Double fertilization is also reported by Nawaschin (11) for Delphinium elatum and by Guignard (7) in Ranunculus flammula, R. cymbalaria, Anemone nemorosa, Helleborus foetidus, Nigella sativa and N. damascena. In Batrachium, the fact that so few ovules develop and the traces of the pollen tube found in those that do, seems to set aside entirely the occurrence of parthenogenesis. The peculiar pale nucleus shown in Fig. 26 may be the second sperm nucleus. In one slide there was what might be taken for double fertilization, but the evidence was so unsatisfactory that the writer prefers to leave the question unsettled.

After fertilization the oospore begins to elongate and soon divides into a two celled embryo (Fig. 26). Before the first longitudinal division there is evidently another transverse one (Fig. 28). These two suspensor cells later divide in both directions varying considerably in method and order of divisions (Figs. 30 and 35.) The suspensor is short and does not seem to function long especially after the formation of the endosperm. The dermatogen is cut off by a series of periclinal walls from the octant and later divides by anticlinal walls. The cotyledons are small compared to the hypocotyl and the embryo is straight (Fig. 37). In the literature consulted there were but few of the Ranunculaceae in which the mature embryo was described. In Delphinium exaltatum Miss Dunn (15) finds a small heart shaped embryo with rudimentary suspensor and short hypocotyl. This seems to be the typical embryo in the Ranunculaceae.

The definitive nucleus divides immediately after fertilization and when the four celled embryo was found there was a single layer of endosperm completely lining the embryo sac (Fig. 29). These nuclei were not enclosed in cell walls but showed faint radiations (Fig. 31). In later divisions however, walls are formed and the entire embryo sac is filled with endosperm cells of varying shapes and sizes. Those in the antipodal region are large and rounded, those near the embryo wedge shaped or rhomboidal, and the peripheral layer is flattened. (Fig. 32.) The cells store up an abundance of starch (Fig. 34) which nourishes the young embryo. The cells are arranged in a radiate manner and as the young embryo enlarges the surrounding cells are emptied of their store (Fig. 33).

The inner wall of the carpel is made up of a layer of elongated cells which are longest in the plane at right angles to the axis of the carpel. Next to these cells there are four or five layers elongated at right angles to the first and rather crescentic (Fig. 38). As the ovule matures these cells develop thick perforate walls while the cells beneath the epidermal layer become somewhat separated to form a delicate spongy tissue (Fig. 39). These cells seem to contain some starch. The thickened cells make it a difficult matter to section the mature ovule so as to obtain good sections of the fully developed embryo.

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DESCRIPTION OF PLATES.

For the drawings a Bausch and Lomb camera lucida and microscope were used with oculars 2, 1 and ½ and objectives 2-3, 1-6 and 1-12; Figs. 1, 8-11, 16-24, 26, 28, 30, 34, 36, 38 and 39 were drawn under the 1-inch ocular and the 1-6 objective; Figs. 2, 3 and 37 with the 2-inch ocular and the 1-6 objective; Figs. 4, 5 and 25 with the ½-inch ocular and the 2-3 objective; Figs. 6, 7 and 14 with the ½-inch ocular and the 1-6 objective; Fig. 12 with the ½-inch ocular and the 1-12 objective; Fig. 13 with the 1-inch ocular and the 1-12 objective; Figs. 29 and 33 with the 2-inch ocular and the 2-3 objective.

Fig. 1—Section of the receptacle showing two stages in the development of the carpels.

Fig. 2—Section of young carpel showing the lamina.

Fig. 3—Section of carpel showing tip of carpellary leaf folded to enclose the nucellus.

Fig. 4—Section of carpel showing cavity closed and integument well developed. Megasporocyte divided.

Fig. 5—Longitudinal section of carpel showing elongating style and stigma and the micropyle.

Fig. 6—Section of young androecium showing division of archesporium into wall cells and sporogenous cells.

Fig. 7—Wall cells divided to form parietal tapetum. Outer wall cells beginning to divide.

Fig. 8—Delayed division in one primary wall cell. Sporogenous cell dividing to form axial tapetum.

Fig. 9—Central section showing tapetum fully developed and a splitting between the peripheral tapetum and the sporogenous tissue.

Fig. 10—Section near tip of stamen showing binucleate tapetum and spindle.

Fig. 11—Longitudinal section of more mature stamen showing the same·

Fig. 12—Microsporocyte dividing.

Fig. 13—Tetrads.

Fig. 14—Disintegrating microspore and two celled pollen grain.

Fig. 15—Mature pollen grains showing tube and two sperm nuclei.

Fig. 16—Nucellus and archesporial cell.

Fig. 17—Double archesporium.

Fig. 18—Megaspores.

Fig. 19—Nucellus showing megaspores and division in epidermal layer.

Fig. 20—Two-celled embryo sac.

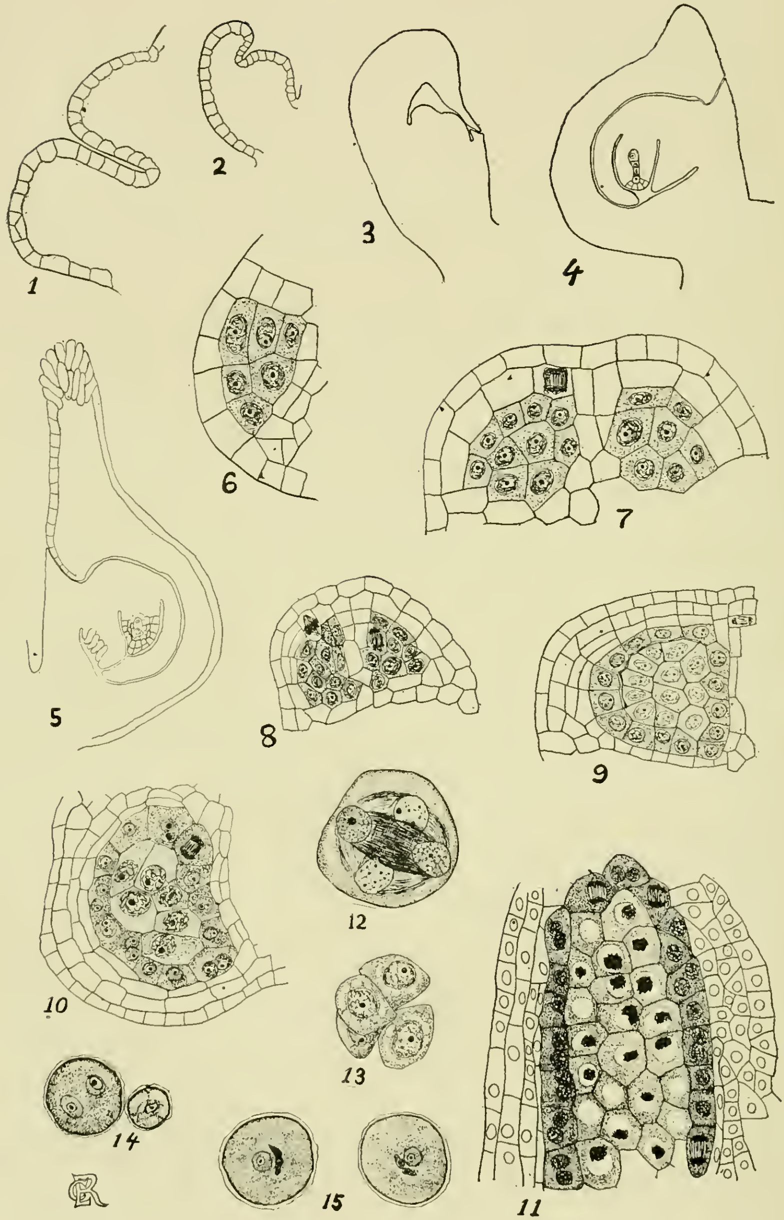
Fig. 21—Four celled embryo sac.

Fig. 22—Eight celled embryo sac.

Fig. 23—Eight celled embryo sac showing synergidae and oosphere, conjugating polar nuclei and antipodals.

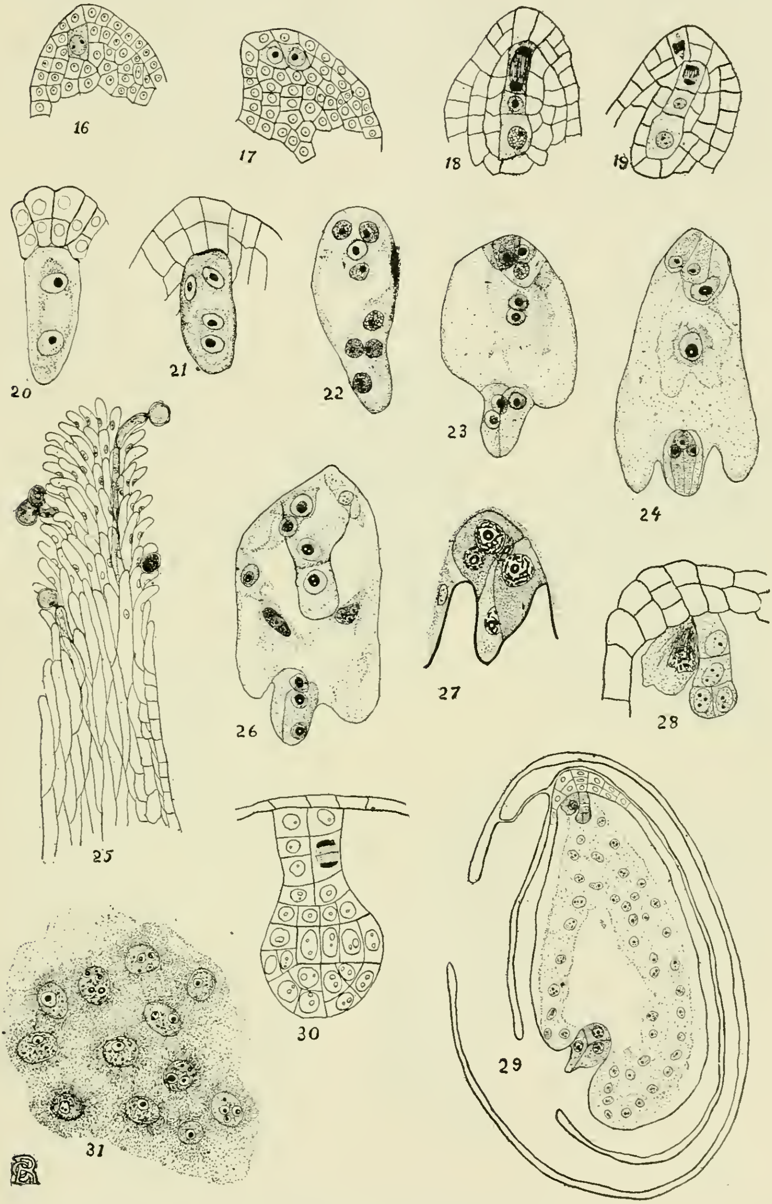
Fgi. 24—Seven celled embryo sac showing egg apparatus, definitive nucleus and antipodals. Embryo sac enlarging in antipodal region.

OHIO NATURALIST. *Plate XXII.*



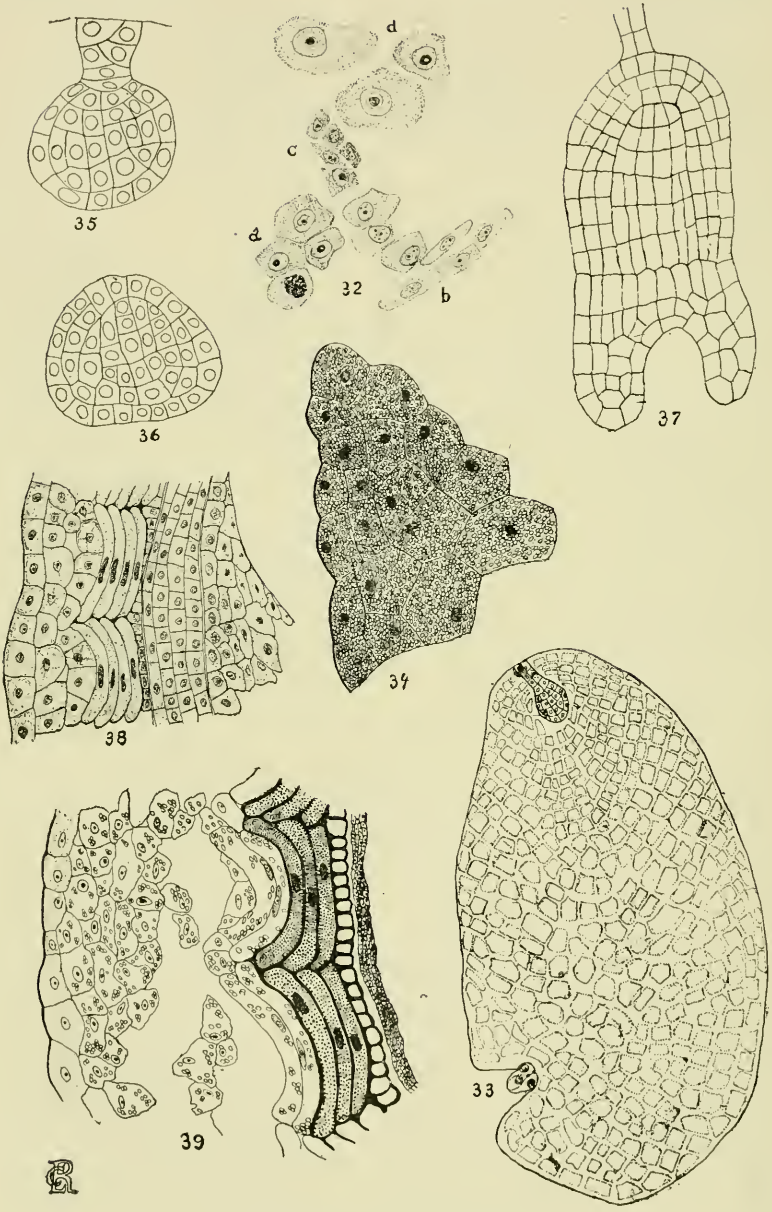
RIDDLE on "Batrachium."

OHIO NATURALIST. *Plate XXIII.*



RIDDLE on "Batrachium."

OHIO NATURALIST. *Plate XXIV.*



RIDDLE on "Batrachium."

Fig. 25—Stigma showing germinating pollen grains.
Fig. 26—Young two celled embryo and endosperm. Possibly the remains of the second generative nucleus and pollen tube.
Fig. 27—Antipodals with five nuclei.
Fig. 28—Four celled embryo and persisting synergid.
Fig. 29—Single integument, nucellus and embryo, the remains of synergid, endosperm, and three nuclei of the antipodals.
Fig. 30—More mature embryo showing dermatogen layer and division in suspensor cells.
Fig. 31—Endosperm from sac of a four celled embryo showing faint radiations.
Fig. 32—Endosperm cells showing variation in shape and size. a-average cells; b-peripheral cells; c-cells near embryo; d-in antipodal region.
Fig. 33—Embryo sac showing the arrangement of endosperm cells and the remains of antipodals.
Fig. 34—Closely packed endosperm filled with starch. From an embryo sac containing a mature embryo.
Fig. 35—Embryo showing rather diagonal division of the suspensor.
Fig. 36—Section of older embryo cut slightly diagonal but showing the beginning of cotyledons.
Fig. 37—Nearly mature embryo showing cotyledons, dermatogen, calyptrogen, pleurome and traces of the suspensor.
Fig. 38—Crescent shaped cells of inner wall of carpel and elongated cells at right angles to the first; integument and nucellus.
Fig. 39—Section of a mature carpel showing these crescent and elongated cells hardened and perforate.

LEAF EXPANSION OF TREES AND SHRUBS. No detailed record of the expanison of leaves was kept for the spring of 1905, but it was noted that the beginning of leafing was seven days earlier than in the spring of 1904. Syringa vulgaris L. came first on March 25, followed by Salix babylonica L., Larix laricina (Du R.) Koch, and L. decidua Mill. Some trees were comparatively earlier than last year and the order of succession was changed in quite a number of species. This was probably due in part to the more uniform advancement of warm weather. Morus rubra L. and Chionanthus virginica L. were the last trees to leaf, coming out on May 6.

J. H. S.

KEY TO THE GENERA OF OHIO WOODY PLANTS BASED ON LEAF AND TWIG CHARACTERS.

John H. Schaffner.

1. Foliage leaves with expanded blades, netted-veined. 8.
1. Foliage leaves needle-shaped, narrowly linear, subulate, or scale-like; conifers, or in one case a dicotyl with delicate twigs and minute leaves. 2,
1. Foliage leaves fan-shaped with dichotomous venation, a number on thick, wart-like, persistent dwarf branches. **Ginkgo.**
2. With typical dwarf branches, persistent for more than 1 year. 3.
2. With feather-like dwarf branches, deciduous each year, the linear leaves spreading into 2 ranks. **Taxodium.**
2. With delicate spray-like twigs deciduous each year; leaves scale-like, minute; a dicotyl. **Tamarix.**
2. Without dwarf branches. 4.
3. Dwarf branches small, self-pruned, with 2–5 foliage leaves. **Pinus.**
3. Dwarf branches thick, wart-like, persistent, with numerous deciduous leaves. **Larix.**
4. Leaf buds scaly; leaves scattered. 5.
4. Leaf buds not scaly, naked; leaves opposite or whorled. 7.
5. Leaf scar on a sterigma, the twigs covered with scales representing the leaf bases. 6.
5. Leaf scar on the bark; twigs without scales; leaves flat. **Abies.**
6. Leaves flat, those on the upper side of the twig much shorter than the lateral ones; trees. **Tsuga.**
6. Leaves flat all of about the same length; ours a shrub. **Taxus.**
6. Leaves more or less 4-sided, spreading in all directions. **Picea.**
7. Foliage leaves small, scale-like, appressed, opposite, 4-ranked, closely covering the twigs which are decidedly flattened and fan-like; leaves of two shapes, the dorsal and ventral broader and less acute than the lateral ones; scales of the carpellate cone not peltate. **Thuja.**
7. Foliage leaves small, scale-like, appressed, opposite, 4-ranked, closely covering the slightly flattened twigs which are not very fan-like; leaves nearly or quite similar; scales of the carpellate cone peltate. **Chamaecyparis.**
7. Foliage leaves of two types, scale-like and subulate, opposite or in threes; the scale-like leaves 4-ranked, appressed, causing the twigs to appear quadrangular, the subulate leaves spreading; one or both types of leaves on a plant; carpellate cone developing into a bluish-black berry-like fruit. **Juniperus.**

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8. Leaves alternate. 9.
8. Leaves opposite or whorled. 110.
9. Leaves simple. 10.
9. Leaves compound. 93.
10. Leaves pinnately veined or with a simple midrib. 11.
10. Leaves palmately veined or at least with 2 or more prominent side ribs coming from near the base of the blade. 74.
11. Leaves not revolute-margined when fully expanded. 12.
11. Leaves decidedly revolute-margined, evergreen, thus appearing on wood of the previous season. 90.
12. Leaves truncate or broadly emarginate; with complete stipular rings at the nodes. **Liriodendron.**
12. Leaves entire. 13.

12. Leaves serrate, dentate, crenate, pinnatifid, or variously lobed. 31.
13. With stipular rings at each leaf node; leaves large. **Magnolia.**
13. Base of petiole covering the axillary bud and twigs with peculiar rings but not at the leaf nodes. **Dirca.**
13. Not with stipular rings; base of petiole not covering the axillary bud. 14.
14. Leaves evergreen, some on wood of the previous season. 15.
14. No leaves on wood of the previous season. 18.
15. Leaves glabrous; erect shrubs or small trees. 16.
15. Leaves hirsute or pubescent; low trailing or spreading shrubs. 17.
16. Leaves green on both sides, thick, coriaceous, oblong to oblanceolate, 5–10 in. long; winter buds very scaly. **Rhododendron.**
16. Leaves green on both sides, or glaucous beneath, coriaceous, 2–5 in. long; oval or oval-lanceolate, winter buds naked. **Kalmia.**
17. Leaves oval or nearly orbicular, hirsute beneath; twigs hirsute; prostrate shrubs. **Epigaea.**
17. Leaves spatulate, minutely pubescent, with hairs on the margins; trailing or spreading shrubs. **Arctostaphylos.**
18. With thorns; either small trees with milky sap or low vine-like shrubs. 19.
18. Without thorns. 20.
19. Trees or erect shrubs with prominent thorns; leaves with milky sap, the base obtuse, truncate, or cordate. **Toxylon.**
19. Climbing shrubs with axillary thorns; leaves not milky, narrowed into short petioles. **Lycium.**
20. Pith with prominent diaphragms but solid; vascular bundles in base of petiole 3–7. 21.
20. Pith not diaphragmed but sometimes with cavities. 22.
21. Leaves 2-ranked; bark with fetid odor; vascular bundles in base of petiole 5–7. **Asimina.**
21. Leaves not 2-ranked; vascular bundles in base of petiole 3. **Nyssa.**
22. Leaves resin-dotted, waxy-dotted or punctate. 23.
22. Leaves not dotted or punctate. 24.
23. Shrubs or small trees; leaves oblong-lanceolate, spatulate, or oblanceolate, short pointed, narrowed at the base. **Myrica.**
23. Shrubs with obovate or elliptic leaves narrowed at the base; bark spicy aromatic; axillary buds superposed. **Benzoin.**
23. Low shrubs; leaves ovate-lanceolate, wedge-shaped at the tip. **Gaylussacia.**
24. Pith prominently 5-angled; leaves with deciduous stipules and with bristle tips; trees. **Quercus.**
24. Pith cylindrical or nearly so; leaves downy with prominent deciduous stipules. **Cydonia.**
24. Pith cylindrical or nearly so; no stipules or stipular scars, if with minute stipules then glabrous. 25.
25. Leaves with the upper 2 lateral veins more or less parallel with the midrib. **Cornus.**
25. Leaves pinnately veined to the tip. 26.
26. Bark when cut very resinous, fragrant; pith large, usually brown. **Cotinus.**
26. Bark not resinous. 27.
27. Trees, sometimes with cavities in the pith; leaves oval or ovate, acute or acuminate, the petioles loosely jointed with the twigs. **Diospyros.**
27. Pith not with cavities; shrubs. 28.
28. Leaves with long petioles; twigs not clustered and the leaf internodes rather uniform, with minute stipules. **Ilicioides.**

28. Leaves with short petioles or nearly sessile; or if with rather prominent petioles then the twigs clustered and the internodes very unequal. 29.
29. Internodes very unequal, the leaves crowded at the tip of the twig and the twigs clustered. **Azalea.**
29. Internodes rather uniform, the leaves not crowded at the tip and the twigs not clustered. 30.
30. Older twigs finely white speckled or granulated and blistered: corolla cylindric subglobose or urceolate. **Vaccinium.**
30. Twigs not white speckled or granulated, prominently self-pruned; corolla open-campanulate. **Polycodium.**
30. Twigs with decurrent ridges from the sides of the petiole base; leaves lanceolate; petiole jointed. **Lycium.**

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31. Lateral veins from the midrib straight and parallel or nearly so; some or all lateral veins usually ending in the serrations, teeth or lobes. 32.
31. Lateral veins not straight and parallel 43.
32. Leaves not 2-ranked. 33.
32. Leaves quite regularly 2-ranked, that is with the third leaf over the first. 36.
33. Pith 3-angled, buds stalked. **Alnus.**
33. Pith 5-angled, buds not stalked. 34.
33. Pith cylindrical or nearly so. 35.
34. Leaves or their lobes bristle-tipped, or if not bristle-tipped then the teeth or lobes not sharply acuminate; buds clustered at the tip of the twig; nut in a cup-like involucre of numerous scales. **Quercus.**
34. Leaves with sharply acuminate teeth; buds not clustered at the tip; nuts with a prickly or spiny involucre. **Castanea.**
35. Usually with prominent and typical lateral thorns; carpels of the pome bony. **Crataegus.**
35. Without thorns but sometimes with thorn-like stunted branches; leaves irregularly dentate, serrate, or crenate-dentate; sometimes lobed; pome fleshy without grit cells; carpels papery or leathery. **Malus.**
35. Without thorns; leaves serrate or serrate-dentate; pome berry-like, carpels not bony. **Amelanchier.**
36. Leaves decidedly inequilateral at the base. 37.
36. Leaves not inequilateral or only very slightly so. 38.
37. Leaves doubly serrate; axillary buds sessile. **Ulmus.**
37. Leaves repand dentate; axillary buds prominently stalked. **Hamamelis.**
38. Lateral veins ending in the large dentations or serrations which are always simple (a vein for each). 39.
38. Leaves doubly serrate or sometimes simply serrate, the lateral veins ending in the main serrations or teeth but not in the smaller ones, or the veins not ending in the serrations. 40.
39. Leaves ovate or ovate-oblong, short acuminate; teeth not with slender points; bark smooth, light-gray. **Fagus.**
39. Leaves oblong-lanceolate, acuminate, with slender often inwardly curved points on the serrations; bark rough. **Castanea.**
40. Lateral veins not ending in the serrations or teeth. **Amelanchier.**
40. Lateral veins ending in some of the serrations, teeth or lobes. 41.
41. Bark smooth, the trunk and larger branches with fluted or projecting ridges; leaves acute or acuminate, sharply doubly serrate. **Carpinus.**
41. Trunk and larger branches not with fluted or projecting ridges. 42.

42. Bark of trunk and larger branches separating into papery or leathery sheets; trees or shrubs with glabrous, pubescent, or glandular-warty twigs. **Betula.**
42. Bark of trunk scaly, fine furrowed; twigs pubescent; carpellate catkin in fruit appearing like that of the hop. **Ostrya.**
42. Bark of trunk and larger branches smooth or rough, not scaly and fine furrowed and not separating into papery or leathery sheets; twigs coarsely glandular pubescent or nearly glabrous; fruit a large nut in a leafy or partly coriaceous cup or involucre. **Corylus.**

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43. Leaves 2-ranked. 44.
43. Leaves not 2-ranked. 45.
44. Bark of trunk and larger branches separating into papery or leathery sheets; leaves doubly serrate, the lateral veins ending in the main serrations, teeth or lobes. **Betula.**
44. Bark not in papery or leathery sheets; leaves not doubly serrate, the lateral veins not ending directly in the serrations or teeth. **Amelanchier.**
44. Bark not in papery or leathery sheets; leaves doubly serrate ending in the main serrations or lobes. **Corylus.**
45. Leaves with spine-tipped teeth or lobes, or some of the leaves reduced to simple or branched spines. 46.
45. Leaves not with spines. 47.
46. Leaves evergreen, with spine-tipped lobes; trees. **Ilex.**
46. Leaves reduced to simple or branched spines, some leaves without spines and deciduous each year; shrubs. **Berberis.**
47. Pith solid but with prominent diaphragms, cylindrical; vascular bundles 3 in the base of the petiole; trees. **Nyssa.**
47. Pith not both diaphragmed and solid. 48.
48. Leaves with 1 or more disc-like, wart-like, or tooth-like glands on the petiole or at the base of the blade, or with tooth-like glands on top of the midrib. 49.
48. Leaves not with distinct glands on the top of the petiole or midrib, or at the base of the blade, but they may be glandular-hairy or glandular-dotted. 53.
49. Pith 5-angled, leaves usually more or less deltoid with gland-tipped teeth. **Populus.**
49. Pith cylindrical or nearly so. 50.
50. With typical lateral thorns. **Crataegus.**
50. Not with typical lateral thorns, but some may have thorn-like stunted branches. 51.
51. With tooth-like glands along the top of the midrib; shrubs. **Aronia.**
51. Glands tooth-like, mostly at the base of the midrib; leaves glabrous when mature, with long petioles; fruit a pome. **Pyrus.**
51. Glands only on the petiole or near the base of the blade. 52.
52. Glands tooth-like or rounded, or the leaf with gland-tipped teeth, but not with 2–4 large disc-like glands at the base on the edges of the blade; terminal bud absent when the twig is mature; twigs with brittle zones; fruit a capsule, in catkins. **Salix.**
52. Twigs green, red, or red and green; nectar glands disc-like, usually 2–4 near the base at the edge of the blade; terminal bud present; twigs without brittle zones; fruit a velvety drupe. **Amygdalus.**
52. Glands various; twigs not red and green, some with cleavage planes in basal joints but not with brittle zones; terminal bud present or absent, fruit a smooth drupe. **Prunus.**

—53—

53. Leaves with peltate scales, or resin dotted, not pinnatifid. 54.
53. Leaves not with peltate scales, but the twigs may be resin-dotted. 55.
54. Leaves evergreen, oblong or oblanceolate, densely covered with scurfy peltate scales. **Chamaedaphne.**
54. Leaves deciduous; oblanceolate or wedge-lanceolate, resin-dotted and peltate scaly. **Myrica.**
55. Pith decidedly 5-angled; leaves not fragrant; trees or shrubs. **Quercus.**
55. Pith cylindrical or nearly so. 56.
56. Leaves long linear-lanceolate or long linear-oblong; deeply pinnatifid, fragrant; twigs resin-dotted. **Comptonia.**
56. Leaves not at the same time linear-lanceolate, deeply pinnatifid, and fragrant; twigs not resin-dotted. 57.
57. Climbing partly herbaceous plants with lobed leaves. **Solanum.**
57. Leaves not lobed unless the plants are tall shrubs or trees. 58.
58. With lateral thorns and sometimes with thorns at the ends of slender branches. 59.
58. Not with thorns. 61.
59. Leaves coriaceous, evergreen, hence on wood of the previous season. **Cotoneaster.**
59. Leaves deciduous, not evergreen. 60.
60. With typical lateral thorns but without terminal thorns; pome with bony carpels. **Crataegus.**
60. With thorns at the ends of long slender branches and also with lateral thorns; pome very hard, with leathery carpels. **Cydonia.**
60. With thorn-like stunted branches; leaves sharply and regularly serrate or nearly entire, long petioled, glabrous when mature; pome with grit cells. **Pyrus.**
60. With thorn-like stunted branches; leaves irregularly toothed or serrate, sometimes lobed; pome without grit cells. **Malus.**
61. Slender creeping evergreen shrubs with fragrant aromatic leaves. **Gaultheria.**
61. Not creeping; leaves not aromatic. 62.
62. Woody twiners; vascular bundle in base of petiole 1. **Celastrus.**
62. Not twining or climbing. 63.
63. With stipules or stipular scars. 64.
63. Without stipules or stipular scars. 70.
64. Outer bud scales of winter buds more than 1. 65.
64. Outer bud scale 1; twigs with brittle zones, hence easily detached and leaving peculiar self-pruning scars; terminal bud of ripe branches absent; bundle scars or vascular bundles in base of petiole. 3. **Salix.**
65. Leaves usually more or less heart-shaped at the base; regularly and sharply serrate or serrate-dentate; fruit a small berry-like pome. **Amelanchier.**
65. Leaves acute or rounded at the base or if heart-shaped then irregularly toothed or serrate-dentate or the leaf with long petiole and acute or acuminate at the apex. 66.
66. Axillary buds usually superposed; leaves not mucronate or bristle-tipped or if so then also abruptly acuminate; fruit a berry-like drupe. **Ilex.**
66. Axillary buds not superposed. 67.
67. Leaves distinctly mucronate or bristle-tipped, glabrous, elliptic or obovate; fruit a berry-like drupe. **Ilicioides.**
67. Leaves not mucronate or bristle-tipped or if so then also abruptly acuminate. 68.

68. Leaves with gland-tipped serrations; terminal bud absent on ripe twigs or if present then the lateral veins prominent and nearly parallel and curving upward at the margin of the leaf; fruit a berry-like drupe. **Rhamnus.**
68. Leaves not with gland-tipped serrations, or if so then not as above; terminal bud present; fruit a pome. 69.
69. Leaves sharply and regularly serrate, glabrous when mature, petioles long; pome with grit cells. **Pyrus.**
69. Leaves irregularly dentate or serrate, or more or less lobed; pome without grit cells. **Malus.**
70. Internodes very unequal; shrubs; fruit a capsule. **Azalea.**
70. Internodes not very unequal. 71.
71. Leaves sour, with prominent scattered hairs on the midrib beneath; trees; fruit a capsule. **Oxydendrum.**
71. Leaves not sour, nor as described above; shrubs. 72.
72. Petiole slender, often one-half as long as the blade or longer; prominently mucronate or bristle-tipped; fruit a drupe. **Ilicioides.**
72. Leaves short-petioled or sessile. 73.
73. Older twigs finely white speckled or granualted and blistered. **Vaccinium.**
73. Twigs not white speckled or granulated, often with decurrent ridges. **Spiraea.**

—74—

74. Plants with tendrils. 75.
74. Without tendrils. 77.
75. Monocotyls, with scattered vascular bundles and a pair of tendrils on the petiole. **Smilax.**
75. Dicotyls with pith, a ring of wood, and true bark; tendrils opposite some of the leaves. 76.
76. Older branches with woody partitions at the leaf nodes; bark brown, shreddy. **Vitis.**
76. Branches without woody partitions; bark smooth, grayish-brown, not shreddy. **Ampelopsis.**
77. Base of petiole covering the axillary bud; twigs with stipular rings. **Platanus.**
77. Axillary bud partly hidden; stems twining; no stipular rings. **Menispermum.**
77. Axillary buds usually evident; stems not twining and twigs without stipular rings. 78.
78. Leaves 2-ranked. 79.
78. Leaves not 2-ranked. 84.
79. Leaves entire, round-heart-shaped. **Cercis.**
79. Leaves serrate, dentate, or lobed. 80.
80. Pith usually in transverse plates; leaves ovate-lanceolate, inequilateral, taper-pointed. **Celtis.**
80. Pith solid, not diaphragmed. 81.
81. With milky sap. 82.
81. Without milky sap. 83.
82. Twigs gray or brown, glabrous or nearly so; leaves pubescent or glabrous beneath. **Morus.**
82. Twigs grayish-green, downy; leaves tomentose beneath. **Broussonetia.**
83. Leaves not inequilateral; vascular bundles in base of petiole 3. **Betula.**
83. Leaves inequilateral at the base; vascular bundles in base of petiole several, scattered. **Tilia.**
84. Leaves more or less star-shaped, with 3–7 long pointed serrate lobes, strongly aromatic when crushed; pith 5-angled. **Liquidambar.**

84. Leaves entire or three-lobed, bark spicy-aromatic; internodes very unequal. **Sassafras.**
84. Leaves crenate, serrate, dentate, or lobed, not star-shaped and not spicy-aromatic. 85.
85. Pith 5-angled; trees usually with resinous buds; leaves usually broad based. **Populus.**
85. Pith cylindrical or nearly so. 86.
86. With prominent typical thorns; trees or erect shrubs. **Crataegus.**
86. Without thorns but often with prickles or bristles; low shrubs. 87.
87. Leaves lanceolate or ovate-lanceolate with gland-tipped serrations or dentations; low erect shrubs. **Ceanothus.**
87. Leaves broad and more or less lobed. 88.
88. Petioles and twigs densely brown-bristly, leaves 4-8 in. broad, angled or lobed. **Rubus.**
88. Twigs not bristly, if the petioles are bristly then the leaves much smaller. 89.
89. Bundle scars or vascular bundles in base of petiole widely separate; petiole not decurrent at the middle or if so then the petiole with long hairs or distinctly pubescent; plants often prickly; fruit a berry. **Ribes.**
89. Bundle scars or vascular bundles in base of petiole closely crowded or nearly confluent; petioles strongly decurrent at the sides and middle; glabrous or only minutely pubescent; plant not prickly; fruit a capsule. **Opulaster.**

—90—

90. Leaves glabrous. 91.
90. Leaves pubescent or woolly at least below. 92.
91. Leaves ¼–½ in. long, bitter. **Oxycoccus.**
91. Leaves 1–2½ in. long, acid. **Andromeda.**
92. Leaves with a fragrant odor, densely tomentose beneath; erect, resinous shrubs. **Ledum.**
92. Leaves 2-ranked, small, oval or ovate, hairy; creeping shrubs. **Chiogenes.**

—93—

93. With tendrils; leaves digitate. **Parthenocissus.**
93. Without tendrils; leaves trifoliate or pinnate. 94.
94. Pith diaphragmed, with cavities; large trees with pinnate leaves. **Juglans.**
94. Pith not diaphragmed. 95.
95. Leaves trifoliate or odd-pinnate. 96.
95. Leaves evenly pinnate or bipinnate; axillary buds superposed. 109.
95. Leaves odd-bipinnate, serrate; twigs and leaves usually prickly. **Aralia.**
96. Leaves with spine-tipped teeth, evergreen. **Berberis.**
96. Leaves not with spine-tipped teeth; but some may be prickly. 97.
97. Lobes or teeth at the base of the leaflets with prominent green glands beneath; leaves pinnate, very large with disagreeable odor. **Ailanthus.**
97. Lobes or teeth if present without green glands. 98.
98. With stipular spines a pair for each leaf; leaflets entire. 99.
98. Without stipular spines, but some may have thorns or prickles. 100.
99. Leaflets oval or ovate, not pointed, usually mucronate, not punctate **Robinia.**
99. Leaflets ovate, pointed, glandular-punctate. **Xanthoxylum.**
100. Base of petiole covering the axillary buds; not prickly. 101.
100. Base of petiole not covering the axillary buds. 103.
101. Leaves 3-foliate, leaflets crenulate, glandular punctate; bark with disagreeable odor; axillary buds superposed. **Ptelea.**

101. Leaves 3-foliate, fragrant; axillary buds not superposed; bark resinous or milky. **Rhus.**
101. Leaves pinnate, not punctate. 102.
102. Leaflets serrate; pith very large; bark resinous or milky. **Rhus.**
102. Leaflets entire; pith small, bark not resinous or milky; trees. **Cladrastis.**
103. Leaflets entire or if occasionally few-toothed then the rachis prominently winged. 104.
103. Leaflets serrate or dentate, the rachis not winged. 105.
104. Stipules large, membranous and sheathing; leaflets 3–5, long silky. **Dasiphora.**
104. Stipules small, not sheathing; leaflets prominently mucronate, bark with strong odor. **Amorpha.**
104. Stipules none, bark with a resinous or milky sap, often poisonous. **Rhus.**
105. With bristles or prickles; shrubs. 106.
105. Without bristles or prickles; leaves pinnate. 107.
105. Without bristles or brickles; leaves trifoliate, poisonous. **Rhus.**
106. Leaves usually pinnate, the leaflets usually of about the same type, if 3-foliate then the petiole separates close to the bark leaving a definite leaf scar; fruit an achene, a number inclosed in the fleshy perigynous disc. **Rosa.**
106. Leaves simple and lobed, or 3-7-foliate; if pinnate then the terminal leaflet usually larger or broader than the others, petiole base persistent; fruit an aggregate of drupelets. **Rubus.**
107. Pith cylindrical or nearly so; leaves with stipules; vascular bundles in base of petiole 3–5. 108.
107. Pith 5-angled; stipules none, base of petiole with numerous vascular bundles, scattered or in 3 areas. **Hicoria.**
108. Trees; leaflets obtuse or acute at the apex. **Sorbus.**
108. Shrubs; leaflets long acuminate. **Sorbaria.**
109. Pith small; base of petiole covering the axillary buds; usually with prominent thorns. **Gleditsia.**
109. Pith very large, base of petiole not covering the axillary buds; without thorns. **Gymnocladus.**

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110. Leaves simple. 116.
110. Leaves compound with tendrils. **Bignonia.**
110. Leaves compound, with 3 or more leaflets, petioles and petiolules coiling; climbing vines. **Clematis.**
110. Leaves compound without tendrils. 111.
111. Leaves digitate with 5 or more leaflets. **Aesculus.**
111. Leaves trifoliate or pinnate. 112.
112. With numerous pit-like glands on top of the petiole near its base; vines climbing by rootlets. **Tecoma.**
112. No glands on the top of the petiole; shrubs or trees. 113.
113. Base of petiole covering the axillary buds; leaflets dentate, lobed, or nearly entire. **Acer.**
113. Base of petiole not covering the axillary buds. 114.
114. Leaves trifoliate, serrate; bark with strong odor. **Staphylea.**
114. Leaflets 5–11. 115.
115. Leaves often with gland-tipped stipels; pith large; shrubs. **Sambucus.**
115. Leaves without stipels; pith small; trees. **Fraxinus.**

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116. Leaves pinnately veined. 123.
116. Leaves palmately veined or at least with 2 prominent side ribs from the base. 117.
117. Leaves entire or if somewhat 3-lobed with entire margin. 118.

117. Leaves serrate, crenate, dentate or variously lobed. 120.
118. Evergreen shrubs parasitic on trees; leaves small. **Phoradendron.**
118. Trees with large leaves. 119.
119. Pith diaphragmed, or with large cavities; petioles usually hollow; axillary buds superposed. **Paulownia.**
119. Pith and petioles solid; axillary buds not superposed. **Catalpa.**
120. Leaves more or less lobed. 121.
120. Leaves not lobed. 122.
121. Leaves without stipules, or if with stipules then large trees with very large-toothed or angled but not serrate leaves; fruit a 2-winged samara. **Acer.**
121. Leaves with stipules, some with glands on the petiole or if not then always serrate-dentate; shrubs; fruit a drupe. **Viburnum.**
122. Stipules none; axillary buds minute, covered; fruit a capsule. **Philadelphus.**
122. Stipules or stipular scars present; fruit a drupe. **Rhamnus.**

—123—

123. Leaves serrate, dentate, crenate, or variously lobed. 124.
123. Leaves entire. 132.
124. Twigs with a prominent pubescent ridge decurrent from the middle of the line connecting the petiole bases. **Diervilla.**
124. No pubescent decurrent ridge from the middle of the connecting line, but the ends of the petiole bases may be decurrent. 125.
125. Leaves evergreen, on wood of the previous season, obovate or obicular; creeping shrubs without stipules. **Linnaea.**
125. Leaves not evergreen. 126.
126. Bark of ripe twigs green, bundle scar or vascular bundle in base of petiole 1; pith rhombic. **Euonymus.**
126. Bark of ripe twigs gray, brown, or red; pith cylindrical or nearly so. 127.
127. Stipules or stipular scars present. 128.
127. Stipules none. 129.
128. Lateral veins 3 or 4 pairs, the outer more or less parallel with the midrib; usually with terminal thorns. **Rhamnus.**
128. Lateral veins 5 or more pairs, the outer not parallel with the midrib but spreading; without thorns. **Viburnum.**
129. Petioles of the lower leaves as long or nearly as long as the large blades. 130.
129. Petioles short. 131.
130. Leaves dentate, outer bark separating readily from the green inner bark. **Hydrangea.**
130. Leaves serrate or serrate-dentate, outer bark not spreading readily. **Viburnum.**
131. Low shrubs; leaves normally entire, occasionally irregularly toothed or somewhat lobed, usually of the ovate or oval type. **Symphoricarpos.**
131 Erect shrubs, leaves serrate or dentate; axillary buds minute covered by the petiole base; twigs minutely angled or striate. **Philadelphus.**
131. Erect shrubs or small trees; leaves dentate or serrate; axillary buds evident, not covered by the petiole base. **Viburnum.**
132. Twigs and leaves white- or brown-scurfy or stellate-pubescent. **Lepargyraea.**
132. Not scurfy or stellate-pubescent. 133.
133. Leaves pellucid-punctate or black-dotted; low shrubs. 134.
133. Leaves not pellucid-punctate or black-dotted. 135.
134. Creeping shrubs; leaves 2-glandular at the base. **Ascyrum.**
134. Erect shrubs; leaves not 2-glandular at the base. **Hypericum.**

135. Leaves coriaceous, evergreen, hence on wood of the previous season, not perfoliate. **Kalmia.**
135. Leaves deciduous each year. 136.
136. Leaves with the two outer lateral veins more or less parallel with the midrib; fruit a drupe. **Cornus.**
136. Leaves pinnately veined to the tip, the outer lateral veins usually spreading. 137.
137. With stipules between the large acuminate leaves. **Cephalanthus.**
137. Without stipules. 138.
138. Upper leaves perfoliate. **Lonicera.**
138. Leaves not perfoliate. 139.
139. Petioles meeting around the stem or connected by a distinct ridge; spreading shrubs or woody climbers. 140.
139. Petioles not meeting, not connected by a ridge; erect shrubs or small trees. 141.
140. Leaves of the ovate, oval or orbicular type, not heart-shaped at the base; stem never twining; bundle scar 1 or appearing as 1. **Symphoricarpos.**
140. Leaves of the lanceolate, ovate-lanceolate, or oblong type, often heart-shaped at the base; stems sometimes twining; bundle scars distinctly 3. **Lonicera.**
141. Leaves lanceolate or ovate-lanceolate, 1–3 in. long; fruit a globose berry. **Ligustrum.**
141. Leaves oval or oblong, narrowed at the base, 3–6 in. long, fruit an oblong drupe. **Chionanthus.**
141. Leaves ovate, or ovate-lanceolate, usually cordate or truncate at the base, 3–7 in. long; fruit a capsule. **Syringa.**

DESCRIPTIONS OF NEW NORTH AMERICAN FULGORIDAE.

HERBFRT OSBORN.

Prokelisia, nov. gen.

Agrees with Kelisia in the narrowed elytra, aborted wings and general facies, with Megamelus in the widening front, and keeled apex of vertex.

Vertex long narrowing anteriorly, front widening on its lower half, narrowing sharply to tip of vertex, the carinae not meeting but extending very prominently over tip and on to vertex. Clypeus somewhat tumid, median carinae somewhat obtuse, lateral carinae distinct, curved; antennae with second joint short, tuberculate. Pronotum with three prominent carinae, lateral ones straight and reaching extreme margin. Scutellum broad, disk quadrilateral with posterior margin produced into prominent obtuse point with reflected margins. Elytra long distinctly narrowed from near base to the tip; wings mere rudiments.

Prokelisia setigera, n. sp.

Light yellow or pallid, unicolorous except for row of dark punctures next lateral carinae of front, the tibial spines, teeth of spur, spines and claws of tarsi and spots on venter. Length: female 3.5 mm.; male, 3 mm.

Vertex longer than broad distinctly narrowing to apex, the carinae strong. Front conspicuously widened at apex narrowed to tip of vertex, carinae high and extending prominently over tip of vertex; clypeus triangular lateral carinae curved. Pronotum wider than long carinae elevated, hind margin slightly emarginate deepest, at middle almost notched; scutellum truncate, hind lobe obtuse, margin strongly reflected. Tibial spur very large, broad, marginal teeth strong. Elytra long, narrowing to apex, veins minutely setigerous. Wings minute not reaching base of abdomen, apex obtusely angular, margins sinuate, no veins visible.

Color: straw yellow; borders of the frontal carinae with short extension upon vertex, a band at base of abdomen, a lateral basal spot on segments one to three and borders of the ovipositor, tibial spines, teeth of tibial spur, spines and claws of tarsi, black. Abdomen of male tinged with fulvus, bases of tergal segments sometimes infuscated.

Genitalia. Female plates short, rounded at apex. Male hooks incurved nearly touching; style, long, slender, compressed.

Described from twenty specimens, fourteen females, six males, collected at Cameron, La., by Prof. J. S. Hine in latter part of August, 1903.

This species shows some striking resemblance to Kelisia, but aside from the characters which seem to require a separate genus it has well marked characters separating it from any species in that genus.

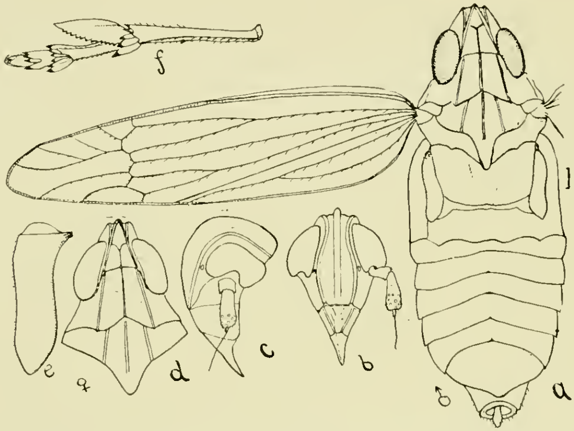

Fig. 1. *Prokelisia setigera.* *a*, male dorsal view; *b*, front; *c*, side view of head; *d*, dorsal view of female; *e*, aborted wing; *f*, posterior leg. From drawings by J. G. Sanders.

Megamelus angulatus n. sp.

Straw yellow, marked on apex of vertex, sides of pronotum, clavus and costa of elytra, base of abdominal segments with black; elytra very short barely covering base of abdomen. Length female, 3.5 mm.; male, 3 mm.

Vertex triangular, the anterior triangle in front of eyes, apex acute; front widening beyond the middle, broadest near base of clypeus, carinae strong; clypeus elongate, carinae prominent. Pronotum equal to vertex and scutellum in length, lateral carinae strongly divergent, reaching hind border outside of origin of lateral carinae of scutellum. Scutellum broadly triangular, apex right-angled, elytra short, veins conspicuous, especially claval and subcostal. Abdomen strongly carinate on median line.

Color, straw yellow above and below with fuscous spots within the fovae of vertex, black patches on apex of vertex on line with black eye and black lateral area of pronotum. Faint black flecks inside carinae of front. Lateral area of pronotum, basal part of lateral area of scutellum, clavus except veins, costal space and portions of discal spaces, basal portion of abdominal segments, plates, border of ovipositor, tip of rostrum, tarsal claws, black, legs tinged with fuscous. The males similarly colored but brown or blackish markings are nearly obsolete on abdominal segments except fourth and fifth and sides of pygofer.

Male genitalia, hooks strongly curved upward, narrowed to acute apex which is quite brown or black.

Specimens are in hand from Mr. A. F. Satterthwaite, Harrisburg, Pa., who collected them on Spatterdock (Nuphar sp.) at St. George's, Del.

Megamelanus spartini. n. sp.

Elongate, slender, female light straw color Male with elytra and beneath black. Length of female, 3 mm., male, 2.5 mm.

Head distinctly produced, vertex produced in front of eyes, nearly twice as long as pronotum, twice as long as greatest length of eye. Lateral margin elevated, central carinae prominent, forked anteriorly. The carinae of fork becoming obsolete near lateral margin, front elongate twice as long as wide, elliptical, central carinae prominent, lateral carinae evenly curved from base to clypeus. Clypeus elongate, triangular, median carinae obsolete, antennae minute, pronotum slightly wider than head, carinae slightly divergent, elytra narrow, nearly parallel veins prominent, minutely setigerous.

Color of female stramineus, unicolorous, male with vertex, upper part of front, eyes, side of head, pronotum, scutellum, and hind tarsi stramineus, otherwise pitch black.

Genitalia—female, plates elongate, male, pygofer obliquely emarginate. Hooks divergent, narrowing to apex.

A number of specimens of this minute species were taken by beating the heads of a rank beach grass (Spartina patens) on the shore of Oyster Bay and Cold Spring Harbor, Aug. 18 and 19, 1904, and two females and fifteen males collected by Mr. J. S. Hine, Bay Ridge, Aug. 7, 1899.

I found my specimens only by beating the blossoms and the females especially bear a striking resemblance to the anthers of the blossom of this grass so it would seem that they get a very distinct protection from their size and appearance. When beaten into the net with the abundant chaff from the blossoms they were very difficult to recognize until they began to move. The colors of the male do not seem to be so distinctly correlated with their habitat. The species is apparently pretty closely related to elongatus Ball described from Florida and I suspect that species will prove to have a similar habitat. Elongatus was taken in abundance at New Orleans, La., in March, by Prof. Hine which would indicate that it hibernates as adult.

Stobaera pallida n. sp.

Superficially resembles tricarinata Say but has lighter vertex, front and pronotum much broader, sides of front not parallel, antennae flattened and elytra pictured, veins ivory white, pustulate, setae very minute or wanting. Length female, 4.5 mm.; male, 4 mm.

Head wider than pronotum, vertex nearly twice as wide as long, lateral carinae slightly divergent, disc deeply impressed each side of central carina, central fovea small but deep, anterior margin straight, front broad, widest at lower margin of eye. Subangulate, converging to clypeus, central carina elevated, forked close to the base, lateral carina prominent directed outward, clypeus long, tricarinate, antennae very broad, flattened, apical portion of second joint pustulate, pronotum broad, lateral carinae very widely separated passing from posterior angle of eye to hind border, scutellum broad, disc depressed, carinae elevated, elytra vitreous, apical nervures forked near apex, pustules with very minute setae where visible.

Color, light straw yellow, front slightly darker with broken, transverse, creamy white bars, all carinae light yellow or creamy, scutellum light yellow at apex, elytra vitreous, somewhat infuscated, nervures ivory white with minute dark pustules. Apex broadly infuscated and clavus at base and apex blackish, transverse bands back of clavus infuscated, all colors darker in male, beneath pallid, spines and tarsal claws, black.

Genitalia—Female pygofers long, carinate on middle; anal style flattened, lanceolate. Male pygofer, truncate, slightly produced medially, hooks erect strongly curved at apex.

Numerous specimens of this rather striking species were collected on a shrub, Baccharis halimifolia, near Oyster Bay, Aug. 19, 1904. and I have in hand also several specimens collected by Prof. J. S. Hine at Bay Ridge, M. D. Superficially this recalls tricarinata, but the more pallid color is apparently constant and the structural characters of the head separate it distinctly. In frontal carinae it would seem hardly to fit genus Stobaera but the pronotal character agrees so well for that genus that it seems best to place it here, provisionally, at least.

Stobaera minuta. n. sp.

Similar to tricarinata Say but very much smaller, front dusky between eyes only, setae of elytra minute or wanting, apical cloud not so much broken. Length of female, 3 mm., male 2.5 mm. to tip of elytra.

Vertex nearly quadrate, fovae rather shallow, anterior one minute, front with sides parallel, pronotum shorter than vertex, hind margin concave scarcely angled at centre. Scutellum with carinae weak, elytral nervures, pustulate but not setigerous.

Color—Vertex yellowish brown, face between eyes brown, sharply separated from yellow lower portion. Antennae brown, slightly darker than upper part of front, pronotum yellowish brown, a dark spot behind eye, scutellum fulvous yellow or shaded brown usually darker on anterior part and some specimens with dark brown on lateral portion. Elytra milky white, veins interrupted with black points corresponding with the pustules, with oblique row of dark spots lying in the discal cells. The smaller posterior one within the fork of the second sector, the dark cloud occupying about one half of the apical cells, including most of the central cell. Beneath light yellow or whitish with dark points on pleurae and black points on the legs, claws black.

Genitalia—Female pygofer narrow behind, plates narrow, ovipositor reaching to their tip, anal style short, whitish. Male—pygofer truncate, aperture narrowing ventrally and slightly concavely excavated. Hooks short, bluntly curved, blackish.

Described from a large series of specimens including twenty-one females and three males, collected by Prof. J. S. Hine at Cameron, La., Aug., 1903. Except for certain details of structure and difference of distribution of color this species might be taken for a miniature form of tricarinata but length of pronotum, color of face, extent of elytral clouds and genitalia present very obvious differences which readily separate it.

MEETING OF THE BIOLOGICAL CLUB.

PROF. OSBORN'S RESIDENCE, April 10, 1905.

The Club was called to order by the President, Prof. Hine. The minutes of the previous meeting were read and approved. The program arranged for the evening was to consist of talks by Professors Kellerman and Hine on their recent trip through Central America. Prof. Kellerman was the first speaker and gave a very interesting account of the trip. The party consisting of E. B. Williamson and wife, C. C. Dean and wife, N. W. Miller, Professors Hine and Kellerman, left New Orleans, Jan. 5. In spite of a bad boat and some sea-sickness the trip down was a pleasant one. Many interesting things were observed ,as flying fish, peculiar birds, and the beautiful deep green of the tropical landscape. The first stop was made at Belize but only for a few hours. The party arrived at Port Barrios, Guatemala, Jan. 10.

Everything in this country was entirely new and interesting to residents of a temperate climate. New plants, new animals, wonderful palms with which there is nothing in the greenhouses of this country to compare. The fauna and flora of this coast region was interesting enough to spend the whole of their time on but they went back into the country by means of a poor railroad. After traveling all day and all night they stopped at Gualan about 80 miles from the coast. The trip on the slow railroad had been a wonderful one. The trees were especially interesting but even more so were the wonderful epiphytes—the Bromeliads and Orchids resting on the trees, some with roots hanging almost to the ground. Bamboos, higher even than the trees were abundant. Nearly every plant around Gualan was new to a northern visitor but Shepherd's Purse Purslane and a few of our more common plants were found. Compositae were numerous and of very large size, many being conspicuous shrubs and some large trees. It was very warm and dry at Gualan and all superfluous clothing was dispensed with. Nearly all the grass was dead. The deciduous trees of this climate have the habit of shedding their leaves whenever they please, usually at the dry season and this makes the landscape very peculiar.

From here the party went on up the railroad to the foot of the mountains, 120 miles from the coast. From here they had to travel 60 miles on mules to Guatemala City. Prof. Kellerman remained here while the rest of the party went on to the Pacific coast. Guatemala City is very beautiful and contains many interesting things, especially the museum and the Temple of Minerva. The scenery there is as fine and charming as that of the Alps but there is no snow. The volcanoes were very interesting. Prof. Kellerman climbed to the top of one of these (Argua) and found many interesting specimens among which was a peculiar Pine which is very probably a new species. Many of our common greenhouse plants were encountered here as Salvia, Begonias, Hibiscus, etc. True rusts (Puccinias) were found in abundance at Guatemala City but scarcely any in the low lands before this. Prof. Kellerman had with him a large number of souvenir postal cards as well as several original photographs which illustrated the character of the country very well.

Miss Riddle acted as chairman while Prof. Hine spoke of the people of Guatemala. The natives along the coast show the influence of the white people and are quite different from those of the interior. The natives seem to take everything they produce as a joke and consider a thing of little value unless brought from some other country. The people apparently are very kind. Their houses are simple consisting of four posts with a thatched roof and sides made of split bamboos or of poles. No windows are needed. Their clothing is very thin and simple. The men and women dress about as in this country. The women go barefooted but the men wear a kind of sandle shoe. Everybody smokes, the men cigars and the women cigarettes. Their food consists principally of beans and of a kind of cake made by baking pounded corn. Their flag is a very pretty one consisting of two blue stripes with a white one between upon which there is an emblem consisting of their national bird and crossed muskets.

Some of our common birds occur there probably passing the winter. The cat bird, mourning dove, Maryland yellow throat, black and white warblers, kildeer and others were observed. The brown pelican was very common but the white one was not seen. The black vulture is the most common of all the birds and dozens of them could be seen around the back yards of the native's dwellings. Kingfishers, pigeons, cuckoos and flycatchers are very common. Cuckoos were observed feeding around cattle or about fires and would catch the startled grasshoppers, etc. Prof. Hine exhibited two specimens of Peripatus which he was fortunate enough to obtain. Prof. Hine also had with him a number of souvenirs of this interesting tropical country. Prof. Kellerman exhibited some dress goods of the natives.

The club then adjourned but at the kind invitation of Prof. Osborn a very pleasant social time was enjoyed during which refreshments were served. It was long after the constitutional hour for adjournment when the members separated, carrying with them the memory of a very pleasant evening.

F. M. Surface, *Secretary.*

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CONTRIBUTION TO THE LIFE HISTORY OF SANGUINARIA CANADENSIS.*

FRANK M. SURFACE.

Sanguinaria is a monotypic genus of the Eastern United States belonging to the family Papaveraceae. Apparently no very great amount of morphological work has been done on the members of this family. Shaw (3) in a recent paper gives some observations on certain Papaveraceae among which is Sanguinaria. Some of the conclusions in the following paper do not agree with his. This may possibly be due to a difference in climatic conditions between the two stations where material was collected, although Shaw does not state definitely, the locality from which his material came.

The following study of the development of Sanguinaria canadensis L. was begun in April, 1904. Material was collected at intervals of about one week until the middle of June when the seeds were mature and had fallen to the ground. In the fall material was collected in October, November and December, while in the Spring of 1905 young capsules were taken at intervals of about two weeks from March 1st to the middle of April.

The material was killed and fixed in chromo-acetic acid, passed through the alcohols and imbedded in paraffin. Sections were cut on a rotary microtome 10–12 microns thick. In the younger stages the entire ovulary was cut, either transversely or longitudinally but in the older stages the individual ovules were sectioned. The orientation of the ovule was not difficult owing

* Contributions from the Botanical Laboratory of the Ohio State University, XXI.

to the distinct crest developed along one side. In the oldest stages it was found necessary to remove the hard covering of the seed before cutting. Several stains were employed among which were anilin-safranin followed by genetian violet, Delafield's haematoxylin and Haidenhein's iron-alum-haematoxylin. The latter well known stain proved to be the most successful in the stages of the development of the megaspores and embryo-sac, while Delafield's stain gave the best results with the microspores.

The flower of Sanguinaria begins its development early in the summer and the ovules and stamens are considerably advanced by the end of September. Material taken on Oct. 6th showed the single, hypodermal, archesporial cell distinctly differentiated (Fig. 2). The ovules at this time were just beginning to curve but no traces of the integuments were discernable (Fig. 1). At this time the microsporocytes were just separating (Fig. 19) and a few of the tapetal cells already had two nuclei. There are three intermediate layers between the epidermis and tapetum (Fig. 19). Material taken on Nov. 9th showed but little change in the development of the ovules, except that they had elongated and the curving was much more marked. The integuments were just beginning to make their appearance but the archesporial cell was still undivided. At this time the microsporocytes had undergone some division and some tetrads were observed. The tapetal cells contained two nuclei (Fig. 20).

By Dec. 9th the archesporial cell had divided twice giving rise to the megasporocyte with two parietal cells above (Fig. 3). The curving of the ovule was much more marked than in the previous stage and the beginnings of both integuments could be readily seen in central sections. The division of the microsporocytes must have proceeded rather rapidly for at this time the microspores were present with large resting nuclei and the tapetum was dissolving (Fig. 21). In this stage the microspores pass the winter.

No material was taken from December until the first of March when it seemed that the weather conditions were favorable for the continued growth of the plant. Sections of material fixed March 1st showed that there had been but little activity during the winter months. One of the parietal cells had again divided so as to form a row of three cells above the large megasporocyte (Fig. 4). In some instances transverse division had taken place forming a considerable tissue (Fig. 5). The integuments had increased quite a little in size and now reached more than half way around the developing ovule. The curving of the ovule was complete at this time. The microspores were in practically the same stage in which they were found in December. The nucleus was undivided but the vacuole in the center of the microspore had enlarged so that the nucleus was forced to one side of the cell. Material taken on March 13th showed but little change from that taken on the previous date. The megasporocyte had enlarged quite a little and seemed to be preparing to divide (Fig. 4), and a few spindles were observed (Fig. 6). The microspores showed no change.

Material fixed on March 22nd showed that the megasporocyte had divided into four megaspores the lowest being the large functional one (Fig. 7). The arrangement of the megaspores varied considerably. In some cases the transverse walls were nearly parallel forming a row of cells but frequently they were very irregular (Figs. 7, 8). These divisions are interesting in that they show a great similarity to the divisions of the microsporocyte and often result in a nearly typical tetrad (Fig. 8). Above the megaspores the rows of parietal cells could be distinctly seen (Fig. 7). These varied in number but it is evident that considerable division has occurred in the three original parietal cells. Vesque (1) states that Papaver orientale has no parietal cells. The nuclei of the microspores were divided at this time (Fig. 21). Pollen grains taken at later dates did not seem to show any further division. It is probable that the generative cell does not divide until after the tube has been formed. Strasburger (2) however, reports that in Papaver the generative nucleus divides in the pollen grain.

From this time the development of the functional megaspore is rather rapid. Material taken on March 28th showed the complete eight celled embryo-sac and often the two polar nuclei had already fused to form the definitive nucleus (Fig. 9). The antipotals are rather large at this stage and each has a single nucleus. Material taken on April 10th showed the oosphere and definitive nucleus still undivided but the antipodals were very large and each contained two nuclei (Fig. 10). This stage corresponded with material taken the year before at about the same date. The egg then seems to be fertilized about the first week in April. Many of the sections show remains of the pollen tube which is very prominent (Figs. 10, 11). The synergids seem to disappear early. Remains of one or more of them could usually be seen at this stage, lying to one side of the oospore and staining very dark (Figs. 10, 11). The early divisions of the embryo seem to occur very slowly for it was not until May 12th that the first division was observed (Fig. 13). This makes a remarkably long period of rest for the fertilized egg. In material killed May 16th the three celled embryo was found (Fig. 14). The divisions of the definitive nucleus had begun in early April and by the latter part of that month the endosperm had 20 to 30 nuclei.

The development of the embryo from this stage on was not traced very closely but the divisions must occur rather rapidly for on May 23rd the embryo had reached about the 12-celled stage (Fig. 15). On May 29th a large spherical embryo was present (Fig. 16). The suspensor had lengthened considerably and sections showed a double row of cells (Fig. 16). At this time the antipodals were degenerating (Fig. 17). They lie in a broad depression at the base of the sac which is greatly enlarged and filled with endosperm. The behavior of the antipodals recalls the condition of these cells in certain Ranunculaceae. On June 6th the ovules had matured and were falling to the ground. The integument is very hard and it was found necessary to remove it before imbedding in paraffin. At this time the embryo was much larger and the two cotelydons were well developed (Fig. 18). The suspensor was still present but showed signs of degeneration.

SUMMARY.

The flowers of Sanguinaria begin to develop very early in the summer previous to the year in which they blossom.

The development of the microsporocytes and microspores is much more rapid than that of the megaspores for the microspores are formed before the winter season begins.

The ovule passes the winter in the megasporocyte stage and during March its development is very rapid while the microspore does not renew activity until the last of March and early April.

Three parietal cells are formed and later these divide forming a parietal tissue of considerable size.

The division of the megasporocyte frequently results in rather typical tetrads.

The generative nucleus does not appear to divide in the pollen grain.

The long resting period of the oosphere is especially interesting.

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The above paper was prepared in the Department of Botany of the Ohio State University as a minor for the degree of Master of Arts. The work was done under the direction of Associate Professor J. H. Schaffner, to whom the writer wishes to express his sincere thanks for the kind assistance and suggestions, without which the paper could not have been completed.

DESCRIPTIONS OF PLATES.

All drawings were outlined under a camera lucida with the following optical combinations:

Bausch and Lomb—1 oc., $\frac{2}{3}$ obj.—Fig. 1.
Bausch and Lomb—1 oc., $\frac{1}{6}$ obj.—Figs. 20, 21.
Bausch and Lomb— $\frac{3}{4}$ oc., $\frac{1}{6}$ obj.—Figs. 2-8, 13, 15-17, 22, 23.
Bausch and Lomb—2 oc., $\frac{1}{6}$ obj.—Figs. 18, 19.
Leitz—4 oc., 7 obj.—Fig. 10.
Leitz—6 oc., 7 obj.—Fig. 14.
Zeiss—18 oc., Leitz 7 obj.—Figs. 9, 12.
Zeiss—18 oc., Leitz 3 obj.—Fig. 11.

Fig. 1. Section of young ovulary, showing incipient ovules. Killed 10–6–'04.

Fig. 2. Archesporial cell. Killed 10–6–'04.

Fig. 3 Megasporocyte with two parietal cells. Killed 12–9–'04.

Fig. 4. Megasporocyte with three parietal cells. Killed 3–13–'05.

Fig. 5. Megasporocyte with parietals divided. Killed 3–1–'05.

Fig. 6. First division of megasporocyte. Killed 3–13–'05.

Fig. 7. Four megaspores and parietal cells. Killed 3–22–'05.

Fig. 8. Four megaspores showing tetrad arrangement. Killed 3–22–'05.

Fig. 9. Eight celled embryo-sac. Killed 3–28–'05.

Fig. 10. Embryo-sac with oospore. Antipodals with two nuclei. Killed 4–16–'04.

Fig. 11. Outline of ovule with oospore. Killed 4–10–'04.

Fig. 12. Oospore with remains of synergids. Killed 4–16–'04.

Fig. 13. Two-celled embryo. Killed 5–12–'04.

Fig. 14. Three-celled embryo. Killed 5–16–'04.

Fig. 15. Young embryo showing eight cells in section. Killed 5–23–'04.

Fig. 16. Spherical embryo with long suspensor. Killed 5–29–'04.

Fig. 17. Degenerating antipodals. Killed 5–29–'04.

Fig. 18. Embryo showing large suspensor and cotyledons at the time the seed falls. Killed 6–6–'04.

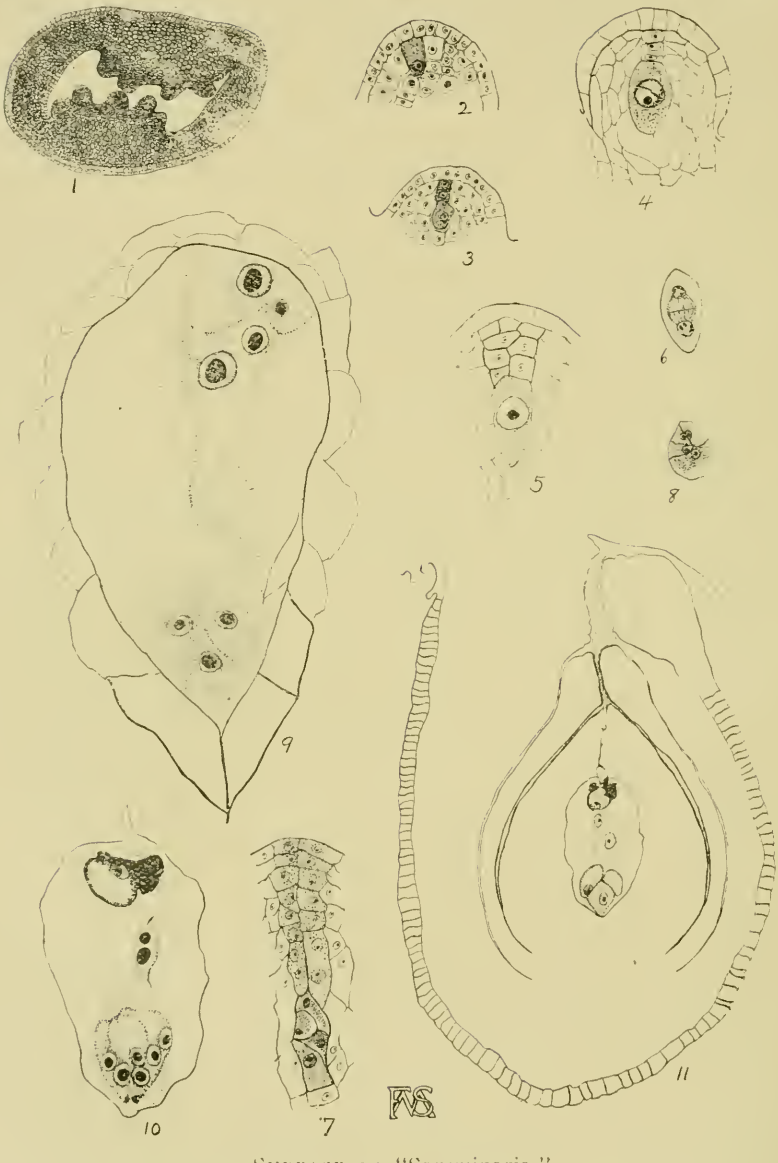
Fig. 19. Section of stamen with microsporocytes and tapetal cells. Killed 10–6–'05.

Fig. 20. Section of microsporangium showing microsporocytes just before formation of tetrads. Tapetal cells with two nuclei. Killed 11–9–'05

Fig. 21. Microspores with remains of tapetum. Killed 12–9–'05.

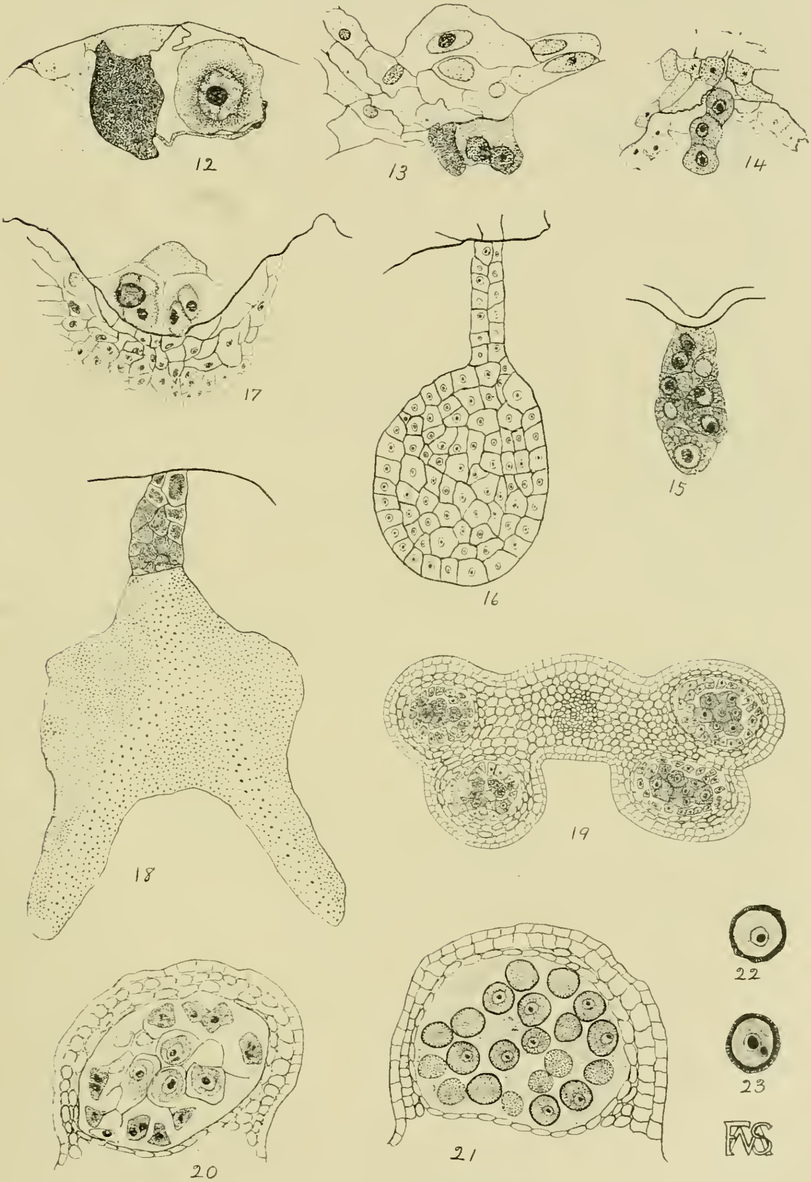
Fig. 22. Single microspore. Killed 12–9–'05.

Fig. 23. Pollen grain. Killed 3–22–'05.



Surface on "Sanguinaria."

OHIO NATURALIST. *Plate XXVI*



SURFACE on "Sanguinaria"

THE CLASSIFICATION OF PLANTS, II.

John H. Schaffner.

The three series of plants (Thallophyta, Archegoniata, and Spermatophyta) fall into smaller groups which also represent a succession of higher and higher stages of progressive development. If the theory of evolution as accepted at present is substantially correct, it becomes evident that some forms of plant life remained in the lowest condition from the beginning while others advanced to higher and more complex stages. Why did large numbers of species develop and continue until the present time without advancing to any appreciable extent from the starting point? The question can be answered by assuming that groups of organisms varied and were specialized in a direction which interfered with further progress upward but not with further variation along subordinate lines. Other groups varied in a direction which led to higher possibilities without imposing a barrier while still others passed back from a higher to a lower condition.

Based on the conception of vertical or progressive evolution, the development of the plant kingdom may be arranged somewhat as follows:

1. Genesis of living organisms.
2. Primordial organisms or Archeophyta, supposed to have been naked, amoebid cells of the simplest structure.
3. Transition to encysted and wall cells of the types found in the lowest plants of the present time.
4. Nonsexual plants consisting of simple cells, masses, or filaments.
5. Development of sexuality or of conjugating organisms.
6. The lower types of sexual plants.
7. Gradual development of the higher and more complex types, many with a simple alternation of generations.
8. The higher Thallophytes.
9. Transition to typical land plants and adaption to aerial conditions.
10. The lowest plants with a typical antithetic alternation of generations and with a simple parasitic sporophyte.
11. Gradual development of a more complex sporophyte.
12. The higher plants with a well developed dependent sporophyte.
13. Transition to plants with an independent mature sporophyte.
14. Plants with homosporous sporophytes with true roots, leaves, and fibro-vascular tissue.
15. Development of heterospory.

16. Archegoniates with heterosporous sporophytes and greatly reduced unisexual gametophytes.

17. Development of the seed habit and siphonogamic fertilization.

18. Seed plants with open carpels without stigmas and with much reduced parasitic gametophytes.

19. Development of closed carpels with stigmas and beginning of the conjugation of polar cells with further reduction of the female gametophyte.

20. The highest seed plants, representing the extreme of progressive development.

Taking the living plants which are delimited by definite transition gaps, readily distinguishable, we can recognize seven great groups. These are represented in the above scheme as follows: First group, No. 4; second group, Nos. 6, 7, 8; third group, Nos. 10, 11, 12; fourth group, No. 14; fifth group, No. 16; sixth group, No. 18; seventh group, No. 20.

The transition from the first to the second group is very gradual and it may sometimes be difficult in practice to place certain species properly, but the progression from nonsexual to sexual plants is so fundamental and apparently so important for all further advance that this may be regarded as the most important step taken in the entire plant kingdom. The changes in the life cycle and in the conditions of heredity are very far reaching. It is also important to have this group defined for purposes of general discussion.

The seven groups may be called subkingdoms. A subkingdom may then be defined as a group which represents a definite stage of evolution in the plant kingdom and which can be delimited from higher or lower groups by a distinct break or hiatus or by a definite transition involving a progressive change in the life cycle of the individual.

It becomes necessary to select names for these subkingdoms. Unfortunately the larger groups have not received any very extensive consideration from systematists. No definite system is here attempted but the names given below have for the most part been used in connection with the groups which they represent.

I. Protophyta. Protophytes.
II. Nematophyta. Nematophytes.
III. Bryophyta. Bryophytes.
IV. Pteridophyta, Homosporae. Homosporous Pteridophytes.
V. Pteridophyta, Heterosporae. Heterosporous Pteridophytes.
VI. Gymnospermae. Gymnosperms.
VII. Angiospermae. Angiosperms.

The first and second subkingdoms are Thallophyta; the third, fourth, and fifth are Archegoniata; and the sixth and seventh are Spermatophyta.

It is often convenient to separate the chlorophyll-bearing Thallophytes from those without chlorophyll. Thallophytes with chlorophyll are Algae. Thallophytes without chlorophyll are Fungi. Protophytes with chlorophyll are Protophyceae. Protophytes without chlorophyll are Protomycetes. Nematophytes with chlorophyll are Gamophyceae. Nematophytes without chlorophyll are Eumycetes.

The seven subkingdoms may be characterized as follows:

I. Protophyta. Protophytes. 3,000 known living species

Plants without sexuality, representing direct descendants from primitive nonsexual organisms; typically unicellular, the cells free, in colonies, in plasmodial masses, or in simple or branched filaments which are free or fixed and in the more highly specialized forms with definite base and apex; nonmotile, or having locomotion either by means of flagella, cilia, or pseudopodia, or by the general contraction of the cell; holophytic or phagophytic; with chlorophyll or without; reproduction by simple fission, by zoospores, or by walled or encysted spores by means of which the plant survives dessication.

II. Nematophyta. Nematophytes. 57,000 known living species.

Plants which have developed sexuality, some type of conjugation being present except in some groups which are supposed to have undergone degeneration from sexual ancestors; the more highly developed forms frequently with a primitive alternation of generations; plant body usually filamentous, either simple or branched, free or fixed, but in some groups unicellular, coenobioid, or a complex solid aggregate; chlorophyll present or absent, the great majority of species without chlorophyll living in aerial conditions as parasites or saprophytes, those with chlorophyll usually being hydrophytes.

III. Bryophyta. Bryophytes. About 14,000 known living species.

Plants, usually of small size, in which there is a typical sporophyte but this never having an independent existence, being supported on the gametophyte in a parasitic condition during its entire life; without true vascular tissue, true roots, or leaves, but sometimes with true stomata; always homosporous. Gametophyte comparatively large, consisting of a thalloid frond or a stem-like, scaly frond, usually preceded by a filamentous proembryo, the protonema, which develops from the spore.

IV. Pteridophyta, Homosporae. Homosporous Pteridophytes. 2,800 known living species.

Plants in which the herbaceous or tree-like sporophyte, after the juvenile stage, has an independent existence with true fibro-vascular tissue, roots, and leaves, and with a terminal growing point; homosporous and either eusporangiate or leptosporangiate. Gametophyte usually rather large, normally hermaphrodite although often unisexual; thalloid and green but sometimes tuberous and subterranean and without chlorophyll

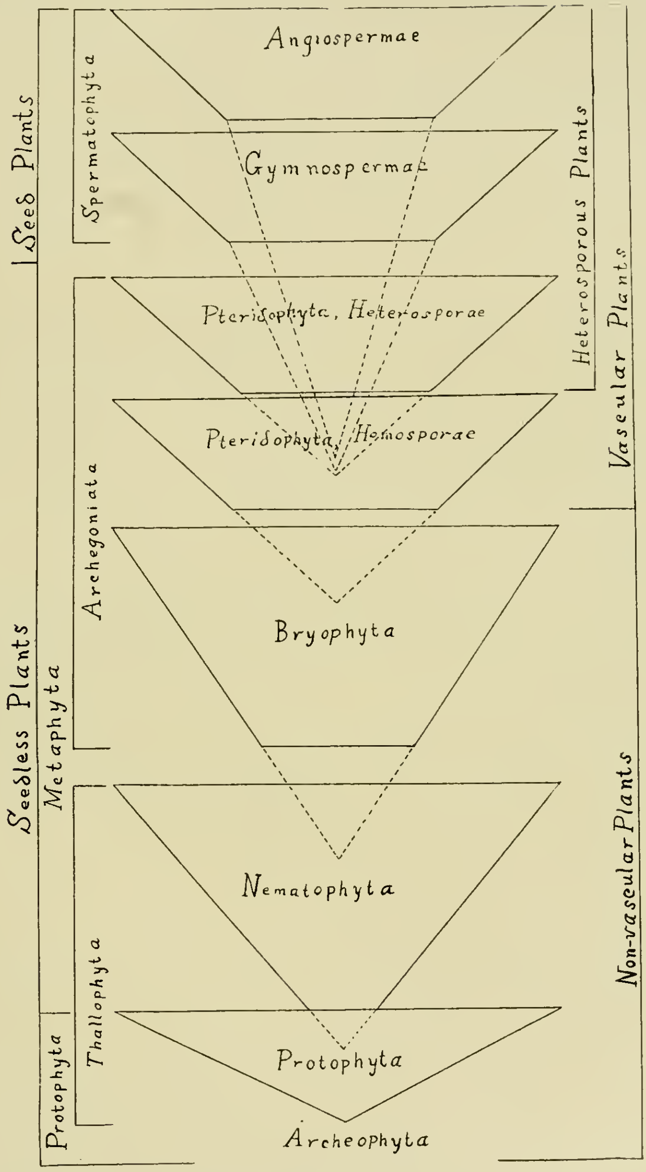


Diagram showing relationships of the Plant Subkingdoms.

V. Pteridophyta, Heterosporae. Heterosporous Pteridophytes. 635 known living species.

Plants in which the sporophyte, in the living species, is herbaceous and after a brief embryonic stage has an independent existence with true fibro-vascular tissue, roots, and leaves; heterosporous, with microspores and megaspores which give rise to greatly reduced male and female gametophytes respectively; eusporangiate or leptosporangiate. Gametophytes always unisexual, with little or no chlorophyll, living on food stored in the spore and developing entirely inside of the spore wall or protruding only slightly through the side, the nonsexual spores often germinating before being discharged.

VI. Gymnospermae. Gymnosperms. 450 known living species.

Plants in which the sporophytes are woody perennials with open carpels (megasporophylls) without a stigma and hence with naked ovules and seeds, the pollen (male gametophyte) falling directly on the micropyle of the ovule (megasporangium); flowers monosporangiate, usually developing as cones but sometimes very simple; female gametophyte with numerous cells but without polar cells and thus without true endosperm as in the Angiosperms; male gametophyte much reduced but usually with vestigial vegetative cells; male cells two, either nonmotile sperms or developed as spirally coiled multiciliate spermatozoids.

VII. Angiospermae. Angiosperms. 125,000 known living species.

Plants in which the sporophytes are of diverse habit, from minute annual or perennial herbs to large trees; ovules in a closed carpel (megasporophyll) or set of carpels provided with an ovulary and with a stigma for the reception of the pollen (male gametophyte) which must develop a long pollentube, usually passing through the open cavity of the ovulary, before reaching the micropyle; flowers more commonly showy and highly specialized and more commonly bisporangiate; female gametophyte greatly reduced, normally with eight cells two of which, the polar cells, conjugate to form the definitive cell from which the endosperm is developed; male gametophyte consisting of three cells two of which are nonmotile sperms, one used for fertilization and the other in many cases uniting with the definitive cell thus producing a triple fusion.

NEW SPECIES OF NORTH AMERICAN CHRYSOPS.

Jas. S. Hine.

Of the four species described in this paper three were taken in Guatemala. The other one is from eastern United States and is described at this time for the reason that a student of the group desires to mention the species in a paper he is preparing for publication. The Guatemalan material was procured in company with Mr. E. B. Williamson of Bluffton, Indiana.

Chrysops melanopterus, n. sp. Female, black, first two segments of the antenna each longer than the third. Length, 9 millimeters.

Relative length of the antennal segments 2:1.5:1. Basal segment without indication of enlargement as is the case with other species of the genus having the first and second antennal segments elongated. Whole body, including wings, legs and antennae, black.

Type taken at a point about five miles up the railroad from Puerto Barrios, Guatemala, Department of Izabal, March 14, 1905. The locality was along the railroad where it passed through an extensive swamp only a few feet above sea level.

Two other specimens were procured at the same place, one from the back platform of a freight caboose. The specimen followed the moving train for some time before it was captured.

The species is entirely distinct from any species I have seen or have found described. The uniform black wings are peculiar for a member of this genus.

Chrysops pachycnemius, n. sp. Female wing with costal margin and crossband black, apical spot separated from the crossband; abdomen yellow at the base, black apically. Length, 8 millimeters.

Lower part of the front, including the frontal callosity, and the face yellow; palpi a shade darker than the face, proboscis black. Region of the ocelli shining black, otherwise the upper part of the front covered with bright yellow pollen. First segment of the antenna yellow, second yellow on the inner side, brown outside, third black. Thorax shining black with four dorsal stripes formed by yellow pollen, the two inner abbreviated behind, the two outer broken at the transverse suture; side of the thorax with a yellow spot behind the eye, one directly beneath the root of the wing and another just behind it. Wing with the base, costal cell and the crossband black, apical spot separated from the crossband by a wide space, extreme base of each costal cell black, the inner margin of the crossband extends from the branching of the second and third veins nearly straight to the anal vein passing near the inner end of the discal and fifth posterior cells. The crossband reaches the posterior margin of the wing filling out the apex of the anal cell and all the fourth and fifth posterior cells with the exception of a small patch at the distal end of the latter; the outer margin of the crossband starts from the union of the first vein with the costa and extends in a somewhat irregular curve to the end of the vein which separates the third and fourth posterior cells. The apical spot fills out the apexes of the marginal and first submarginal cells and invades the second submarginal, reaching the posterior border of the wing at the apex of the vein which separates the latter cell from the first posterior. All the femora black at each end, otherwise yellow, tibia black, all of them quite distinctly enlarged, but the anterior pair more than the others; anterior tarsi black, others with the first segment wholly yellow and remaining segments with apexes more or less black. First segment of the abdomen above narrowly yellow on the sides, second segment yellow for its entire width on each side but this color narrows toward the front border until at the mid-dorsum where the two meet it is very narrow; a mid-dorsal yellow marking on the second and third segments, widened and triangular on the second and elongate and narrow on the third; the posterior third of the fourth segment yellow; venter with first two segments yellow, remainder black.

Type taken at Santa Lucia, on the Pacific slope of Guatemala at an altitude of about a thousand feet, February 1, 1905.

Chrysops calopterus, n. sp. Female with black body and variegated wings. Length, 6 millimeters.

Face and palpi yellow, antenna yellow, except the annulated portion of the third segment which is black; region of the ocelli shining black, frontal callosity yellowish on the disk and black above, otherwise front covered with gray pollen. Thorax black with indications of stripes on the anterior part; legs black except a broad ring on the distal part of each femur and basal segments of each tarsus which are yellow. Anterior fourth of each basal cell, entire costal cell and marginal cell to beyond the stigma are infuscated. The black of the crossband and apical spot are much broken up and the hyaline triangle is crossed and encroached upon by dark markings; there is a very dark quadrangular spot at the furcation of the third vein; the discal cell is hyaline with an irregluar dark patch at its middle; the posterior margin of the wing is infuscated all the way to the fifth posterior cell and more pronounced at the intersection of the veins; the veins at the inner ends of the discal, first, fourth and fifth posterior cells are widely margined with black. None of the cells of the wing except the costal are entirely infuscated, and none are entirely hyaline except the axillary. Abdomen black on the dorsal side except segments two, three and four each have a transverse gray marking on the posterior border.

Type taken at Los Amates, Guatemala, 60 miles inland from Puerto Barrios, at an elevation of perhaps 250 feet, February 21, 1905.

Other specimens were procured at Morales and at Puerto Barrios.

Chrysops dimmocki, n. sp. Female, body colored like callidus, wing like montanus. Length, 8 millimeters.

Frontal tubercle black, front covered with a greenish gray pollen which follows the margins of the eyes to the occiput widening somewhat, below the frontal callosities. Face light yellow, palpi darker, proboscis brown. First and second segments of the antenna and base of the third yellowish and clothed with rather course black hairs, remainder of third segment black. Thorax above with four rather wide greenish gray stripes which are slightly less distinct posteriorly. Legs mostly yellow, but apical parts of middle and hind tarsi blackish; front legs with apex of tibia and whole of tarsus black or dark brown. Wings with costal margin and crossband black, first and second basal cells with very slight infuscation at base; the crossband reaches the posterior margin, filling out the fourth posterior cell, outer border curved, fifth posterior cell largely hyaline in the middle but plainly infuscated along the veins at each side; apical spot wide, filling out all the marginal cell, two-thirds of first submarginal and half of second submarginal. The abdomen has a small black spot on the first segment beneath the scutellum, second segment with a black inverted V whose apex reaches the anterior margin, otherwise yellow, remaining segments with the exceptions of the lateral and hind margins black, the hind margin expands into a triangle in the middle on each segment; venter yellow with dark markings toward the apex.

Type taken at Longmeadow, Massachusetts, by Dr. Geo. Dimmock. Eight other specimens taken at Columbus, and Wauseon, Ohio, and Anglesia and Westfield, New Jersey, those from the latter state by V. A. E. Daecke and H. S. Harbeck, of Philadelphia.

This species has been in my collection for a long time and I hesitated to name it for the reason that no male specimen could be procured, but the characters are so constant and so many specimens have been collected and sent in that it seems that it must be distinct.

BRUSH LAKE PROTOZOA.

LUMINA C. RIDDLE.

During the Fall of 1902 the writer studied and listed the Algae found at Brush Lake, Champaign Co., Ohio, and the list was published in Ohio Nat. **5**:268; at the same time a careful record was kept of the Protozoa found in the same material and was reported at the 1903 meeting of the Ohio Academy of Science by Professor F. L. Landacre as the writer was at that time located in the West. Delay in publication has been due to the writer's anxiety for accuracy in nomenclature and citations. As far as has been possible the names have been arranged after Butschli's system, taking the classification from Calkins' "Protozoa" and Blochman's "Die Mikroskopische Thierwelt des Suesswassers."

My grateful acknowledgments are due to Professor Landacre, and to Professor L. B. Walton of Kenyon College, for the use of literature in revising the list.

RHIZOPODA.

Fam. *Amoebidae.*

Amoeba proteus L.
Amoeba villosa Wall.
Dactylosphaerium radiosum Ehrbg.

Fam. *Arcellidae.*

Arcella dentata Ehrbg.
Arcella vulgaris Ehrbg.
Difflugia corona Wall.
Difflugia urceolata Cart.
Centropyxis aculeata Ehrbg.

HELIOZOA.

Fam. *Aphrothoracidae.*

Actinophrys sol Ehrbg.

MASTIGOPHORA.

Fam. *Heteromonadidae.*

Anthophysa vegetans(O.F.M.) S.K.
Spumella vivipara Ehrbg.

Fam. *Euglenidae.*

Euglena oxyuris Schmarda.
Euglena spirogyra Ehrbg.
Euglena viridis Ehrbg.
Phacus pyrum (Ehrbg) S. K.
Phacus triqueter Ehrbg.

Fam. *Astasidae.*

Astasia trichophora (Ehrbg) Clap.

Fam. *Peranemidae.*

Entosiphon ovatus Stokes.

Fam. *Peridinidae.*

Peridinium tabulatum Ehrbg.

INFUSORIA.

Fam. *Enchelinidae.*

Pseudoprorodon niveus Ehrbg.
Coleps hirtus O. F. M.
Coleps uncinatus C. & L.
Arachnidium globosum S. K.
Didinium nasutum O. F. M.

Fam. *Trachelinidae.*

Trachelocerca olor O. F. M.
Trachelocerca versatilis O. F. M.
Lionotus fasciola (Ehrbg) Wrzes.
Lionotus helus Stokes.
Loxodes magnus Stokes.
Loxodes rostrum O. F. M.

Fam. *Chlamydodontidae.*

Nassula ornata Ehrbg.

Fam. *Chiliferidae.*

Holosticha caudata Stokes.
Leucophrys patula Ehrbg.
Glaucoma scintillans Ehrbg.
Colpidium putrinum Stokes.

Fam. *Urocentridae.*

Urocentrum turbo O. F. M.

Fam. *Paramoecidae.*

Paramoecium aurelia O. F. M.

Fam. *Pleuronemidae.*

Pleuronema glaucoma O. F. M.

Fam. *Isotrichidae.*

Plagiopyla nasuta Stein.

Fam. *Plagiotomidae.*

Metopus sigmoides C. & L.
Spirostomum ambiguum Ehrbg.

Fam. *Bursaridae.*

Bursaria truncatella O. F. M.

Fam. *Stentoridae.*

Stentor coeruleus Ehrbg.
Stentor polymorphus Ehrbg.
Caenomorpha oxyura Stein (Gyrocorys).

Fam. *Oxytrichidae.*

Stichotricha aculeata Wrzes.
Uroleptus dispar Stokes.
Uroleptus longicaudatus Stokes.
Uroleptus rattulus Stein.
Uroleptus sphagni Stokes.
Gonostomum affine Stein (Plagiotricha).
Stylonychia mytilus O. F. M.
Stylonychia pustulata O. F. M.
Histrio inquietus Stokes.

Fam. *Euplotidae.*

Euplotes carinata Stokes.
Euplotes plumipes Stokes.
Euplotes variabilis Stokes.
Aspidisca costata Duj.

Fam. *Vorticellidae.*

Scyphidia inclinans (D'Udek) S. K. on Nais.
Vorticella aquaedulcis Stokes.
Vorticella hamata Ehrbg.
Vorticella nebulifera Ehrbg.
Vorticella procumbens From.
Vorticella similis Stokes.
Opercularia elongata Kellicott.
Cothurnia crystallina Ehrbg.
Vaginicola gigantea D'Udek.
Lagenophrys vaginicola Stein.

AN ABNORMAL CONE OF PINUS LARICIO.

WALTER FISCHER.

It has been customary to try to explain the homology of the ovuliferous scale in the Conifers by the study of monstrosities. So the chance discovery on May 12 of a cone of Pinus laricio which was both carpellate and staminate led the writer to look up again the numerous theories which have been advanced to explain this structure.

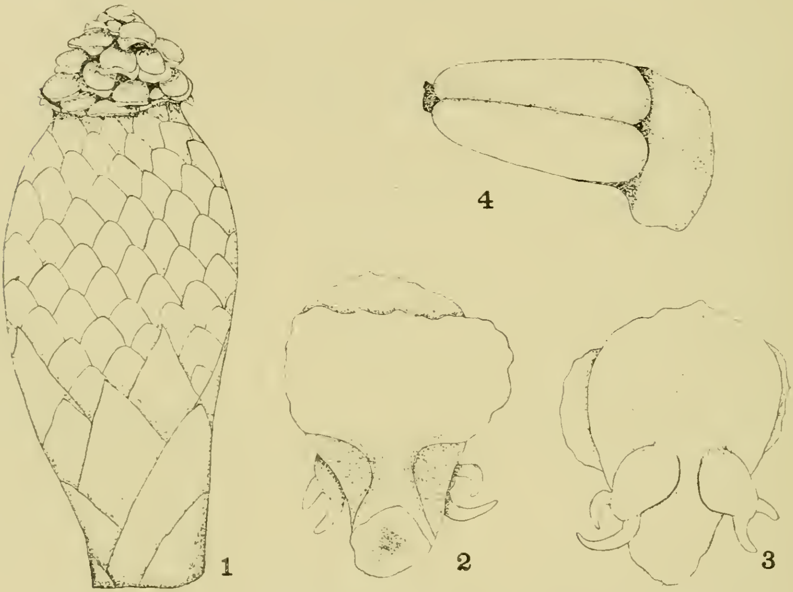


FIG. 1.—1. The abnormal cone. 2. Under side of carpel showing carpellate bract and ovuliferous scale. 3. Upper side of same. 4. Under side of stamen.

The cone was one of two growing in the normal position of the staminate cone and consisted of two well marked zones, the lower or staminate part making up about four-fifths and the upper or carpellate part making up about one-fifth of the entire cone. The other cone was staminate only. As a closer examination showed that both kinds of sporophylls were perfectly normal, their description will correspond to that of those on other cones. The carpellate part bore bracts on the upper sides of which were the ovuliferous scales bearing the ovules or megasporangia. The staminate part of the cone bore but one kind of scales, the stamens or microsporophylls bearing the microsporangia on the under side.

Since the homology of the stamen and the bract subtending the seed bearing scale is evident, the contention is still concerning the homology of this extra structure the ovuliferous scale. As an excellent summary of the numerous theories relating to this subject is given in Coulter and Chamberlain's Morphology of Spermatophytes, and as their repetition here would be entirely beyond the scope of this article, they may for convenience be condensed into the two following simple propositions:

First. The carpellate cone represents a regular branch; the bract represents a leaf; the ovuliferous scale represents an axillary stem with one or with two leaves all greatly reduced and modified and it may or may not also represent the outer integument.

Second. The carpellate cone represents a dwarf branch like the staminate cone; and the ovuliferous scale is a ligular or chalazal outgrowth of the megasporophyll or carpellate bract which corresponds to the microsporophyll.

The writer is inclined to favor the second view not only from the study of this monstrosity if any great importance is to be attached to it but also for the same reason that Bessey gives in his article in the Botanical Gazette, **33**:157, namely, that were we to favor the first view we would have to assume that the megasporangiate cones and sporophylls in the closely related families of Pinales, in some of which there is no ovuliferous scale, are not homologous.

NOTES FROM THE OHIO STATE HERBARIUM. IV.

H. A. Gleason.

During the past year much of the unidentified herbarium material has been studied, and a number of particular genera have been worked over, with the result that several species of flowering plants and ferns are to be added to the state flora. A list of those species with notes on their distribution and their distinguishing characters is here given. Some of them have already been reported in this journal, but for sake of completeness are listed again. In every case the writer is responsible for their identification.

36b. *Asplenium parvulum* Mart. and Gal. Ohio Nat. 5:206.

460a. *Carex alata ferruginea* Fernald. Along Big Darby Creek in Madison County, Professor W. A. Kellerman. The variety, as described by Fernald (Proc. Am. Acad. Arts and Sci. 37:477. 1902.) differs from the species in the spikelets tawny colored from the first, the narrower ovate perigynia about 2.5 mm. wide, and the ovate-lanceolate scales. The species has spikelets mostly green, perigynia 2.8–3.7 mm. wide, almost orbicular, and narrower scales.

472b. *Mayaca aubleti* Michx. Auglaize County, A. Wetzstein. The occurrence of this aquatic species so far north of its usual range is of much interest.

547a. *Smilax pulverulenta* Michx. Montgomery County, S. E. Horlacher. Distinguished from *Smilax herbacea*, which it closely resembles, by the pubescent lower surface of the leaves.

755a. *Gomphrena globosa* L. An Amaranthaceous plant frequently cultivated for ornament and escaped in Wood County, where it was collected by Professor Kellerman.

877a. *Bocconia cordata* Willd., the Plume Poppy, likewise commonly cultivated, has escaped around London, Madison County, and specimens have been sent to the herbarium by Mrs. K. D. Sharp.

1033a. *Aronia atropurpurea* Britton. Ohio Nat. 5:264.

1058a. *Cassia medsgeri* Shafer. Ohio Nat. 5:264.

1245a. *Hypericum boreale* (Britton) Bicknell. Ohio Nat. 5:249.

1794a. *Xanthium commune* Britton. This, our commonest species of Cocklebur, has generally been confused with *Xanthium canadense*. It is at once recognized by the densely hispid-pubescent spines of the burs; all other species in our region have burs either glabrous or merely puberulent, the hairs never exceeding the diameter of the spines.

1794b. *Xanthium glabratum* (DC.) Britton. Apparently common in southeastern Ohio, extending north and west to Franklin County. It is distinguished by the glabrous burs with beaks straight or nearly so.

1963a. *Bidens elliptica* (Wiegand) Gleason, and 1967a, *Bidens vulgata* Greene, are described in Ohio Nat. 5:316.

Mr. L. D. Stair, of Cleveland, has contributed the following species, all from Cuyahoga County: 131a, *Panicum implicatum* Scribn.; 196a, *Agrostis asperifolia* Trin.; 212c, *Beckmannia crucaeformis* (L.) Host.; 255a, *Festuca capillata* Lam.; *Bromus brizaeformis* Fisch. and Mey.; 265c, *Bromus arvensis* L.; 376a, *Carex tenuis interjecta* (Bailey) Britton; 1303a, *Kneiffia fruticosa pilosella* (Raf.) Britton; 1615a, *Scrophularia leporella* Bicknell; 1893a, *Aster lateriflorus horizontalis* (Desf.) Burgess.

Mr. S. E. Horlacher, of Dayton, has added 757b, *Allionia nyctaginea ovata* (Pursh) Morong; 1650b, *Gerardia tenuifolia asperula* Gray; 1755a, *Cichorium intybus divaricatum* DC.

NEWS AND NOTES.

The fifteenth annual meeting of the Ohio State Academy of Science will be held at The University of Cincinnati, on Dec. 1st and 2nd. A number of important papers will be presented and a very interesting meeting is anticipated.

Ohio Plants With Extra-Floral Glands. The following plants should be added to the list of Ohio plants having extra-floral nectaries and glands, as given in The Ohio Naturalist 4:103-106.

With glands on the petiole or at the base of the blade:

Impatiens balsamina L.
Ascyrum hypericoides L.

With tooth-like glands on top of the midrib or at its base:

Aronia arbutifolia (L-) Medic.
" atropurpurea Britt.
" nigra (Willd.) Britt.
Pyrus communis L.
Malus angustifolia (Ait.) Mx.

Some weeks ago the Zoological Museum received from a former student, Mr. John C. Britton, a fine donation consisting of a pair of large Iguanas nicely mounted. Mr. Britton gives the following account of their capture: "While travelling in the Bahama Islands in the summer of 1903 we visited Watlings or San Salvador and were told by the natives there that great numbers of large lizards lived on an island or kay in the lake which occupies nearly one-half of the island or Watlings. We were directed to the spot by guides and found that the story was true. On this small island there must have lived hundreds of large iguanas and all of one species belonging to the genus Cyclura. It may be mentioned incidentally that this island, called Iguana Kay by the natives, is very near the spot where Columbus is supposed to have landed. These reptiles are very swift on foot and extremely shy. After much difficulty we succeeded in shooting a number of specimens. When we returned to the United States the iguanas were given to Dr. Leonard Stejneger of the United States National Museum for description. They were described as a new species and given the name Cyclura rileyi in honor of Mr. J. H. Riley with whom I was associated as a member of the expedition."—J. S. H.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, May 1, 1905.

The club was called to order by the President, Prof. Hine. The minutes of the previous meeting were read and approved. The program for the evening consisted of an address on "The Present Status of Darwinism," by Prof. Edward L. Rice of the Ohio Wesleyan University. Prof. Rice gave a brief review of Darwin's work and the conditions under which "The Origin of Species" was published. Darwin really gave us nothing new in his theory but he gave the actual data for evolution, and it was for this reason that his work attracted so much attention. Formerly the struggle was between science and religion, but now it is between scientists as to the method of evolution. Ultra-Darwinians go far beyond Darwin with the theory of natural selection and many, as Weisman and Haeckel, deny Lamark's theory entirely. Whether it is inheritance or environment that makes the arm of the blacksmith's son strong and that of the preacher's boy weak is the important question. A recent article in the American Field Journal by Redfield of Chicago, on the evolution of the setter may possibly have some bearing on this subject. In tracing the history of the offspring of two male dogs it was found that the offspring of the one which had been used constantly in the field appeared seven times in champion trials. Offspring of the brother of this dog, which had been kept for stud purposes only, did not occur among the champion dogs. It is the general verdict of breeders that horses and dogs give better offspring if not kept for stud purposes only.

Prof. Rice mentioned several of the objections which had been raised against the theory of natural selection and attempted to show that these might not all be entirely valid.

In a summary, Prof. Rice stated that he believed that many laws were operative in producing the results of evolution. In regard to their effectiveness he believed that they would stand in about the following order: Darwin's and DeVries' theories first, Romanes second, and sexual selection and environmental influences of less importance.

Mr. Henriksen, Prof. Landacre, Miss Wilson, and Prof. Schaffner took part in the discussion which followed.

J. H. Gourley and Miss Caroline Carmack were elected to membership. The club then adjourned.

FRANK M. SURFACE, *Sec'y.*

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A NEW SPECIES OF CAMBARUS FROM LOUISIANA.

DR. A. E. ORTMANN,
Carnegie Museum, Pittsburgh, Pa.

The types and cotypes of the new species described herein were collected by Professor Jas. S. Hine on July 12, 1905, in a small freshwater pool, ¼ mile from Gulf Beach, near Cameron, Cameron Parish, Louisiana. There are 2 males of the first form, and 4 females. They were found associated with a number of large and small individuals of *Cambarus* (*Cambarus*) *clarki* Gir.

CAMBARUS (CAMBARUS) HINEI spec. nov.

(See Fig. 1).

Description of male of the first form.

Rostrum triangular, about twice as long as broad on the basis; margins very slightly convex, almost straight, rather evenly converging to the acute tip, with a very slight indication of lateral angles at the base of the short acumen. No marginal spines. Upper face of rostrum flat at the base, slightly concave toward the tip; margins slightly elevated. *Postorbital ridges* short, divergent posteriorly, sharp at anterior end, but without distinct spine. *Carapace* ovate, slightly compressed, punctate. Infraorbital angle blunt. Branchiostegal spine small. Cervical groove sinuate. No lateral spines on carapace. *Areola* as long as or slightly shorter than half of the anterior section of carapace, very wide, with 4 or 5 irregular rows of punctations.

Abdomen as wide as, and longer than carapace. Anterior section of telson with two spines on each side, posterior section rounded.

Epistoma with anterior part triangular. *Antennal scale* rather broad, broadest in the middle. *Flagellum* longer than carapace, but shorter than body.

First pereiopod subcylindrical. Hand elongate, subcylindrical, very slightly compressed, margins subparallel. Surface covered with fine granulations and a few short, scattered hairs. Palm long; fingers remarkably short, hardly over one-third as long as palm, with some scattered hairs. Cutting edges without tubercles. Carpopodite short, and almost smooth, without distinct sulcus on upper side, and without spines or tubercles on inner side. Meropdite smooth, without tubercles or spines, its lower margin densely pilose.

Ischiopodites of third and fourth pereiopod with hooks, that of the third is long and strong, conical, that of the fourth is smaller, but distinct and of similar shape. *Coxopodite* of fourth pereiopod with a prominent, semicircular, compressed tubercle; that of the fifth pereiopod with a small, conical tubercle.

Fig. 1. *Cambarus hinei spec. nov.* Male sexual organ of left side, inner view. Enlarged.

First pleopod rather short and stout, reaching to the coxopodite of the third pereiopods. Its distal third is thinner than the proximal part, slightly tapering, gently but distinctly curved backward. Tip truncate, with two sharp, pointed, triangular horny teeth, belonging to the outer part. Inner part pointed at tip, point straight, slightly directed outward, distinctly longer than truncated part, and also longer than the horny teeth. Inner face of inner part with a row of beard-like hairs.

The male of the second form is unknown.

In the *female*, the *chelipeds* are much shorter, chiefly so the hand, and the fingers are only slightly shorter than the palm. Hand hardly granulated, but with scattered hairs, more abundant than in the male. Pilosity of lower margin of meropodite wanting. *Annulus ventralis* a simple, rounded, low tubercle with an S-shaped fissure.

Measurements: ♂ (Type): Total length: 35 mm.; carapace: 16, areola: 5. width of areola: 2.75; abdomen: 19 mm.; length of hand: 13 mm., width of hand: 3.5, length of palm: 9.5, of fingers: 3.5 mm. ♀ (Type): Total length: 45 mm.; carapace: 21, areola: 7, width of areola: 3.5, abdomen: 24 mm.; hand: 9.5 palm: 5.5, fingers, 4 mm.

The shape of the male organs places this species in the *subgenus Cambarus* (see Ortmann, Pr. Amer. Philos. Soc. 44. 1905, p. 96, and Ann. Carnegie Mus. 3. 1905 p. 437). The hooks of the pereiopods and the subcylindrical chelae place it in the *section of C. blandingi*. The shape of the rostrum and of areola indicate the *group of C. alleni.* Within the latter group it stands rather isolated with regard to the male organs, which show a rather primitive conformation, within exception of the distinct backward curve of the distal part. The shape of the rostrum is peculiar on account of the almost triangular outline (similar to *C. advena*), with hardly any traces of lateral angles in the place of marginal spines. The areola is exceptionally broad, broader than in any of the known species of this group. The most striking character (disregarding the male organs) is furnished by the chelae of the male, since the fingers are unusually short, shorter than in any other species of the genus. Thus the new species is well characterized by the shape of the rostrum, of the areola, chelipeds, and the male sexual organs.

Its distribution agrees with that of the *alleni-group*, in so far as it belongs of the lowlands of the coastal plain of the southern United States. It is the most western locality known for this group, being close to the Texas state-line (disregarding the Mexican *C. wiegmanni*).

NOTES FROM THE OHIO STATE HERBARIUM, V.

H. A. Gleason.

A Revised List of the Hypericaceae of Ohio.

The status of the family *Hypericaceae* in the catalogues of Ohio plants has been very varied. Dr. J. L. Riddell, in his Synopsis of the Flora of the Western States, listed nine species from Ohio, including among them *Hypericum galioides* Lam. and *H. densiflorum* Pursh, species which in all probability do not occur within the State. They are both plants of the austroriparian zone, ranging from New Jersey to Texas along the coastal plain, and inland to Tennessee. Dr. Riddell's Synopsis, as its name indicates was not restricted to Ohio, but included all of the Western States so far as he knew them, and he might possibly have seen specimens from Tennessee. A few other doubtful species have been added to our flora by some of the earlier authors, such as *H. adpressum* Bart., *H. ellipticum* Hook., and *Triadenum petiolatum* (Walt.) Britton. From these sources they were admitted to the Catalogue of Ohio State Plants by W. A. Kellerman and Wm. C. Werner, and from that to the Fourth State Catalogue by W. A. Kellerman, the latest one published. Two of the seventeen listed by Kellerman and Werner do not appear in the Fourth Catalogue, *H. densiflorum* Pursh and *H. galioides* Lam. Two others were added, *H. gymnanthum* Eng. and Gray and *H. drummondii* (Grev. and Hook.) T. and G., leaving the total number of species still at seventeen.

Under the present policy of the Department of Botany at Ohio State University only those species are included in the flora of the state which are actually represented by specimens in the State Herbarium. The necessity of such a regulation is obvious and requires no comment here. Five other species of the Fourth Catalogue are accordingly to be dropped, *H. ellipticum* Hook., *H. adpressum* Bart., *H. majus* (Gray) Britton, *H. canadense* L., and *Triadenum petiolatum* (Walt.) Britton. There is no apparent reason why the first four of these should not occur in Ohio. Their geographical distribution, as given in the standard manuals, includes this State, they have been reported from adjoining States, and it is quite probable that future collecting, especially in the northern and northwestern parts of the State, will eventually result in their re-addition to the Ohio flora. *Triadenum petiolatum*, on the other hand, is not to be expected within the State. It is essentially a plant of the coastal plain swamps, extending from New Jersey to Louisiana and along the inland extension of the coastal plain to southern Illinois, where it grows in deep cypress swamps.

Three additional species, however, are to be added to the list, *H. boreale* (Britton) Bickn., reported in 1904,* *H. virgatum* Lam. and *H. subpetiolatum* Bickn., here reported for the first time from Ohio. Fifteen species of *Hypericaceae* are therefore actually represented in the State Herbarium, and this number will probably be raised in the future to nineteen. On this account the four species in question are included in the key.

Both the flowers and fruit are necessary for the identification of most of the species, and in collecting care should be taken that the specimens show both. Except at the beginning and close of the blooming period a single plant will generally show both. Ripe capsules may easily be sectioned to show the number of cavities and the character of the partitions either dry or after soaking in hot water.

Key to the Ohio Genera.

1. Sepals 4, in two very dissimilar pairs. *Ascyrum.*
1. Sepals 5, equal or nearly so. 2.
    2. Receptacular glands none; flowers yellow. 3.
    2. Three receptacular glands alternating with the stamen-clusters; flowers not yellow. *Triadenum.*
3. Leaves normal. *Hypericum.*
3. Leaves scale-like, appressed, flowers sessile. *Sarothra.*

Ascyrum L.

One species in the State.

1. *Ascyrum multicaule* Michx. Not *Ascyrum hypericoides* L. or *Ascyrum crux-andreae* L. as given in the standard manuals. These two names, which are synonyms, belong to a plant of the

* Ohio Naturalist, 5: 249, 1904.

southeastern States. *Ascyrum* is essentially a southeastern genus, and this species, which is its northernmost representative, is confined mainly to the austro-appalachian and austro-riparian areas. In Ohio it grows in dry upland woods and hillsides in the southeastern part. Specimens are in the State Herbarium from Hocking, Lawrence, Fairfield, Gallia, Scioto, Hamilton and Jackson Counties.

HYPERICUM L.

1. Capsules 5-celled, styles 5. 2.
1. Capsules 3-celled or 1-celled. 3.
 2. Leaves on main stem 6–8 cm. long, flowers 3–4 cm. wide, capsules ovoid, 2 cm. long. 1. *H. ascyron.*
 2. Leaves on main stem 2-3 cm. long, flowers 2 cm. wide, capsules narrowly ovoid, less than 1 cm. long. 2. *H. kalmianum.*
3. Stamens very numerous. 4.
3. Stamens 5–12. 10.
 4. Capsules 3-celled. 5.
 4. Capsules 1-celled. 8.
 4. Capsules incompletely 3-celled, stem 4–5 dm. high, flowers 1.5 cm. broad, short pedicelled, capsule 3–4 mm. long. (*H. adpressum.*)
5. Shrubs, capsules about 1 cm. long, leaves narrowly oblong or oblanceolate, usually revolute. 3. *H. prolificum.*
5. Herbs, capsules 3–6 mm. long. 6.
 6. Leaves oblong or linear-oblong, crowded, flowers about 2 cm. wide. 6. *H. perforatum.*
 6. Leaves broader, elliptical to ovate, flowers about 1 cm. wide or a little larger. 7.
7. Leaves sessile, cordate, sepals acuminate. 7. *H. maculatum.*
7. Leaves narrowed at the base, sepals obtuse. 8. *H. subpetiolatum.*
 8. Styles separate, leaves oblong, sharply acute, ascending, 2–3 cm. long. 5. *H. virgatum.*
 8. Styles united below into a beak, leaves obtuse or nearly so. 9.
9. Leaves narrowly oblong, 3–6 cm. long. 4. *H. sphaerocarpum*
9. Leaves elliptic or ovate, 1.5–2.5 cm. long. (*H. ellipticum.*)
 10. Leaves lanceolate to ovate. 11.
 10. Leaves linear. 14.
11. Capsule 8–10 mm. long. (*H. majus.*)
11. Capsule 6 mm. long or less. 12.
 12. Leaves obtuse or rounded at apex. 13.
 12. Leaves acute, ovate and cordate-clasping. 11. *H. gymnanthum.*
13. Bracts subulate. 9. *H. mutilum.*
13. Bracts broader, foliaceous. 10. *H. boreale.*
 14. Leaves 3-nerved, spreading, capsule longer than the sepals. (*H. canadense.*)
 14. Leaves 1-nerved, subulate, capsule about equalling the sepals. 12. *H. drummondii.*

1. *H. ascyron* L. In rich moist woods and river bottoms. Monroe, Holmes, Lucas, Lake, Cuyahoga, Erie, Summit, Franklin, and Richland Counties. A plant of generally northern range, in Ohio apparently with the widest distribution in the northern counties.

2. *H. kalmianum* L. Along or near the lake shore in Ottawa, Erie and Summit Counties. Occurs generally along all the Great Lakes.

3. *H. prolificum* L. Champaign, Hocking, Defiance, Franklin, Hamilton, Tuscarawas, Montgomery, Carroll, Holmes, Jackson, Coshocton, Adams, Gallia, Harrison, Portage, Stark, Wyandot, Wayne, Scioto, and Fairfield Counties. Data are not at hand concerning its ecological habits but it probably prefers dry woods.

4. *H. sphaerocarpum* Michx. Lake, Franklin, Montgomery and Clermont Counties. Should be found in dry woods in all the western counties.

5. *H. virgatum* Lam. A single specimen from Jackson County. This species is more characteristic of the coastal plain of the Atlantic from Delaware and New Jersey southward, but has been reported from a number of places inland. It is easily recognized by its leaf habit alone.

6. *H. perforatum* L. Naturalized from Europe in fields and along roadsides, Auglaize, Gallia, Ashtabula, Summit, Morrow, Highland, Lorain, Clinton, Stark, Union, Carroll, Wayne, Tuscarawas, Knox, Clark, Montgomery, Franklin, Richland, Noble, Guernsey, Ross, Harrison, Madison, Butler, Jefferson and Medina Counties.

7. *H. maculatum* Walt. Scioto, Muskingum, Franklin, Adams, Wayne, and Logan Counties.

8. *H. subpetiolatum* Bickn. Most abundant in moist, shaded woods. Stark, Highland, Lake, Richland, Erie, Shelby, Crawford, Summit, Carroll, Union, Auglaize, Clinton, Cuyahoga, Defiance, Hocking, Hamilton, Tuscarawas, Clermont, Gallia, Lorain, Huron, Morgan and Licking Counties.

9. *H. mutilum* L. In moist woods and along streams. Huron, Stark, Morgan, Jackson, Wayne, Brown, Franklin, Perry, Monroe, Scioto, Lake, Vinton, Clarke, Hamilton, Cuyahoga, Fairfield, Hocking, Clermont and Auglaize Counties.

10. *H. boreale* (Britt.) Bickn. In peat bogs, Defiance and Geauga Counties.

11. *H. gymnanthum* Engelm. and Gray. Erie County.

12. *H. Drummondii* (Grev. and Hook.) T. and G. In dry soil and on rocks, Ashtabula and Hamilton Counties. Probably introduced in the former.

Sarothra L.

A monotypic genus.

1. *S. gentianoides* L. In sand and on dry rocks, Erie, Gallia and Scioto Counties. Probably occurs elsewhere along the lake shore.

Triadenum Raf.

One species in the State.

1. *T. virginicum* (L.) Raf. In peat bogs and swamps in the northern half of the State. Wayne, Erie, Geauga, Licking, Cuyahoga and Huron Counties.

HABITS AND DISTRIBUTION OF THE PSEUDOSCORPIONIDAE, PRINCIPALLY CHELANOPS OBLONGUS, SAY.*

E. W. Berger, Ph. D. (J. H. U.).

The observations that prompted the writing of this paper were made mainly in Jamaica, W. I., at intervals between the 14th of June and the middle of August, 1897, while the writer was a member of the Marine Biological Laboratory of the Johns Hopkins University, located for that summer at Port Antonio.

Soon after our arrival an abundance of material, with most of the females bearing egg and brood pouches, was discovered upon the Bogg Estate, just to the west of the above named town. The majority of the specimens collected (several hundred in all) belong to a single species, *Chelanops oblongus*. Ten specimens only of another, a smaller, more active species, but with larger mandibles (chelicerae) and with a more rectangular abdomen, were found in the same locality living together with the previous species. This smaller species is *Chthonius pennsylvanicus*, Hagen.

I believe it proper to add here, that I was turned aside from this to other work soon after my return from Jamaica, and that before I had identified these species. Later, when I desired to identify them I had no facilities, and in 1900 sent specimens to the Smithsonian Institution. These were promptly identified for me by Mr. Nathan Banks, Honorary Curator of the Section of Arachnida, as the species above named. I have only recently had the opportunity to identify them for myself at the Ohio State University, using Mr. Bank's key (III).

The Pseudoscorpionidae (Chernetidae) constitute an order in the Class Arachnoidea, or spider-like animals, and some species are very small. The specimens in L. Balsan's list (I) range from 1.20 to 7.10 mm. in length. The *C. oblongus* from Jamaica measures 3.33 to 4.00 mm.; some specimens collected by Professor Jas. S. Hine at Georgesville, Ohio, measure only 2.00 mm., but are evidently not fully matured. The males are slightly smaller than the females. *C. pennsylvanicus* measures 1.90 mm. only. They are called Pseudoscorpions because of their resemblance to real scorpions, except in size and in the absence of the post-abdomen and a poison sting. Many species are blind, including *C. oblongus; C. pennsylvanicus* has four small eyes.

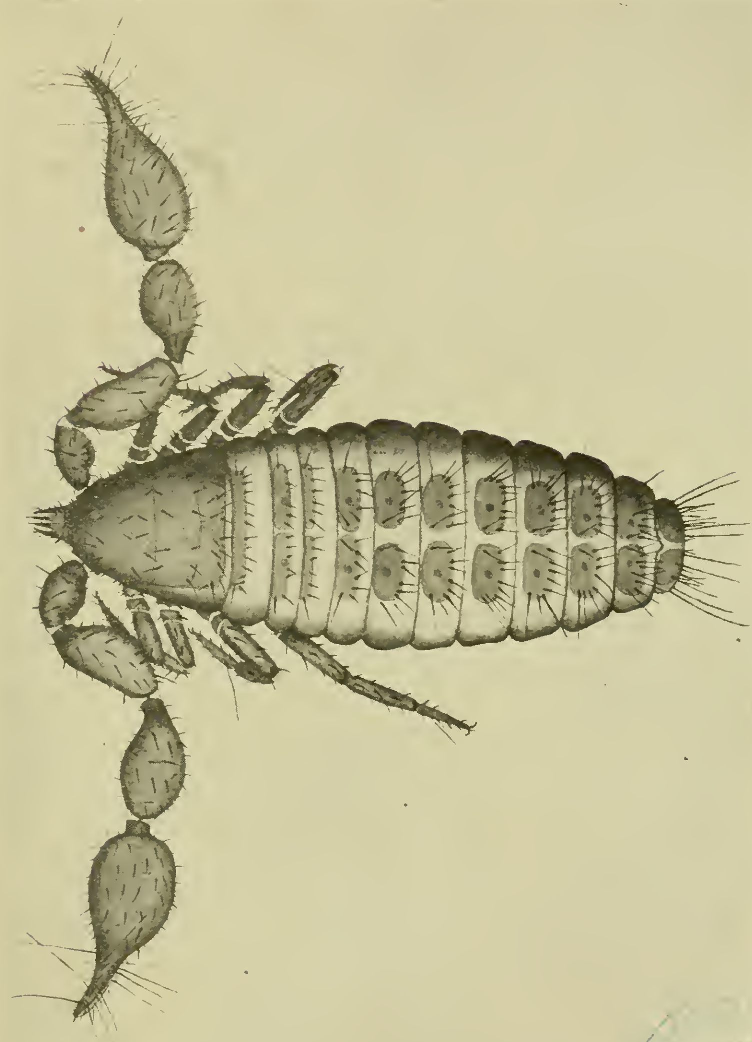
Distribution.—I was surprised to find that both the species collected in Jamaica should occur quite throughout the eastern U. S. Mr. Banks names the following localities for *C. oblongus:* Ithaca, N. Y., Washington, D. C., Brazos Co., Texas, Citrus Co.,

* Contributions from the Department of Zoology of the Ohio State University, No. 23.

Fla., Sand Point, Fla., Retreat, N. C., Fredericksburg, Va., and Detroit, Mich. (To this list can now be added Port Antonio, Jamaica, and Georgesville, Ohio.); for *C. pennsylvanicus*, Poughkepsie, N. Y., and Lake Poinsett, Fla. I read over carefully the list named by Mr. Banks in his paper (III) above quoted, for the purpose of noting the distribution north and south, and east and west. I have concluded from this that there are distinct eastern and western species, but probably only a few distinct northern and southern species. Thus Pacific Coast species are reported no farther east than Utah, Montana and Wyoming, while eastern species are reported no farther west than Texas, Kentucky, and Michigan. *Obisium Brunnerium*, Hagen, common in the east, is reported from Utah, but Mr. Banks seems to have some doubt in this case that the Utah species is the same. *Chelifer cancroides*, Linn., Faun. Suec., is of course reported from the Pacific Coast and perhaps occurs over the whole U. S., and if not now, will very likely soon occur throughout the entire world. Two or three species are reported only from Texas and Colorado. Eastern and Pacific Coast species, on the other hand, generally have a wide north and south distribution. Thus among other eastern species named by Mr. Banks, *Chelifer biseriatum*, Bks., reported only from Lake Poinsett, Fla., was found by myself under a neglected carpet infested with buffalo moths, at Berea, Ohio, in 1901. The two species collected in Jamaica also illustrate this far north and south distribution nicely, extending even to within the tropics.

This wide north and south distribution of the species of pseudoscorpions versus their rather limited east and west distribution, I believe is associated with the migration of insects or birds. Pseudoscorpions have, however, to my knowledge, never been found upon birds, so that nothing definite can be stated in this respect. On the other hand, they are known to cling to insects (chiefly flies and beetles) and arachnids (see ASSOCIATIONS WITH INSECTS) and to be transported from place to place by these. Certain insects are known to migrate for hundreds of miles. Thus a moth, the Black Witch, *Erebus odora*, is supposed to migrate from the West Indies and Mexico to the U. S., while the Monarch, *Anosia plexippus*, is believed to migrate south in fall and north in Spring. No doubt there are other migratory insects, so that the distribution of pseudoscorpions will, I believe, sometime find its explanation in this direction. There being nothing like a complete list of pseudoscoripons in existence, it is evident that these speculations are somewhat tentative.

I tried to gain some idea of the distribution in South America by comparing the papers of Ellingsen (VIII), Balsan (I) and Banks (III). I found no species mentioned that are common to



E. W. Berger, Del.

Chelanops oblongus, female.

both North and South America. Two species, *Chelifer canestrinum*, Bal., and *Chelifer longichelifer* occur both in Ecuador (Guayaquil) and in Venezuela, i. e., to the west and east of the Andes. Two other species from Venezuela occur in Paraguay and Uruguay. Hagen in one of his papers (IX) mentions *Chelifer americanus* occurring in Venezuela and South Brazil. Of the few species noted from Peru and Chili, west of the Andes, none are reported from the east. The evidence from South America, while insufficient, I believe nevertheless suggests a distribution similar to that in North America.

The distribution of the order Pseudoscorpionidae is, of course, worldwide: North America, South America, Europe, Asia, Africa, Australia, Madagascar, Sumatra and New Celebes, each having representatives reported.

Habitats.—I collected almost all my specimens from under the loose bark of flat-lying trees. A few were found in banana plant rubbish (dried leaves, pieces of stems, etc.) and in dead pines (Pine here refers to a relative of the pinaepple that grows as an aerophyte upon trees in the tropics.) While I could not state that pseudoscorpions are social in their habits, I always felt that when I found one, others were not far away, and that they were scattered in groups rather than singly. It is also interesting to note that the places of occurrence of these species in Jamaica were always damp or even wet: frequently so wet that I could press water from the bark and wood with my fingers. I never found them in dry places, and when I kept some in captivity under small pieces of bark in glass jars, I found that they died and dried up if the bark was not kept quite moist and the jars covered. By taking proper precaution, however, to provide moisture, several colonies were kept alive for about ten months. In one instance I prepared a roll of bark about a core of decayed wood and set it one end in a glass jar. This worked very well, the animals living between the layers of the bark and wood. In this jar and others some females even produced eggs, and some young were hatched. To keep water from condensing upon the sides of the glass, I lined the jars with filter paper. Not all preudoscorpions, however, require such wet conditions; thus *Chelifer biseriatum* already referred to, and *Chelifer cancroides*, the book scorpion, both live in very dry places in houses. Other localities where these little creatures find their abode are: upon the leaves of trees (palmetto), between the crevices of rocks, under rocks, driftwood and leaves in the woods. *Obisium maritimum*, Leach, and *Chelanops tristes*, Bks., live under stones between tide marks: the former on the Isle of Man and other British Isles, the latter on Long Island, N. Y. Immes, who reports the former species, suggests that it retains sufficient air in its tracheae to keep it alive during high tide.

These two species represent the extreme in wetness to which members of the order have become accommodated.

To this list of habitats must be added parisitism and commensalism, habits which the order has developed in connection with other insects.

Association with Insects, Food.—Pseudoscorpions evidently associate themselves with insects and a few arachnids in three ways: as travelers, parasites and commensalists. As travelers they make use of insects and other arachnids by holding fast with the chelae of their pedipalps to the legs of flies, bedbugs, phalangids (harvestmen), tipulids (craneflies), etc., or by concealing themselves under the elytra of the larger beetles, *Alaus oculatus*, and others. It appears that in the tropics they are more often reported upon beetles, while in the north more frequently upon flies and the other insects named.

As supposed parasites they occur mainly upon beetles. The cases of Chernetidae on record, occurring under the elytra and wings of beetles where the body is softest, seems to make this belief probable. I see no reason why it should not be easy enough for a pseudoscorpion to penetrate the softer parts of a beetle with its sharp mandibles.

In commensalism the species of insects with which they are associated are prboably the same as in parasitism. The truth is, it would be quite a difficult matter to name either the species of insects or of pseudoscorpions that belong strictly to any one of these three groups. Since pseudoscorpions are carnivorous, sucking the juices from smaller insects, mites, etc., it appears not at all improbable that they should find their prey under the wings of a beetle, and stay there until the supply is exhausted.

I, myself, have found neither *C. oblongus* nor *C. pennsylvanicus* upon other insects, but Hagen (IX) reports it (*Ch. alius*, Leidy) under the elytra of the beetle *Alaus oculatus*. He further states that blind Chernes species travel mainly upon beetles, and mentions *Chelifer americanus*, De Geer, on *Acanthocinus longimanus* in Venezuela and South Brazil; another in Brazil on *Passalus;* and one in Melbourne (together with a tick) upon *Passalus politus;* all occur under the elytra. A special few, he says, travel fastened to flies, as *Ch. Sanborni* in Mass. and *Ch. Loewii* in Panama. Hagen evidently favors the transport theory and believes that certain species limit themselves to certain species of flies, beetles or other insects. Moniez and Wagner also favor the transport theory.

Other writers favor either parasitism or commensalism. Thus Leydig in discussing the occurrence of a pseudoscorpion under the wings of a Brazilian beetle, emphasizes the fact that they are located under the wings where the abdomen is most vulnerable, and believes in parasitism. Ihering believes in commensalism, and mentions species of *Pyrophorous* between which and the pseudoscorpion he thinks a definite relation has been established; but he admits that the species upon leaves are probably the same as upon the beetles.

As will be seen in the following topic pseudoscorpions evidently do attack and may cause the death of flies much larger than themselves. It occurs to me that this instinct for robbery is the starting point that lead to the habit of holding fast to insects for travel, to parasitism and to commensalism, in whatever degree these exist as a habit. It is perhaps natural for a pseudoscorpion to lay hold of anything alive that comes within its reach. I have distinct recollections of teasing specimens with a needle or with a splinter, and that they would lay hold of these objects with their chelae. If, then, the attacked insect is strong enough to walk or fly away, and the pseudoscorpion does not kill it, he becomes a passenger; if he finds natural secretions or succeeds in wounding his host, he is a parasite; if he finds other insects or mites that serve his wants, he is simply a commensalist. It is thus quite easy to understand how the three conditions of travel, parasitism and commensalism may have developed as a habit, if indeed they are not accidents, for pseudoscorpions can live very well without hosts.

Food, Cannibalism.—As I have stated before, the food of pseudoscorpions is the juices of insects, mites, etc., usually smaller than themselves. I have seen specimens holding some smaller insect either by means of the chelae of the pedipalps or by means of the chelicerae. It is generally known that they feed upon psocids (corrodentia) and Hagen mentions *Atropus pulsatorius*, the death watch, as their probable food. On the other hand, I have found them (*Chelifer biseriatum*) associated with buffalo moths and believe that they were there because the moths were abundant and good feeding.

The following observations by Bachhausen are important and interesting. Thus Prof. C. Berg reports (V) that Bachhausen in South America found a pseudoscorpion attached to the leg of a blow-fly and hanging free. He noticed after several hours that the legs of the fly became stiff. The next morning the fly was dead and the pseudoscorpion sucked full under some scraps of paper. Bachhausen next hungered a number upon moss under a glass and then gave them some small flies. The pseudoscorpions soon appeared from concealment and began to attach themselves to the legs of the flies by one pedipalp. When two happened to get the same fly one or the other soon let go in order to get a victim of its own. The legs of the flies soon become stiffened and when the flies died they dragged them into concealment. A tabanus is reported as dying much slower than the other flies. On the other hand, Muehlhausen does not find that the fly's leg was stiffened by a *Chelifer cancroides* (the book scorpion), which held fast for fifty-six hours, or until it was drowned in a drop of milk. Nor did the microscope show any evidence of injury to the fly's leg. It occurs to me, however, that *C. cancroides* is one of the smaller species and consequently was not able to injure the fly's leg as an individual of a larger species could have done.

Cannibalism.—I observed several times, while collecting specimens, that large individuals were holding smaller ones in their chelae. I also observed the same thing upon some specimens kept in the jars (see Captivity). Then, again, the specimens in the jars were continually on the decrease. From these several observations I am led to believe that *Chelanops oblongus* and other pseudoscorpions are cannibalistic. On the other hand, the immature of *C. oblongus* and other pseudoscorpions build small nests in which they live (or rather become torpid) during their moulting periods and in which they remain until their cuticle has hardened (see Breeding). This evidently indicates danger from enemies and probably from their own kin. I believe rather more from their own kin than from other enemies, since the places where pseudoscorpions live are small and they could easily crawl into some crevice where a larger enemy could not reach them. I furthermore found but few insects and other animals under the bark of sufficient size to be of much danger. These consideraitons strengthen my belief in the probability of cannibalism. I know of no writer who has made similar observations.

Captivity.—In the three jars used for confining live specimens I kept from thirty to forty for nearly ten months. I can perhaps best give the history of these by quoting the brief notes verbatim.

Jar A. Sept. 3d.—All seem contented. Found one specimen carrying a smaller one in his jaws. Is this ca*nnibalism?* Found one with a small bunch of yellow eggs.

Sept. 30th.—I find fewer specimens, but all appear happy. There are none with eggs. There is a plenty of other little insects and mites in all the jars; also some small earthworms.

Oct. 21st.—There are now only five specimens and none with eggs.

Jar B. Sept. 4th.—This jar had three specimens with bunches of yellow eggs, and other specimens with and without small eggs. I can find nothing of those with eggs today. Found small one building a casting nest. No evidence of eggs on any, but I had no lens with which to examine them. Bunches of eggs may be very small at first, quite colorless and difficult to see without a lens or without turning the animals over.

Sept. 30th.—I found none with eggs and fewer specimens. What has become of them? Some doubtless lost their life by drowning in drops of water precipitated upon the glass, but this does not account for all missing.

Oct. 20th.—Found two dead and one small one alive. Found one in moulting nest preparing to cast.

Jar C.* Sept. 7th.—Bark arranged in concentric layers and populated with adults. All seem contented. Found eight specimens with yellow bunches of eggs. One encased in moulting nest. One with small one in jaws (cannibalism?) No small ones were put into this jar nor any with eggs.

Sept. 30th.—Looked over Jar C where previously there were adults with eggs, and now I find none. The number of adults is fewer. What has become of them? Do they eat each other and also the females with eggs? Have not noticed any undue amount of empty skins, did however observe remnants of pedipalps, etc., at the bottom of the jar.

Oct. 21st.—There are now eight specimens living and four found dead. None with eggs. One small one in moulting nest preparing to cast, found Oct. 20th, casted Oct. 23d, but at eleven a. m. still in the nest. Two days later "baby" is out of its nest and under bark.

June 3d, 1898.—All specimens are dead in all the jars. Some shells and claws of them only can be found. Some little white hexapods, also some black ones, and some small mites are living in the jars.

Breeding, Nests, Moulting.—The genital opening is located ventrally between the second and third abdominal segments, and it is here that the female carries her eggs in a small whitish pouch. The young are hatched within this pouch and remain there until ready to shift for themselves, being nourished in the mean time by a fluid secretion from the mother. This secretion is produced either by the oviduct or by some other glandular structure within the genital opening. The pouches enlarge as the young increase in size, until they become quite cumbersome for the mother to carry. I have counted twenty-four eggs in a pouch. Metchnikoff says about fifty and that they are one-tenth of a millimetre in diameter. Barrois says that he found about thirty. It is generally understood that the young are nourished in the pouch.

Moulting Nests.—I shall next describe more fully the moulting or casting nests. These are composed of a wall of small fragments of wood and bark that completely incloses a circular or oval space three to four millimetres in diameter. One of these little nests extends from the wood of the tree to the bark, and is lined with silk. When a young specimen is ready to shed its skin it builds one of these nests, suspends itself within, supported by several fibres of silk which cross and recross the enclosed space, becomes torpid and moults in two or three days. It then remains in its nest for one or two days longer, or until its cuticle hardens, when it is ready to break through the wall of its little prison. (See notes Jar C above; also figure.)

Some writers convey the idea that these nests are built by the mother for the entire brood after they leave the pouch, and that they remain there until sufficiently hardened. Judging by my own observations this is not the case. I have never found but a single specimen in a nest of this kind, and that always an

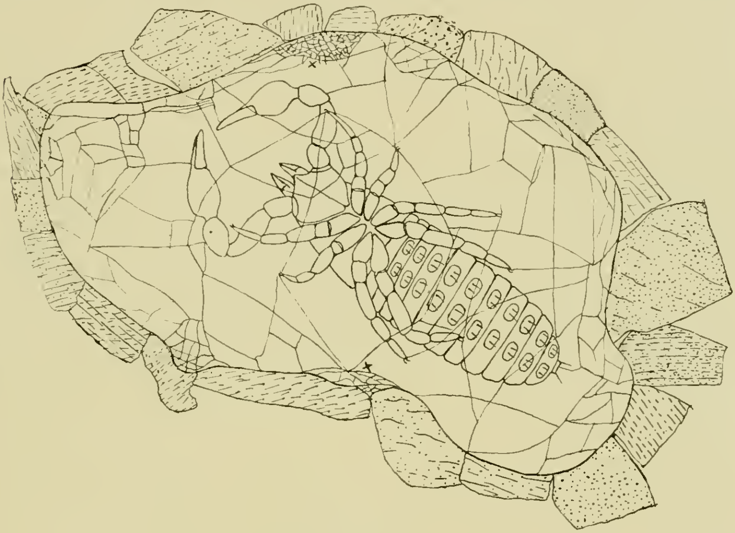


Fig. 1. Moulting Nest of Chelanops oblongus.

immature one. (I collected and observed not less than two dozen such nests.) Furthermore, I usually found the empty skin in the nest and sometimes the skin and the animal, in fact I all but saw them in the act of moulting. (See notes under Jar C.) As I have never found an adult, with or without eggs, in a nest, I think there can be no doubt that the casting or moulting nests are built by single immature individuals for a safe retreat during moulting and not by the parent for the entire brood. Mr. Banks has this statement in his paper (III) which corresponds exactly with my observations: "Many were young and had formed little cases of silk and earth in which to pass the moulting period." This was reported by Mr. Hubbard for *Garypus bicornis*, Bks., which lives between the laminae of rocks at Specimen Ridge, Yellow Stone National Park.

The following observations by J. Barrois (IV) upon a chelifer living in the temperate zone are interesting, and show that females may build nests, but evidently for themselves and not for the brood. This chelifer was found in small closed nests under rocks. Only the females built the nests. The males hid as best they could and were smaller and fewer than the females. Between October and February the occupants were plump with swollen abdomens. By the end of April or May the nests were empty or contained only an emaciated female. The eggs were not laid before January, but after that they were found in a packet adhering to the vulva, with the cavity of the packet in free communication with the oviduct, evidently a nutritive adaptation. Here we see how the female uses a nest for another purpose. In the tropics where my observations were made, such an adaptation would hardly be necessary and I do not think that it exists.

Moulting.—I made no observation indicating the number of times pseudoscorpions moult. That they moult after becoming sexually mature is probable from the fact that the normal genital openings appear when they are about three-fourths grown and that they produce eggs at that stage. Smaller animals show no signs of genital openings. Then again, a case of regeneration of a pedipalp (descr. below) indicates that mature animals probably moult even when apparently full grown. In arthropods generally the enlargement of a regenerating organ takes place at moulting time, in fact regeneration presupposes moulting, and if the same rule holds true for pseudoscorpions, it suggests that older specimens may moult. (See, however, *Moulting Nests.*)

The manner of moulting is as follows: The dorsal skin of the cephalothorax splits at the anterior and lateral margins, remaining hinged posteriorly. The animal then extricates itself through this opening. This is the situation indicated by the exuviae examined, in which this skin exists as a hinged lid.

Regeneration.—I found a few specimens that had lost one to several segments of the pedipalps, and one specimen with a large (normal) pedipalp and a small one of about half the normal size. The smaller pedipalp was of lighter color and thin, and in every way suggested a case of regeneration similar to that found in crabs.

Body Movements, Light or Heat.—A pseudoscorpion can retract one or both of its chelicerae and move them in any direction. The pedipalps can be moved in any direction and the trochanter and femur folded back almost against the sides of the body, the tibia and the chelae, or hand, extending forward. It cleans the chelae of its pedipalps with its chelicerae, or mandibles, using them either singly or as a pair. The legs are used in pairs when walking, and those of each side constitute two pairs, an anterior and a posterior pair. When at rest the two anterior pairs extend forward and the two posterior pairs backward from a right angle with the body. When walking it uses its *four pairs* of legs quite as any four-footed animal uses its legs. When disturbed it contracts its abdomen, the latter thus becoming shorter and thicker.

I focused the direct sunlight from a small engraver's lens upon the desk, the specimen being under a watch glass. It appears that in a few instances the animal took note of the focus and went around it. It seems to have become conscious of the focus by reaching into it with its pedipalps. At other times it walked right through the focus without any concern whatever. Once I directed the focus upon the cephalothorax for some little time, when all at once it seemed to feel something, probably the heat of the focus, and it hurried away apparently discomforted. No eyes could be discovered, and the above experiments, I believe, simply indicate that the animal felt the heat of the focus. With a lens I could make out in many instances light circular disks near the anterior lateral margins of the cephalothorax. These were very suggestive of the so-called eye spots of the eyed elaters.

Color.—The color of the adult is light brown, with the pedipalps, the dorsal part of the cephalothorax and the dorsal plates of a darker shade. In newly moulted specimens the appendages are of a light slate color, sometimes of a green or blue cast, or cream color, while the body is of a uniform yellowish brown or cream color, with the dorsal plates not well marked off.

Economic Value.—To what extent these little animals serve any useful purpose in the destruction of insect pests, is not well known and difficult to determine. But, since they are carnivorous, we may imagine that they destroy many small insects, larvae and mites that would otherwise be harmful; and if Bachhausen's observations are correct, many flies, and perhaps other insects larger than themselves The book scorpion no doubt serves a useful purpose in keeping down the number of book-lice, and to what extent this is done might be a subject for investigation. On the other hand a more complete study of the group may show us more clearly its economic value.

The writer desires to express his sincere appreciation to Professor Osborn for his interest manifested in this paper and for the publication of the same as a University Bulletin.

Biological Hall, Ohio State University, November 24, 1905.

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DESCRIPTION OF FIGURES.

Plate XXVIII.—*Chelanops oblongus*, female. The long hairs upon the chelae, the chelicerae, the cephalothorax, the dorsal scutae and at the posterior end of the abdomen are exact copies of nature. The second visible segment figured on the legs is not movable upon the third segment and is properly speaking not a joint.

Fig. 1.—Small immature *C. oblongus* in a moulting nest. Notice lining of silk at X; this was not sketched over the entire inside of the nest as it would have obscured the fibres that support the animal. Hairs on ventral scutae are as in nature. Note that one leg lacks a segment; this is as in nature. Sketched from living animal (torpid) in the nest. While drawing I noted two droplets of liquid accumulate near a joint and spread over the surface.

KEY TO THE OHIO DOGWOODS IN THE WINTER CONDITION

John H. Schaffner.

Cornus L. Shrubs or trees with opposite, whorled, or sometimes alternate leaf scars; twigs green, red, brown, or gray, glabrous or pubescent; terminal bud present with 2 acuminate outer scales; axillary buds single, minute or well developed; leaf scars narrow, u-shaped, usually connected by a line or ridge, the uppermost notched; bundle scars 3, stipular scars none; pith small, solid, cylindrical; fruiting peduncle self-pruned, producing distinct terminal scars.

1. Leaf scars opposite; shrubs or trees. 2.
1. Leaf scars alternate; twigs green or yellowish-green, glabrous; internodes very unequal, axillary buds usually minute; small trees or erect shrubs. *C. alternifolia* L. Blue Dogwood.
1. Low geophilous shrubs with small creeping rhizomes and herbaceous aerial stems, 4–12 in. high, with a whorl of leaves at the summit. *C. canadensis* L. Dwarf Dogwood.
2. Axillary buds usually minute and undeveloped except at the base of the peduncle which is self-pruned; twigs green or reddish-green, glabrous or nearly so; a small tree with rough, reticulate bark; flowers in involucrate heads which are prominently developed in winter. *C. florida* L. Flowering Dogwood.
2. Axillary buds normally well developed and prominent; typical shrubs, or if tree-like very pubescent; flowers cymose and not involucrate. 3.
3. Twigs green or greenish, glabrous or nearly so, warty dotted; a compact shrub with upright, grayish stem. *C. circinata* L'Her. Roundleaf Dogwood.
3. Twigs bright red or red-purple, glabrous or nearly so; a spreading shrub rooting freely and multiplying by stolons; usually in wet places. *C. stolonifer* Mx. Red-osier Dogwood.
3. Twigs pubescent, rarely glabrate when old, greenish or reddish brown or gray. 4.
4. Twigs silky downy, usually purplish; fruit blue; a shrub with spreading branches growing in wet soil. *C. amomum* Mill. Silky Dogwood.
4. Twigs very rough pubescent, brownish or reddish-brown; fruit white; erect or tree-like shrubs in river bottoms and moist or dry soil. *C. asperifolia* Mx. Roughleaf Dogwood.
4. Twigs glabrate, with scattered hairs, gray, rather slender; fruit white; a much branched shrub. *C. candidissima* Marsh. Panicled Dogwood.

FREE-FLOATING PLANTS OF OHIO.

MABEL SCHAFFNER.

In general all hydrophytes may be classed into two groups, those rooted in the soil and those which are free. The rooted plants are either completely submerged or they may have part of the body above and part below the surface of the water. Among the latter type of plants are numerous species with only the leaf blades floating on the surface, as Potamogeton natans and Castalia odorata. The non-rooted vegetation consists (1) of microscopic, free-floating and free-swimming Thallophytes and (2) of higher plants adapted to a free-floating condition, among which must also be included rooted forms accidently torn from their anchorage and the specially developed propagative buds known as hibernacula. The microscopic plants together with the Protozoa and other low animal forms make up the plankton, while the second type of societies has been called the derived or secondary phyto-plankton.

The typical members of the secondary plankton are passive, free-floating plants which as appears from their general structure and life cycle were evidently derived from rooted ancestors. In free-floating plants like the duckweeds, which are among the most highly specialized forms, the leaves are entirely absent and the stem is a flattened, disc-like body, or in a few species it is nearly spherical. The plants are buoyed up on the surface of the water by means of air cavities developed either in the body of the stem or in the leaves. The most striking of these adaptations is a spongy enlargement of the petiole as in the water hyacinth. The air reservoirs usually consist of spongy tissue with large intercellular spaces.

Most floating plants have a suitable counterpoise to prevent the plant from being turned upside down by ripples and waves. In Azolla and most of the duckweeds the counterpoise consists of one or more dangling roots. In Salvinia dissected leaves looking much like hanging roots act as counterpoises. In Ricciocarpus the counterpoise consists of numerous slender scales.

There are various adaptations to afford protection against wetting. The larger duckweeds have a very smooth and glistening surface from which water rolls in the spheroidal form. Lemna trisulca which is usually submerged does not have the power of shedding water. In Salvinia curious, tufted hairs, the tips of which spread out in three or four branches, are developed on the upper surface. When the plant is overturned air is imprisoned by these tufted hairs and it is immediately turned right side up.

Surface floating plants are exposed to intense light. Some species like Azolla develop anthocyan while others like Salvinia are protected by hairs. In some, as in Lemna trisulca the chlorophyll granules shift their position with the changes in the intensity of the light. In diffused light the granules lie against the horizontal walls, but if strong light strikes the surface perpendicularly they are transferred to the vertical walls.

Vegetative propagation is usually effected with great rapidity by the branching and budding of the stem and the separation of these branches. The duckweeds and other free-floating plants frequently cover great areas very closely and largely prevent the formation of waves when one throws a stone into the water. In the south the water hyacinth (Piaropus crassipes (Mart.) Britt.) covers large areas of rivers and lakes, causing much inconvenience to navigation.

Among the Ohio plants which may be found floating free in the water though normally attached may be mentioned the following: Hottonia inflata Ell., Philotria canadensis (Mx.) Britt., Ceratophyllum demersum L., Myriophyllum sp., Utricularia sp., and Potamogeton sp.

Utricularia has little bladders which not only assist in floating the plant but act as traps for capturing small organisms which are digested for food.

The typical, free-floating plants which are found in the secondary plankton of Ohio are as follows:

LIVERWORTS.

Riccia fluitans L.
Ricciocarpus natans (L.) Corda.

WATER FERNS.

Salvinia natans (L.) Hoffm.
Azolla caroliniana Willd.

MONOCOTYLS.

Spirodela polyrhiza (L.) Schl.
Lemna trisulca L.
Lemna cyclostasa (Ell.) Chev.
Lemna minor L.
Wolffia columbiana Karst.
Wolffia punctata Griseb.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, June 5, 1905.

The club was called to order by President Hine. The minutes of the previous meeting were read and approved. Mr. York, chairman of the committee to nominate the editors of the NATURALIST for the coming year made the following report:

Editor-in-chief, J. H. Schaffner.

Business manager, J. S. Hine.

Associate Editors: F. L. Landacre, Zoology; J. E. Hyde, Geology; Z. P. Metcalf, Ornithology; R. F. Griggs, Botany; W. C. Mills, Archeology; J. N. Frank, Ecology.

On the motion of Prof. Osborn the report was adopted.

The program of the evening consisted of reports of theses by members in the biological departments of the University.

Miss L. C. Riddle reported the second part of her thesis which dealt with the "Development of the Embryo-sac and Embryo of Batrachium longirostris."

Mr. F. M. Surface reported his thesis on "The Scent Glands of Hemiptera Heteroptera with a special reference to the Nymph of Avasa tristis." He also gave a report on the embryology of Sanguinaria canadensis.

Mr. H. H. York had finished and reported his thesis the previous year, and therefore gave an account of his more recent observations on Myriophyllum.

Mr. J. F. Clevenger gave a review of his thesis on "The North American Species of Phyllachora."

Mr. E. C. Cotton reported his investigations on "The Insects of the Black Locust."

Miss Opal I. Tillman gave a summary of her thesis on the "Life History of the Cucumber Plant with Notes on the Economic Value of the Cucurbitaceae.

Mr. L. M. Smith reported his thesis on "The Insects Injurious to Stone Fruits." He dealt especially with the peach borer.

Mr. R. C. Young was elected to membership.

The club then adjourned until the opening of the fall term.

FRANK M. SURFACE, *Sec'y.*

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THE EMBRYO SAC AND EMBRYO OF CUCUMIS SATIVUS.*

OPAL I. TILLMAN.

Before the present investigation was begun practically no detailed morphological work had been reported on the Cucurbitaceae and as there has been much doubt concerning the systematic position and relationship of the plants constituting this family it seemed to offer an interesting and profitable field for research.

Cucumis sativus was taken by the writer for special investigation as a representative of the group but before the results of the work could be published Kirkwood reported (3.) the results of his work on "The Comparative Embryology of the Cucurbitaceae." In this paper he considers seventeen species, but not Cucumis sativus. Longo has worked on the behavior of the pollen tube (1.) and in his more recent paper (2.) he reports an interesting condition of the pollen tube in Cucurbita pepo which is practically the same as occurs in Cucumis sativus.

Material for study was collected during the summer and fall, killed in chromo-acetic acid, passed through successive grades of alcohol and preserved in 70%. Serial sections were cut 10–12 mic. thick, 10 mic. being the usual thickness. The stains used

* Contributions from the Botanical Laboratory of the Ohio State University, XXII.

were Anilin Safranin and Gentian Violet, Heidenhain's Iron-Alum-Haematoxylin, and Delafield's Haematoxylin, the latter perhaps giving the best results. Care had to be taken with it and the Iron-Alum-Haematoxylin as the embryo sacs and embryos stained so deeply that it was difficult to make out the details unless a large part of the stain was removed. The stages just after fertilization were quite difficult to observe as the pollen tube discharges a quantity of material which stains very deeply and obscures the embryo sac structures.

Orientation for sectioning was not difficult as the ovulary when cut crosswise gives longitudinal sections of a number of ovules. For the older stages only a portion of the ovulary could be sectioned on account of its size.

The cross section of the very young ovulary shows the placentae with minute protuberances which represent the incipient ovules (Fig. 1). The carpel has three placentae, and the ovules are delveoped in six rows which are usually double, but this is somewhat irregular. The tip of the ovule remains straight for only a short time after the appearance of the archesporial cell (Fig. 6). The cells along the outer margin begin to divide more rapidly than those of the inner side. This unequal growth causes the ovule to turn, and this process continues until the micropyle is brought close to the funiculus. Before the megasporocyte has divided and before the integuments have grown over the nucellus the ovule has curved half the distance, and the normal anatropous condition is practically attained when the ovule has reached the megaspore stage (Fig. 5). At this time the characteristic beak which develops at the tip of the nucellus is already becoming prominent.

The integuments lengthen greatly forming a long narrow micropyle into which the neck-like process of the flask-shaped nucellus projects, even to the tip of the integuments.

The archesporium is as usual a single hypodermal cell that terminates the axial row of the nucellus. It can easily be distinguished from the surrounding cells by its greater size and deeper color due to the denser protoplasmic contents (Fig. 6).

By a transverse division the archesporial cell gives rise to two cells, the megasporocyte and primary parietal cell (Fig. 7). The latter continues to divide by both periclinal and anticlinal walls thus forming the parietal layer (Fig. 8) which remains persistent and with adjoining cells keeps on dividing to form the long beak of the nucellus (Fig. 22).

The megasporocyte is carried down into the tissue quite a distance by the development of the parietal layer before any division occurs. The division of the megasporocyte is normal, giving rise to four equal megaspores (Fig. 10). The potential megaspores soon begin to dissolve and the lower or functional megaspore begins to enlarge (Figs. 11-12). The latter acquires a very large and distinct nucleus with a nucleolus of unusual size. Kirkwood reported to have found in Trichosanthes that after the division of the megasporocyte the upper cell did not again divide but immediately disorganized, while the lower cell again divided transversely, the upper cell of which also disorganized. The ultimate result, however, is the same in both Cucumis sativus and Trichosanthes, that is, the lowest of the megaspores always becomes the functional one.

The embryo sac and its associated structures are quite small in comparison with the very large nucellus. The development proceeds in the normal way, by a longitudinal division of the nucleus of the megaspore (Fig. 13). At this stage often the potential megaspores have not completed their dissolution and remains of the third one can be seen just above the sac. The nuclei arrange themselves at either end of the sac in the center of which is a vacuole across which strands of protoplasm may extend. In the four-celled stage the large irregular vacuole in the center is also prominent. By two successive divisions the eight-celled embryo sac is formed (Figs. 14–15). The synergids are distinct and lie above the egg. In the early stage they are somewhat globular in shape and follow the outline of the sac. They lengthen considerably and at the time of fertilization they are quite long, sac-like structures. The egg is large and extends below the synergids, at first merely protruding a little beyond their base, but before fertilization it becomes much elongated and swollen (Fig. 17). The polar nuclei are unequal in size, the lower one being the larger. They conjugate before the entrance of the pollen tube. No case of double fertilization was observed; if it occurs it must take place sometime after the polar nuclei are in contact. The antipodals are small cells which lie side by side, in the lower end of the sac. They take the stain more deeply than does the egg apparatus, and for this reason it is often difficult to make out their outline. They do not enlarge but remain in place and are quite distinct even after considerable endosperm has developed.

The development of the embryo is quite irregular. The first division of the oospore is transverse and the upper cell does not divide further and may be regarded as a rudimentary suspensor (Fig. 18). At this stage the synergids have begun to dissolve. The second division is by a longitudinal wall, the lower cell alone dividing. Later, one of the lower cells divides by a more or less oblique wall forming a four-celled embryo (Fig. 19) which is almost surrounded by endosperm. Above the embryo the remains of the two synergids can still be seen, although almost dissolved at this time.

The endosperm is continuous in the region of the embryo but in the lower end of the sac it forms only a thin layer. The later divisions of the embryo are irregular; an oval mass of cells is formed from the end of which the cotyledons develop. When the embryo is about in the ten-celled stage walls begin to appear in the endosperm (Fig. 20). Kirkwood found in Lagenaria lagenaria and other species somewhat flask-shaped embryos with prominent end cells which correspond closely to those of the same age in Cucumis (Fig. 21).

The endosperm is not abundant but there is a greater amount around the embryo than elsewhere, often the lower portion of the embryo sac is entirely destitute of it. The endosperm stains more deeply along the peripheral margin and around the embryo where the nuclei and starch grains are more abundant. The embryo, however, takes the stain much more prominently than any of the endosperm cells.

The embryo develops a distinct layer of epidermal cells before any cotyledonary protuberances appear (Figs. 23–24). The embryo develops apically two cotyledons and distinctly shows the root tip before there is any sign of the appearance of the plumule (Fig. 25). The mature embryo sac contains only a small amount of scattered endosperm, the main food for the young plant being stored in the large cotyledons. In the mature embryo the plumule is two-lobed showing the incipient first leaf (Fig. 26).

The microsporangia appear to develop in the usual way from a plate of hypodermal cells. The cells of the sporogenous tissue are easily distinguished from the adjacent cells by their large size, and different reaction to stains. The young anther shows in cross section a single row of three microsporocytes in each microsporangium (Fig. 31); but in longitudinal section the plate shows a considerable length (Fig. 32).

The mature pollen grain has a thick wall with a bulging at opposite sides. The tube nucleus and generative nucleus lie to one side of the grain near each other; the latter takes the stain more deeply than the cytoplasm of the rest of the grain, due to its denser structure.

The behavior of the pollen tube in this species is of special interest. It is large and distinct and with Delafield's Haematoxylin stains an amber color while the surrounding cells are a purplish blue; with other stains it is of a deeper color. It enters the micropyle through the opening at the tips of the integuments, pierces the beak of the nucellus and makes its way down to the embryo sac by following a central path of much elongated clear cells which seem to offer little resistance and serve as a definite conducting tissue. The tube sometimes makes its way with little deviation (Fig. 27) throughout its entire course; but usually there is a peculiar and characteristic bulging (Fig. 28) some distance above the embryo sac. It spreads out in the surrounding tissue, completely breaking down the cell structure. However, before it reaches the sac it again narrows, sometimes to a greater extent than elsewhere along its course. After it has pierced the sac it turns to one side or widens out into a foot-like process.

The most typical tubes have not only a bulging but decided haustoria-like processes (Fig. 29) which extend out into the cell structure of the nucellus and in some cases even break through the inner integument (Fig. 30). The haustorial prolongations appear to act as absorbing and conducting agents for the food material of the embryo. Longo reports to have observed these processes in his study of cucurbita and believes them correlated with the distribution of starch in these parts. He also reports to have found in Cucurbita pepo a conducting tissue which the pollen tube follows from the stigma to the embryo sac.

The points of especial interest and peculiarity observed in the deveolpment of Cucumis are (1) the long micropyle into which extends the long neck of the flask-shaped nucellus, (2) the presence of two well developed integuments, (3) the anatropous ovule with orthotropous embryo, (5) the small size of the embryo sac and associated structures in comparison with the size of the nucellus, (6) the irregular development of the embryo, and (7) the peculiar behavior of the pollen tube.

The work represented in this paper was carried on under the direction of Prof. John H. Schaffner, to whom I wish to express my sincere thanks for valuable assistance and suggestions.

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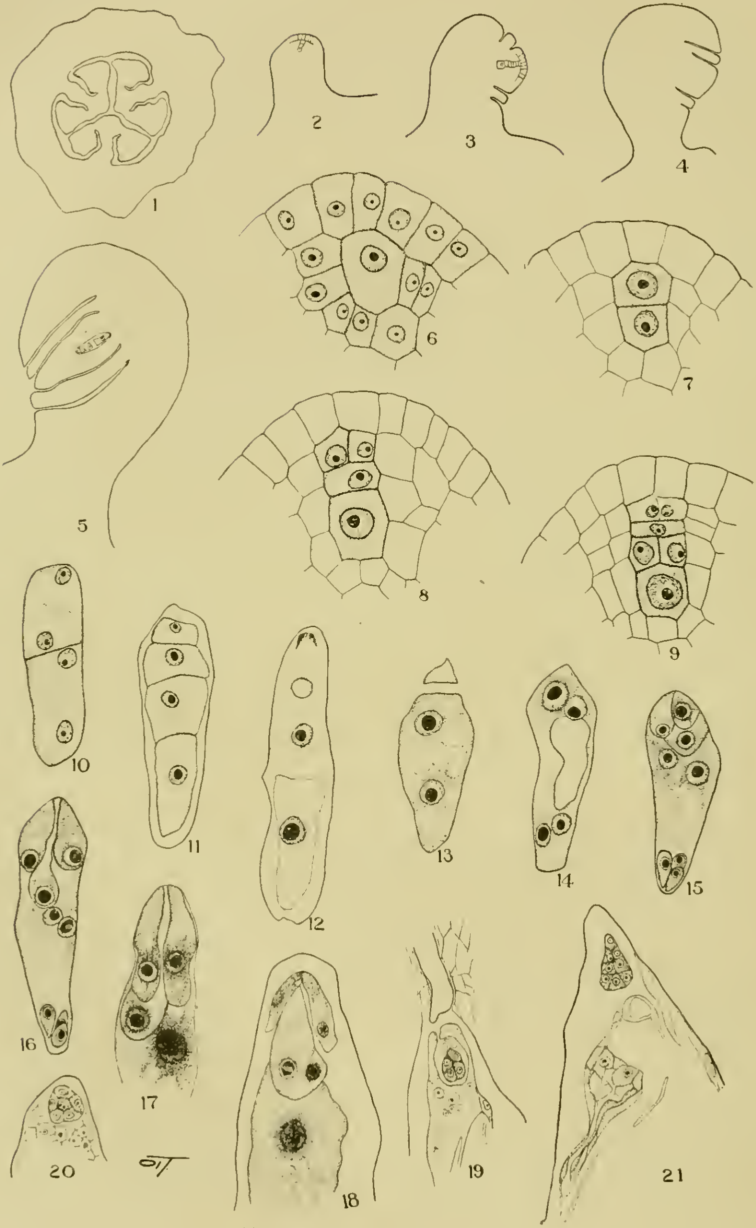
OHIO NATURALIST. *Plate XXIX.*



TILLMAN on "Cucumis."

TILLMAN on "Cucumis."

EXPLANATION OF PLATES XXIX AND XXX.

The drawings were made with the aid of an Abbe camera lucida and various combinations of $\frac{2}{3}$, $\frac{1}{6}$, and $\frac{1}{12}$ oil immersion objectives and No. 2, 1, and ¾ oculars.

Fig. 1. Cross section of young ovulary showing incipient ovules.

Figs. 2–5. Series of outlines showing development of integuments and degree of curvature of ovule at different stages.

Fig. 6. Nucellus with archesporial cell.

Fig. 7. Primary parietal cell and megasporocyte.

Fig. 8. Transverse and longitudinal division of parietal layer.

Fig. 9. Further division of parietal layer.

Fig. 10. Second division of megasporocyte producing the four megaspores.

Fig. 11. Potential megaspores beginning to dissolve.

Fig. 12. Enlargement of functional megaspore and further dissolution of three upper megaspores.

Fig. 13. Two-celled embryo sac showing remains of third megaspore.

Fig. 14. Four-celled embryo sac showing large vacuole in center.

Fig. 15. Younger eight-celled embryo sac.

Fig. 16. Older eight-celled embryo sac, showing polar nuclei in contact.

Fig. 17. Upper end of embryo sac just before fertilization, showing large sac-like synergids, and polar nuclei fusing.

Fig. 18. Two-celled embryo, and definitive nucleus.

Fig. 19. Four-celled embryo with endosperm, and remains of two synergids, also pollen tube.

Fig. 20. Young embryo of about ten cells showing irregular division.

Fig. 21. Young embryo and scattered endosperm.

Fig. 22. Outline of eight-celled embryo sac stage, showing micropyle with long beak of nucellus.

Fig. 23. Section of young somewhat spherical embryo.

Fig. 24. Embryo slightly older than that in preceding figure.

Fig. 25. Section of embryo showing cotyledons.

Fig. 26. Outline of mature embryo showing cotyledons, and plumule.

Fig. 27. Entrance of pollen tube into micropyle and course through nucellar beak.

Fig. 28. Entrance of pollen tube into embryo sac, showing peculiar widening near the tip.

Fig. 29. Pollen tube showing enlargement with haustoria-like processes, and bending to one side after entrance into the sac.

Fig. 30. Pollen tube showing the haustoria-like processes extending through inner integument.

Fig. 31. Cross section of anther showing microsporangia and microsporocytes.

Fig. 32. Longitudinal section of anther.

Fig. 33. Mature pollen grain with two nuclei.

PHYSIOGRAPHY AND GEOGRAPHY—THEIR RELATIONS, DIFFERENCES AND ESSENTIAL FIELDS.*

Geo. D. Hubbard.

Theoretically, it is conceded that geography shall be taught in the grades and physiography in the high schools, but practically both are taught more or less all the way through. Hence, many do not see the boundary line which separates these two sciences. I speak of the subjects in the public schools only, because at present they are best known as parts of public school curricula, not because I believe they are or should be confined to these stages. Neither do I object to the above mentioned lack of differentiation in the elementary teaching.

Pupils came to us in the colleges and universities totally blind, as have been their teachers before them, to any real distinction between geography and physiography. The idea seems to prevail that the former includes the latter. Undoubtedly the use of the name physical geography for the latter cultivates the notion. Truly they are related but not quite in that way. Physiography, if not able to go alone, is more properly considered a corporate part of geology. What then is the relation existing between these two sciences? Can one be studied without the other? Which one should receive attention first? Are they so related that they may be concurrently studied?

These questions will be discussed in inverse order. In elementary work the pupil's interest centers in, and radiates from the human or life element. So in his geography he finds man harvesting grain with a cradle in Vermont, with a two- or three-horse reaper in Ohio and a steam header in Southern California, and he asks why. The answer comes in noting the topography, soil, and climate, and the condition of, and uses for, the straw. He incidentally learns something of the physiography of the places studied in order to explain the relations and responses which he has found. He reads of the arid climate of the Great Plains and then discovers the influence of the Rockies in producing the aridity, and ultimately comes to appreciate several points about mountains. He finds the railroads coming into Indianapolis and Columbus from all directions while they enter Cincinnati, Albany and Helena from only three or four. The teacher calls attention to the topography and he learns facts about plains and prairies, about mountains, passes and valleys. But through it all he is studying geography, not physiography. He is using simple, physiographic facts to explain and answer geographic questions. It is time enough to introduce the physiographic when the geographic requires it.

* Read at the Cincinnati meeting, Ohio St. Acad. of Sci., Dec. 2, 1905.

Again, when in physiography he studies the life history of a plateau and traces the feature from its geotectonic uplift through the steps of its dissection and aging, watching its valleys first deepen, then widen, and its level topped divides melt away to crests with long slopes, while the valley floors widen to occupy half or two-thirds of the region, he may incidentally note that the population and highways occupy the tops of the hills—the plateau surface—in youth, that the culture descends the slopes as the valleys mature, and that in maturity transportation routes, cities, and most of the people are in the valleys while the hill tops are left to pasture or forest. To sum up, a few facts in either science are gathered in the pursuit of the other, but the two subjects do not develop concurrently.

To the second question, "which should receive the attention first," the answer depends upon the age and maturity of the pupil. If a child, geography first everytime. If a mature student, he may well prepare for geography by a strong course in physiography; but the phenomena, reasoning, and philosophy of the latter are far beyond the experience and power of the child, to say nothing of the locus of his interest.

The remaining question, "can one be studied without the other," has been at least partly answered. In physiography, one does not need to learn many facts of geography, and he certainly ought not to follow up the relations to man and his responses to the influence of the conditions, far enough to detract from the systematic development of his subject. In geography, he uses the facts of this related science as he does those of history, sociology and anthropology, but he does not attempt to grasp its philosophy.

Turning to the second division of the subject, "their differences" it is apparent from what has preceded that they often deal with the same features and phenomena. They seem in many topics to use the same basal materials but in a different way. For illustration—in physiography the valley is a topic. It is described, its origin and the evolution of its parts are discussed. Its development is traced and a definite age is ascribed to it. Its end is predicted. Its genetic relation to the surrounding region is discussed. In geography, the same valley is noted as a control of the movements of men and goods, as a home for a state, clan or a certain group of men, or as the seat of adapted industries. Its commercial or economic relations to the surrounding region are noted.

Another illustration is furnished by the river. In physiography, its course through the valley and the regional topography is considered; the work accomplished in its normal development; its method of procedure in carving its valley, enlarging its curves, extending its course, and broadening its territory; its relation to other streams, to lakes or the ocean. But in geography the transportation facilities offered, the power made available, thê possibilities for irrigation, city water supply, and park and scenic uses, these are the subtopics. Its location, whither it leads, what cities on its banks and why; the inter-relation and the inter-action of man and the river, there are its interests. In a similar way the plain and mountain, the sea and shoreline receive different treatment in the course of the development of the two subjects.

These sciences, however, are not different from others in this respect; for chemistry, geology and physics all deal with matter and natural forces, and history, economics, and sociology all study man's institutions.

The difference between geography and physiography is one of point of view. Physiography concerns itself with the description, and the classification of physiographic forms on the basis of the cycle, process or the family; geography with the relations of these same forms to man. In the former the principle is systematization; in the latter, relation. For example, take a plain. In physiography its characteristics are listed, its origin is determined, its age in its normal cycle of development, the processes in operation upon it, and its relation to the surrounding topographic features. A comparison with other plains is made and the types are discussed until the specific feature, say the coastal plain of Alabama and Mississippi has been referred to its type and class, to its variety and age. It may be called a belted coastal plain, submaturely dissected in its inland portion and less dissected and slightly drowned along the coast. Systematization is the objective.

In geography the same plain comes up as the home of the cotton growing industry. The especial adaptations to this business and to others are discussed; the features of the plain to which transportation responds, the location of its cities, roads and ports, the distribution of its crops and minerals, population and industries are shown to be related to its levelness, its belted structure, its stage of dissection, and the position of its harbors and other commercial outlets. In all these points it may be compared with other plains. In these *relations* centers the interest, and through their recognition comes the gain to the student.

This essential difference appears early in the study but becomes clearer as each subject emerges from the high school curriculum. Beginnings are made, and some facts learned, but the complete organization of the truth pertaining to the science can not be accomplished in elementary schools nor by immature pupils. Just as nature study introduces the plant and animal kingdoms to the child and high school zoology and botany continue to familiarize him with them, so as to pave the way for college and university research into the fundamental principles of the sciences of zoology and botany; so nature study, and subsequently, geography and physiography supply basal conceptions for the extended quest for knowledge in the separate sciences of our subject.

We are now prepared for a brief treatment of the third division of the subject, "their essential fields." We have gone far enough already to begin to see the scope of each. Physiography describes, classifies, and discusses the origin of the features of the earth. It compares similar and dissimilar, related and unrelated forms always seeking to reduce the multitudinous variety to a system, to group likes and correlate related specimens. It concerns itself with the physiographic processes and forces of the earth, air, and sea and endeavors to explain all the workings of all, and to understand the nature of all physiographic features. Such a field and purpose constitute physiography a science. They proclaim it to have problems, easy and hard, short and long, solved and unsolved, and I may say, solvable and unsolvable. All this means, further, that the elementary introduction, which the high school boy receives, to the general subject does not acquaint him with the science. It only puts him in touch with some of its facts and theories, and enables him to see and work out for himself, other truths; or to pursue the subject more at length in the University.

And geography possesses a field more biotic, anthropic, and industrial but centering in the relation of the anthropic phenomena to the physiographic. Its seeks to discover all responses of mankind to his physical environment; to show how human industries are related to the distribution of natural resources and to the facilities for moving and marketing them; to show why man lives where he does and as he does so far as these depend upon the physiographic, climatic, and geographic conditions or upon the distributions of natural features or phenomena; to trace his institutions, the elements of his character and the nature of his aspirations as far as they are related to the physical surroundings; and, having accummulated all these data, to reduce them to systems, and to organize them into laws and principles. Geographers have been working in this field for two milleniums and a vast body of material has been collected. Much of the material has been classified; laws have been found, principles discovered, and, today, one of the oldest of sciences is again finding itself.

Here, too, only beginnings are mastered in the elementary schools. In subject matter, both quality and quantity, and in method of treatment and philosophy, geograpby in its higher phases is a university subject. Universities in France, Germany, Austria and to some extent in other countries, have prepared for the study of geography in their courses. Two or three American universities give some systematic instruction in advanced geography. Many more should and, I trust, will, if for no other reason than the utilitarian, the preparation of teachers for elementary and secondary schools and the equipment of men for business, diplomatic, and government positions where a knowledge of the principles of geography is of inestimable value.

To sum up, then, physiography and geography are two distinct sciences. They each contribute to the full appreciation of the other; especially does the former minister to the latter. They often deal with the same basal materials, but not in the same way nor to the same end. Physiography describes and classifies physiographic features and discusses the processes and agencies by which they are made. Geography shows the relations existing between man and his physical environment and classifies the influences and responses. Both physiography and geography are large, complex, and, as yet, not fully developed sciences, and therefore present to the investigator many unsolved and difficult problems.

A NOTE ON THE OCCURRENCE OF SEX ORGANS IN AELOSOMA.[1]

Jas. A. Nelson, Ph. D.

The genus *Aelosoma*, representing the family *Aphanoneura*, and containing the most primitive members of the oligochaetous annelids, is remarkable, among other things, in that sexual reproduction occurs very rarely, the asexual method being the usual one. The latter consists in a process of fission or budding, by which the young individual is constricted off from the posterior portion of the parent, this process often taking place so rapidly that chains of individuals are formed, representing three or more generations. This process is continuous during the life of the individual, and probably amply suffices, as far as numbers are concerned, to insure the maintenance of the species. Sexual reproduction does, however, step in occasionally, and has been described by U'Ddekem in 1862,[2] and more recently by Stolc[3] and Maggi.[4] According to these authors a testis is found in the fifth segment, (counting the prostomium as the first); an ovary

1 Contributed from the Laboratory of Entomology and General Invertebrate Zoology of Cornell University.
2 Bull. Acad. Sci. Roy. Belg. XII.
3 SB. Bohm. Gesc. 1889.
4 Soc. Ital. Nat. Sci. I.

with a central opening in the sixth segment; pairs of spermatothecae in the third, fourth, and fifth segments; and a clitellum confined to the ventral surface of the fifth, sixth and seventh segments.

Among a number of individuals of an undescribed species of *Aelosoma*, taken from the vivarium of the University of Pennsylvania about December 1st, 1901, ten were found containing the sex products in various stages of development. Of these three were hermaphroditic, four contained ova alone, and three male sex cells alone. Thus while this species is plainly hermaphroditic, it seems probable that eggs and sperms do not mature simultaneously in the same individual. The occurrence of ripe spermatozoa, (represented in Fig. 5), and immature ova in the same individual indicates that the species is protandrous, but the evidence is insufficient to decide this question. Many of those in which sex cells were found were also reproducing asexually in the usual manner.

The ova, (Fig. 1), are found in the fifth, sixth, and seventh segments, in some cases in only one of these segments, in others in all three. One individual, however, contained ova in the fourth, fifth and sixth segments. They are attached to the thin peritoneal layer lining the body cavity, and lie below the stomach and lateral to the ventral blood vessel, In Fig. 1 the larger of the two ova represented is by far the largest observed, measuring ca. 55 micra across, and is probably approaching maturity. It occupies a median position, compressed between the stomach wall (st.) and the ventral hypodermis (hyp.), the walls of the ventral blood vessel (b. v.) having been ruptured. The smaller ovum occupies the usual position. Both ova possess a vesicular nucleus (germinal vesicle) containing scattered chromatin granules and a large nucelolus, enclosing a vacuole. The cytoplasm is packed with deeply staining yolk granules. The number of ova is small in all of my preparations, one of the best showing only eight in the three ova-bearing segments. No evidences were found of an oviduct, a clitellum, or of spermatothecae.

Although no clear evidence of the presence of testes was found the ripening male sexual elements (Figs. 2–5) were seen floating free in the body cavity, being found in greatest abundance near the point where stomach and intestine join. They appear as groups or nests of cells, more or less spherical in form. Four kinds of these can be readily distinguished by the character of their component cells; the primary spermatocytes, the secondary spermatocytes, the spermatids, and the spermatozoa. The primary spermatocytes, (Fig. 2), form cell nests made up of comparatively few cells, in size the largest of the series, their nuclei measuring ca. 3.9 micra in diameter. As Fig. 2 shows, the nuclei lie at the outer ends of their cells; each contains a closely packed ball of chromatin granules, separated from the nuclear membrane by a slight space, while at the periphery of the nucleus is a large and conspicuous nucleolus (plasmasome). The cytoplasm is faintly granular. The secondary spermatocytes make up cell masses similar to those of the primary spermatocytes, differing from the latter only in the size and number of the component cells. The cell masses of which the spermatids are composed, however, present a very different appearance, (Fig. 4). The nuclei, although now much reduced in size, still show the closely packed ball of chromatin granules and the prominent nucleolus characteristic of the two former stages, and have also

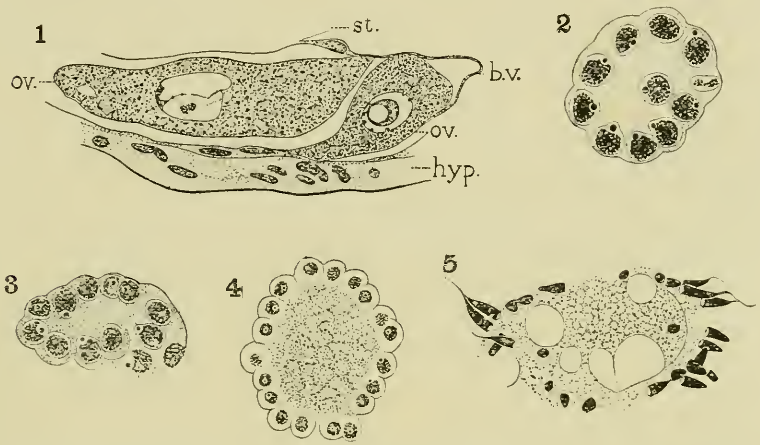


Fig. 1. Portion of a cross-section through seventh segment, two ova (ov.), lying between the stomach wall (st.), and the ventral hypodermis (hyp.); Fig. 2, primary spermatocytes; Fig. 3, secondary spermatocytes; Fig. 4, spermatids; Fig. 5, spermatozoa. Fig. 1, x 770; Figs. 2–5, x 1050.

maintained their position at the periphery of the cell mass. Each nucleus is now surrounded by an area of clear cytoplasm, the clear areas of the different cells being contigous, so that the cell mass is divided into an external zone of clear and transparent cytoplasm, within which is a mass of darkly granular cytoplasm, which already shows signs of vacuolization. This latter mass, of course, represents the inner ends of the spermatids. Between the spermatids and the ripe spermatozoa, no intermediate stages were found. The spermatozoa, (Fig. 5), consist of a long fusiform chromatic portion, which no doubt represents the spermatid nucleus, and which tapers posteriorly to join with a slender tail, composed of clear cytoplasm. The anterior end of the chromatic portion is sharply truncate, and somewhat concave. In this concavity lies the biconcave, clear, apical body. The spermatozoa surround a mass of protoplasm, within which their heads are buried. This mass, greatly vacuolated, and clearly in process of degeneration, represents the granular mass formed by the central ends of the spermatids. Thus only a slight portion of the original cytoplasm takes part in the formation of the spermatozoan, by far the larger portion being cast aside. It is, of course, possible that this mass may serve for a time to nourish the spermatozoa, although it would seem likely that the blood lymph contained in the coelom would suffice to perform that function.

In the maturation of the male germ cells one point is especially noteworthy, namely, the appearance of a large nucleolus in the spermatocytes of both orders and in the spermatids. With but rare exceptions, throughout the animal kingdom the maturation divisions occur without the intervention of even a brief resting stage. The formation of a nucleolus, then, of such a considerable size in comparison with the cell size is remarkable in indicating the occurrence of a long resting stage between the two maturation divisions, and also a long pause before the metamorphosis of the spermatid into the spermatozoon.

With respect to the sexual reproduction of *Aelosoma* several questions arise, which are still unanswered. For example, it is important to discover what factors determine the occurrence of sexual reproduction; whether due to changes in temperature, food supply, or to some other cause; the breeding habits should be carefully studied, and the complete history of the sex cells recorded. Species of *Aelosoma* are found abundantly in our inland ponds and streams, and are easily kept in aquaria throughout the year, I hope these facts may stimulate some one to the further investigation of the life history of this beautiful form.

A PRELIMINARY REPORT ON THE MOSQUITOES OF OHIO.*

A. F. Burgess.

Since it was positively demonstrated that mosquitoes are the means of communicating yellow fever and malaria, many investigators have given attention to collecting, studying and describing these insects; hence, during the past five years rapid strides have been made in our knowledge concerning this interesting family.

In the catalog of North American Diptera, published by Mr. J. M. Aldrich, in 1905, thirty genera, containing one hundred and sixty-five species of Culicidae, are listed. Some of these species are tropical or sub-tropical forms which do not occur in northern latitudes.

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* Read at the meeting of the Ohio St. Acad. of Sci., Cincinnati, Dec. 2, 1905.

Several states have undertaken special investigations of the mosquito problem, and as a result Dr. Felt reports fifty species as occurring in New York and the adjoining states. Dr. J. B. Smith has found forty-two species in New Jersey, and Dr. Dupree has collected thirty-seven species in Louisiana.

Doubtless some of the species found in these states do not occur in Ohio, as they are either inhabitants of a warmer climate, or breed in salt or brackish water found along or near the sea coast.

It is the object of this paper to list the species that have been collected in this state, giving the localities where they were taken and the dates the captures were made, and it is hoped that sufficient interest may be aroused in the subject so that further investigations may be made of this important family.

Some collecting was undertaken by the writer at spare moments during the past summer, but this resulted in the collection of only a few species. The accompanying list represents the record of the material in the collection of the Entomological Department of the Ohio State University, which has been placed at my disposal through the courtesy of Profs. Osborn and Hine; and the assistance received from the latter has made it possible to prepare this report. Records of specimens are also included, which were collected by Mr. W. E. Evans, a student in Entomology at the Ohio State University, and credit is given in each case. I am also indebted to Dr. L. O. Howard, Entomologist to the United States Department of Agriculture, for having placed at my disposal the notes in his office on species received from Ohio, and to Mr. D. W. Coquillett for determining many of the species in the following list:

Anopheles maculipennis Meigen. Sandusky, (Cedar Point) July 8, 1903. (Hine).

Anopheles punctipennis Say. Columbus, September 8, 1898. July 13, 1898. October 12, 1900. March 9, 1903. (Hine).

Megarhinus portoricensis Roeder. Portsmouth, September 9, 1897. (Hine).

Toxorhychites rutilus Coq. Cincinnati, August 27, 1902. (Dury).

Janthinosoma musica Say. Vinton, June 5–12, 1900. (Hine).

Psorophora ciliata Fabr. Medina, June 10, 1899. Sandusky (Cedar Point), August 7, 1902. Wauseon, September 5, 1903. Akron, June 16, (Hine).

Culex canadensis Theobald. Medina, July 19, 1898. Vinton, June 6–12, 1900. (Hine).

Culex cantans Meigen. Sugar Grove, May 25, 1901. Medina, June 16. Columbus, May 14. Sandusky (Cedar Point), July 23, 1903. London, June 23, 1904. (Hine).

Culex confinis Arrib. Sandusky (Cedar Point), July 27, 1905. (W. E. Evans).

Culex consobrinus Desvoidy. Columbus, October 23, 1905. (W. E. Evans)

Culex pipiens Linn. Columbus, March 16, 1898. October 12, 1900. (Hine). Cincinnati, September 13, 1905. (Burgess). Dayton, October 4, 1905. (E. C. Cotton). Columbus, November 20, 1905. (Burgess).

Culex restuans Theobald. Vinton, June 5, 1900. (Hine).
Culex sylvestris Theobald. Wauseon, September 5, 1903. (Hine). Sandusky (Cedar Point), July 27, 1905. (W. E. Evans). Hooker, September 5, 1905. (Cotton). Dayton, September 27, 1905. (Burgess).
Culex triseriatus Say. Medina, July 7, 1898. Vinton, June 5–12, 1900. (Hine). Cincinnati, August 2–8, 1905. (Dury).
Culex trivittatus Coq. Ft. Ancient, June 10–12, 1902. (Hine).
Taeniorhynchus perturbans Walk. Sandusky (Cedar Point), July 23, 1903. (Hine).
Aedes smithii Coq. Cleveland. (Reported by Howard.)

It will be observed that seventeen species have thus far been captured in Ohio. The most interesting among them, from an economic standpoint, are Anopheles maculipennis, which was taken at Sandusky, July 8th, 1903, and A. punctipennis, which has been taken at Columbus in March, July, September and October of various years, as they are the probable agents for the distribution of malaria.

Aside from the biting propensities of many species of mosquitoes, which cause annoyance and render some localities well nigh uninhabitable at certain seasons of the year, the knowledge that these two species are present in the state is very important. Although malaria is not considered a fatal disease, it caused sixty-eight deaths in the state during the year 1903, and doubtless this number represents only a small percentage of the persons who suffered from its enervating effects.

From the fact that one of the species listed, namely, Culex confinis, was first collected and described in South America, but was taken this summer at Sandusky, and further that the yellow fever mosquito (Stegomyia fasciata) was collected at Louisville, Ky., in October, 1903, by Dr. T. B. Berry, and has been found during the present year at Evansville, Ind., and Lexington, Ky., it is evident that some of the species of this family have a wide range of distribution

It would appear possible for the latter species to be carried by boats from southern ports to almost any Ohio river town. Our knowledge of the distribution of this and other species is at present imperfect, and many points concerning the habits, life history and hibernation must be investigated if the problem is to be dealt with in an intelligent manner.

Neglect to obtain positive knowledge may at some future time result in loss of life, as well as seriously injure the business interest of localities involved; hence it would appear that no time should be lost in carefully and thoroughly investigating the problem.

Columbus, Ohio.

ANNUAL REPORT ON THE STATE HERBARIUM FOR THE YEARS 1903, '04, AND '05.*

W. A. Kellerman, H. H. York, and H. A. Gleason.

No report of the progress of the State Herbarium has been published since January, 1904. During this time it has grown steadily and improved both in size and usefulness. Botanists throughout the state have shown an interest in it, and have aided in its development by sending specimens. Of especial value are the donations of L. D. Stair and S. E. Horlacher, the former including a fine series from Cuyahoga County, with a number of species new to the state flora, and the latter covering a number of counties in the southwestern part of the state and likewise containing several unreported species.

Following the usual custom, a list is appended of the collectors and of the number of specimens contributed by each.

Aiken, W. H.	1	Mark, Clara G.	2
Billups, A. C.	1	Sanders, E. A.	1
Brockett, Ruth E.	1	Sanders, J. G.	7
Brown, G. J.	1	Schaffner, J. H.	3
Bryant, F. B.	3	Sharp, Mrs. K. D.	33
Coventry, E. J.	16	Shull, G. H.	2
Edgerton, L. B.	2	Stair, L. D.	367
Hacker, O.	1	Tangeman, Clara M.	1
Hard, M. E.	3	True, H. L.	1
Herzer, H.	15	Webb, R. J., and Rood, A. N.	2
Hopkins, L. S.	74	Wetzstein, A.	2
Horlacher, S. E.	823	Williams, T. D.	1
Jennings, O. E.	216	Wilkinson, E.	7
Kellerman, W. A.	93	Young, C. H.	1
Lantz, E. F.	1		
Lazenby, W. R.	1	Total	1692

The following species have been added to the state flora:

The following species have been added to the state flora:

36a. **Asplenium ebenoides** R. R. Scott. Hocking County, W. A. Kellerman and K. F. Kellerman.

36b. **Asplenium parvulum** Mart. and Gal. Adams County, W. A. Kellerman. Reported in Ohio Naturalist 5:206.

60.a **Lycopodium porophilum** Lloyd and Underw. Fairfield County, J. H. Schaffner.

131a. **Panicum implicatum** Scribn. Cuyahoga County, L. D. Stair.

196a. **Agrostis asperifolia** Trin. Cuyahoga County, L. D. Stair.

212c. **Beckmannia erucaeformis** (L.) Host. Cuyahoga County, L. D. Stair.

255a. **Festuca capillata** Lam. Cuyahoga County, L. D. Stair.

265a. **Bromus brizaeformis** Fisch. and Mey. Cuyahoga County, L. D. Stair.

265c. **Bromus arvensis** L. Cuyahoga County. L. D. Stair.

274a. **Elymus hirsutiglumis** Scribn, and Sm. Ottawa County, J. H. Schaffner; also in Huron County.

* Presented at the Ohio St. Acad. of Sci., Cincinnati meeting, Dec. 2, 1905.

460a. **Carex tenuis interjecta** (Bailey) Britt. Cuyahoga County, L. D. Stair.
376a. **Carex alata ferruginea** Fernald. Madison County, W. A. Kellerman
472b. **Mayaca aubleti** Michx. Auglaize County, A. Wetzstein.
477a. **Tradescantia reflexa** Raf. Auglaize County, A. Wetzstein.
547a. **Smilax pulverulenta** Michx. Montgomery County, S. E. Horlacher.
627a. **Salix babylonica** L. X **fragilis** L. Erie County, R. F. Griggs.
715a. **Polygonum punctatum leptostachyum** (Meisn.) Small. Auglaize County, A. Wetzstein.
755a. **Gomphrena globosa** L. Wood County, W. A. Kellerman.
757b. **Allionia nyctaginea ovata** (Pursh) Morong. Green County, S. E. Horlacher.
877a. **Bocconia cordata** Willd. Madison County, Mrs. K. D. Sharp.
963a. **Philadelphus grandiflorus** Willd. Auglaize County, A. Wetzstein.
1033a. **Aronia atropurpurea** Britton. Licking County, W. A. Kellerman.
1037a. **Crataegus wilkinsoni** Ashe. Richland County, E. Wilkinson.
1037b. **Crataegus decens** Ashe. Richland County, E. Wilkinson.
1037c. **Crataegus habilis** Ashe. Richland County, E. Wilkinson.
1037d. **Crataegus macgeeae** Ashe. Richland County, E. Wilkinson.
1037e. **Crataegus tenuifolia** Ashe. Richland County, E. Wilkinson.
1037f. **Crataegus exigua** Ashe. Richland County, E. Wilkinson.
1037g. **Crataegus prona** Ashe. Richland County, E. Wilkinson.
1058a. **Cassia medsgeri** Shafer. Reported from several counties, OHIO NATURALIST 5:264.
1147a. **Linum medium** (Planch.) Britt. Erie County, E. L. Moseley.
1242a. **Hypericum virgatum** Lam. Jackson County, W. A. Kellerman.
1243a. **Hypericum subpetiolatum** Bickn. Reported from twenty-four counties. Heretofore confused with H. maculatum.
1245a. **Hypericum boreale** (Britton) Bicknell. Defiance County, E. L. Fullmer; Geauga County, O. E. Jennings.
1303a. **Kneiffia fruticosa pilosella** (Raf.) Britton. Cuyahoga County, L. D. Stair.
1417a. **Fraxinus biltmoreana** Beadle. Erie County, W. A. Kellerman; Hamilton County, Walter Aiken.
1561a. **Monarda mollis** L. Miami County, S. E. Horlacher; also in Cuyahoga County, L. D. Stair, and Erie County, W. A. Kellerman and F. J. Tyler.
1615a. **Scrophularia leporella** Bicknell. Cuyahoga County, L. D. Stair.
1628a. **Synthyris bullii** (Eaton) Barnh. Montgomery County, H. Grenen.
1650b. **Gerardia tenufolia asperula** Gray. Green County, S. E. Horlacher.
1699a. **Galium claytoni** Michx. Champaign County, J. H. Schaffner, O. E. Jennings, and F. J. Tyler.
1755a. **Cichorium intybus divaricatum** DC. Montgomery County, S. E. Horlacher.
1794a. **Xanthium commune** Britton. Erie County, E. O. Jennings.
1794b. **Xanthium glabratum** (DC.) Britton. Franklin County, O. E. Jennings.
1811a. **Lacinaria punctata** (Hook.) Kuntze. Franklin County, J. H. Schaffner.
1834a. **Solidago juncea scabrella** (T. and G.) Gray. Erie County, E. L. Moseley.
1893a. **Aster lateriflorus horizontalis** (Desf.) Burgess. Cuyahoga County, L. D. Stair; Madison County, Mrs. K. D. Sharp.
1963a. **Bidens elliptica** (Wiegand) Gleason. Common throughout the state.
1967a. **Bidens vulgata** Greene. Throughout the state.
2008a. **Arctium tomentosum** (Lam.) Schk. Erie County, J. H. Schaffner; Huron County, H. H. York.

HOW TO COLLECT STYLOPIDAE.*

CHARLES DURY.

It is well known to entomologists that many genera of wasps, bees and insects of other orders, are at times affected with parasites which live in their abdominal cavities. In the genera *Xenos* and *Stylops*, the adult female is larvaform and never leaves the body of the host, but the male when ready to pupate projects the end of the pupa case outwards, between the segments, where it can easily be seen protruding. By examining wasps and bees when they frequent flowers, it can readily be observed as to whether or not they are parasitized. The female *Xenos* can be distinguished from the male by the broad flat projecting head. The male pupa case is rounder and separates the segments to a greater extent. When a wasp is found with male pupa, it may be secured and brought home alive. Confine it in a jelly tumbler with a cheese cloth cover over the top; in the bottom of the glass there should be placed a round bit of blotting paper and a piece of screen wire, raised up from the bottom. This is necessary because the instant the *Xenos* hatches the wasp rushes after it, in an endeavor to catch, kill and bite it to pieces, an example of an interesting instinct. The movements of the *Xenos* are so rapid, that the wasp can not catch it until it falls exhausted in the bottom of the glass. By having the false bottom of wire, the *Xenos* falls through, the wasp not being able to follow, and the specimen can thus be secured. The wasp while confined in the glass must be fed. This may be done with jelly and water, putting it on the cheese cloth cover in one small spot, with a camel's hair brush. Many fine specimens have been hatched by the writer in this way, from five genera of wasps, several of which are new host wasps, and the facts and species obtained are entirely new to science. There are yet some interesting problems in the life history of these curious insects that are unknown. In looking through some of the largest and finest collections of insects recently at Washington and New York, only a few poor specimens in this family were found while in some otherwise valuable collections they are not even represented. In view of a monograph of these insects in course of preparation by W. D. Pierce, the publication of which will occur soon, material from all parts of the country is very much desired.

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* Presented at the Ohio St. Acad. of Sci., Cincinnati meeting, Dec. 1, 1905.

SOME NOTES ON MARTYNIA.

V. Sterki.

During the summers of 1904 and '05, I made a series of observations on some plants of Martynia proboscidea, and a few notes may not be without interest. The seeds sprout very slowly, whether wintered in the ground or indoors. Some sown in April and early May did not come up until the middle of June and the first part of July. It seems that the seeds require a rather high temperature. In fairly rich soil the plants grow to a diameter of from four to six feet, while on poor soil and in the shade they remain quite small.

The leaves, at first opposite, gradually become more and more scattered on branches of the second, third, etc., orders. They are decidedly dimorphous; those standing above and below on the branches are typically symmetrical and comparatively wider, while those at the sides are narrower and asymmetrical, especially at the base, the proximal part being longer than the distal and more or less incurved.

The plants are decidedly heliotropic. While still quite young and only a few inches high, they are inclined towards the East in the morning and towards the West in the evening. When they grow larger, the leaves take a conspicuous part in the movements. Those standing towards the East and West raise and lower their blades, while those directed North and South turn on their petioles. It was especially noted that even on cloudy mornings, at dawn, when the eye could hardly distinguish a difference of light between East and West, the plants were decidedly inclined towards the East.

All parts of the plant, except the inner surface of the deeper part of the corolla tube and of the calyx, are densely beset with glandular hairs containing a viscid fluid on which hundreds of small insects are caught. It is a question as to whether they are assimilated as food.

Frost kills the plants and they soon decay or become dry. But the immature fruits remain green and fresh for one to several weeks if protected from severe frosts. There is no doubt that the thick fleshy husk has an important part to play in the ripening of the seed.

The most interesting variations occur in the flower. Normally the calyx is split down to the pedicel or nearly so, on the inferior side, with five lobes, the upper, median lobe being the longest. The corolla, large and showy on strong plants, 50–65 mm. long and of about the same diameter, has normally five lobes, two upper ones which are the equivalent of an upper lip, one on each side, and one lower which is broader than the others and of somewhat different shape. Along the inferior side of the corolla tube and extending into the inferior lobe is a group of usually five orange colored stripes, which I call the "lyra." The stamens are four, in two pairs, arranged so that the four large anthers are contiguous in two pairs and adjacent to the upper arch of the corolla. There is also an upper median, short stamen-vestige, usually somewhat bent to the right or left. These well known details are given for a better understanding of the variations noted below:

1. Small, more or less abortive, flowers appear late in Sept. and Oct.; but it is remarkable that such were from the first on the same spike with and among large, perfect flowers, without intermediate forms. Later with cooler weather and slow growth they became numerous. The corolla was only 20–30 mm. long and the lobes, always of the normal number, were quite small and not at all or little spread out. The colors were paler than in the large flowers. The stamens were nearly straight or irregularly curved, isolated and not joining above and the anthers were small, pale, more or less abortive, yet usually bearing some pollen. The vestigial stamen was always present and the calyx of the usual shape but comparatively somewhat larger than the corolla. At least part of the flowers were fructescent, as the ovularies grew so far as the weather permitted. The bumble bees are regular visitors of the flowers and the latter may have been pollinated from the large perfect flowers.

2. In some cases there is only one upper lobe of the corolla and not a trace of the stamen vestige; otherwise corolla, stamens, and calyx are normal. Over a dozen such flowers were seen on a few plants during 1905.

3. One flower, observed Aug. 31, 1905, was very abnormal. There were four corolla lobes, apparently an upper, lower, and two lateral, yet the whole upper part of the corolla appeared to be wanting. The lower part had the usual "lyra" and the right and left sides and lobes each with faint lyra markings. There were four stamens spreading and curving about irregularly with the anthers arranged T-shape on the filaments rather than lengthwise. There was no trace of an upper stamen vestige. The calyx was divided irregularly into two parts down to the pedicel, a smaller portion consisting of one lobe on the right, upper side and a larger one with three somewhat rudimentary lobes. The fruit resulting from this flower is also abnormal; the pod is straight, of the same formation above and below; the projecting crest on the upper side is wanting; both halves of the beak are curved to the left.

4. In some otherwise normal flowers, the upper stamen vestige grows to one-third and even to fully the length of the other stamens, and has a more or less well developed anther sometimes even with some pollen.

5. Flowers having the corolla of the usual size with two lateral lobes on the right or left side and three stamens on the same side. Either the upper or the intermediate stamen seems to be the additional one of the three. In a flower with two corolla lobes and three stamens on the right side, the intermediate one was evidently additional, being only half as long as the others and with a rudimentary anther. In all of these flowers the usual upper stamen vestige was present and the calyx normal. In the descriptions "right and left" refer to the flower and not to the observer.

6. One flower, with two corolla lobes and three stamens on the right side, had the left lobe distinctly but not deeply incised in the middle and there was no trace of a third stamen.

7. One flower of good size had two lateral corolla lobes and three stamens on the left side and one lobe with two stamens on the right. The upper lobes were separated by only a slight but distinct incision and the stamen vestige was wanting. The calyx was closed below and had an additional lower median lobe.

8. A flower with two lateral lobes and three stamens on each side. In this case the stamen vestige was present and the calyx normal.

9. A type of flower with the lower lobe of the corolla double, and two well formed "lyras". One additional, median stamen was developed below. This sometimes curved upward to join the cluster of the other anthers, or in some flowers it was directed nearly straight forward. The upper vestige was present and the calyx was closed below and contained a sixth median, inferior lobe. In 1904 two such flowers were seen and in 1905 at least one developed a normal two-parted fruit.

10. One flower with the same peculiarities as those mentioned under 8, but the left lower lobe and the left lyra were not fully developed. The lower, median stamen filament was adnate to the corolla its entire length, as also the lower half of the anther, but the other half was standing out free.

11. One flower with two lower lobes and two "lyras"; two lateral lobes on the left side and one on the right; with stamens to correspond, three on the left and two on the right and one inferior, median stamen. The calyx was entire and had an additional, inferior, median lobe as in No. 8.

12. One flower of normal size with two inferior lobes and two "lyras." The lateral lobes were present but were separated from the inferior lobe by incisions less distinct than usual. There were three stamens, the upper pair and one inferior median stamen longer than the two others. There was no trace of the inférior pair but the vestigial stamen appeared as usual, and the calyx was the same as in No. 8.

In all the normal and abnormal flowers the style was of the same form except that it was smaller in the defective flowers mentioned in No. 1. All the abnormal flowers were found on large strong plants, while the flowers on smaller plants growing in poorer soil were all normal, although numerous and of fair size,

Martynia seems to be a plant peculiarly adapted for studies in variation and peculiar forms of flowers, and it would be very desirable to have some person take up the subject further.

New Philadelphia.

CLASSIFICATION AND MAPPING OF THE LOWER ORDOVICIAN IN KENTUCKY.*

A. M. Miller.

The paper presented the results of the operations of the New Kentucky Geological Survey as they relate to the Lower Ordovician.

Highbridge is accepted from the Richmond Folio as a saitsfacotry name for the "Kentucky River Limestones" known in the Old Kentucky Survey Reports as Chazy and Birdseye. Camp Nelson, Oregon and Tyrone are proposed as names for what were formerly known as Chazy, Kentucky River Marble, and Birdseye Proper respectively. Lexington is also accepted from the Richmond Folio, and is divided in ascending order into Curdsville, Logana, Wilmore, Paris and Perryville, the latter being Linney's "Upper Birdseye."

Flannagan Chert of the Richmond Folio, as the name for a persistent horizon, is dropped. It has been found to truncate beds lying in and just above the Upper Paris where there have been brought to the surface under the influence of slow atmospheric weathering.

Near the summit of the culminating point of the Cincinnati Anticline in Central Kentucky (Jessamine Dome) this horizon is marked by an abundance of phosphate, in some cases rich enough to invite an attempt to exploit for commercial purposes. This deposit is identified as the geological equivalent of the Mt. Pleasant Phosphate of Tenn.

Winchester is accepted from the Folio referred to above, as the name for the formation coming next above the Lexington, and an attempt is made to assign to it more definite limits than heretofore. A wave marked crinoidal limestone, carrying in northern situations Trinucleus concentricus, is taken as the upper limit of the Winchester. The fauna of the Winchester is found to possess strong Cincinnatian affinities and is accordingly

* Abstract of paper read Dec. 2, Cincinnati, Ohio St. Acad. of Sci.

grouped in with this division of the Ordovician as its basal member.

Eden is accepted from Orton's Report on the Lower Silurian published in Vol. I of the Ohio Geological Survey 1873, as the name for the 250 feet of shale series which surmounts the Winchester. Southward it is found to be thinner, aggregating perhaps 200 feet and with a well prounonced sandstone ("Siliceous Mudstone" of the older Kentucky Survey Reports) in the upper part. The name Garrard is retained from the Richmond Folio for this portion, and Million, a name proposed by Foerste, is accepted for the remainder. The Eden is found to be a very widespread formation in Central Kentucky, with its outcrop everywhere marked by the same topographic features. It disstecs into very steep slopes, which, under the influence of cultivation soon wash bare of soil.

As regards economic features: The Highbridge yields excellent building stones. The Lexington is traversed by lead and zinc mineral veins, which have as their most common gangue, barite, shows phosphate and furnishes soil which is the "Blue Grass" par excellence. The Winchester furnishes grazing lands scarcely inferior. The Eden, however, is found to furnish soils which wear out rapidly under the influence of cultivation, and its outcrop is found to mark a poor strip of country between areas that are rich.

A NEW CASE OF MUTATION.*

FRED. J. HILLIG.

The origin of two varieties of Commelina nudiflora L. by mutation has been observed by the writer. The new varieties differ from the parent plant in the color of the sepals and stamens. The flowers of one variety are white, of the other, purple, while the color of the parent plant is blue. Minor differences have also been observed. The change was sudden and persisted through subsequent generations without a single exception. The group of individuals from which the mutated forms originated comprises about half a million plants and can be traced back for 12 generations. The white and purple varieties occur in European gardens, but their origin from the blue variety had not been observed heretofore. Commelina nudiflora produces a great number of other forms differing from the systematic species in many ways, such as size of plant, form of leaf, number of petals, etc. No effort has as yet been made to decide whether these divergent forms remain constant. Prof. Hugo de Vries in a letter to the writer recommended a careful study of this valuable material.

* Presented at the Cincinnati meeting, Ohio St. Acad. of Sci., Dec. 1, 1905.

A FEW GENERAL NOTES AND REMARKS WITH RESPECT TO THE LAND AND FRESH WATER MOLLUSCA.*

V. Sterki.

A friend of mine, lover and observer of nature, has told me repeatedly that "forty or fifty years ago, snails were plenty, large and beautiful; now you hardly ever see any." Even during the last 22 years (of my collecting), I have noticed a change for the worse. Several species and forms have disappeared at certain places, or become scarcer. The same is true, probably, over most of the state. Owing to deforestation and cultivation, the sheltering places have become more scarce and, what counts more, the atmosphere as well as the soil is less humid and is unsuitable for a large part of molluscan life. (It may be mentioned that the same man states that e. g. "huckleberries" have become scarcer and smaller.)

Still worse is it with fresh water mollusca. Springs are disappearing, runs and creeks are dry during a large part of the summer, rivers come to their lowest stages, when sun-heat kills the animals even where still under a few inches of water, which in itself becomes of poor quality. At many places the banks are denuded of trees and undergrowth, and protection from shade is cut off.

Another factor towards the same end, is the unrestricted discharge of all kinds of refuse and contamination from factories and towns into the rivers and creeks, doubly detrimental with low water. Mr. Geo. H. Clapp has stated, some years ago, that for eighty miles below Pittsburg, hardly a living mussel, or other mollusk could be found in the Ohio River. The same conditions I found at Wheeling: the bottom was covered with a muddy, ferruginous deposit; a very few dead mussel shells of depauperate form were found, but not a living animal or plant. Destruction of life in our "great and beatuiful river" will go on and on, if radical measures are not resorted to for "amendment." Some other rivers, or parts of them, are still in a better condition, but almost everywhere the effects of the causes mentioned are noticeable and becoming more so from year to year. As an example on a smaller scale, I cite the eastern branch of the Tuscarawas river, running southeast to Warwick: it is a dreary, black, barren mud-ditch, in which no fish or other animal can live, owing to the refuse of factories, principally at Barberton.

Students of other groups of animals have, no doubt, to tell the same tale, especially the ichthyologists. The wealth of fish which was in our rivers, and still might be in a large measure, is

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* Presented before the Cincinnati meeting, Ohio St. Acad. of Sci., Dec. 2, 1905.

disappearing. And last, but not least, the influence on general health is a grave consideration.

But to come back to mollusks. Of late years, the shell and pearl hunters have come, and killed our mussels, where there still were any, by the millions, in rivers and creeks. In many places they have been nearly exterminated, and only the naturalists deplore the fact.

What can we do? When Hebra, the great dermatologist at the University of Vienna, presenting to his students a peculiarly malignant case of a skin disease, asked the practicing student what could be done for the patient, and the young doctor could only shake his head and stand silent, "well, we will have him photographed," Professor Hebra would say. This is about our position. In the first place, we can record the fact, and deplore it. In the second place, we can take a careful inventory of what is still left. And that we should do, energetically: work up the muollsca in the rivers, creeks, springs, swamps, in the forests and copses left, and have them in our records and collections, for future generations to look at. In the third place, we might find some creek here or there, or part of such, preserve it in as natural conditions as possible, eventually with additional ponds, and try to preserve in it, and on its banks, such mollusks as are threatened with extermination. This sounds utterly fantastic! and yet the time may come when such a plan may be considered.

And in the fourth place, and above all, let us unite forces with government officials, and anybody who will try to put an end to the reckless deforestation of our land, and the reckless contamination of our waters with factory and city refuse. Already it is much too late, but still much can be accomplished. I believe it is not below the dignity of the Academy and its members to direct their attention to these eminently important tasks and to do all in their power to promote them.

I know well that I go far beyond my scope with these last remarks, but these matters were so much no my mind that I could not help at least touching them, and I hope to be excused for doing so, even if the topic "mollusks" is only incidental to them.

ADDITIONAL OBSERVATIONS ON SELF-PRUNING.

John H. Schaffner.

In 1901, Mr. Tyler and the writer published some notes, in The Ohio Naturalist, on the self-pruning habits of a considerable number of trees and shrubs. The list has been extended from time to time by the writer, the work being confined necessarily to the common woody plants of our region. It is gratifying to note that one can occasionally find reference to this curious habit in the recent textbooks. There are few subjects better suited to arouse the interest and curiosity of the student.

In 1903, O. F. Cook described the striking self-pruning habit of the temporary and permanent branches of Castilla, the Central American rubber tree (Bull. No. 49, Bureau of Plant Industry, U. S. Dept. of Agr.) Plates X and XI are fine representations of self-pruned branches. Recently the writer was enabled to examine such branches brought by Prof. Hine from Guatemala. The development of temporary branches with a special arrangement for their removal is of unusual interest because of the economic value of these rubber trees.

The following common trees and shrubs have also been studied for self-pruning:

Acer pseudo-platanus L. Self-prunes small twigs and buds by means of a basal joint.

Sambucus canadensis L. Unripe ends of the branches are pruned off by cleavage planes developed in the upper leaf nodes. Sometimes the tips of all the branches of an individual are self-pruned, making a very peculiar appearance in the winter.

Sambucus pubens Mx. Self-prunes in the same way as the preceding.

Chionanthus virginica L. Self-prunes the leafy, fruiting panicles like the hackberry and choke cherry.

Diospyros virginiana L. This tree has an imperfect method of self-pruning by which large numbers of small twigs are cut off.

Lepargyraea canadensis (L.) Greene. Self-prunes small twigs by means of basal joints.

Ulmus alata Mx. This tree produces cleavage planes in basal joints and in the annual nodes produced by the winter buds, like the white and cork elms.

MEETINGS OF THE BIOLOGICAL CLUB.

ORTON HALL, OCT. 2, '05.

The meeting was called to order by Pres. Hine. The minutes of the last meeting were read and approved. On the motion of Prof. Schaffner the president appointed Z. P. Metcalf secretary pro tem. Pres. Hine then appointed Prof. Hambleton, Miss Wilson and Miss Riddle as a committee to nominate officers for the ensuing year.

As this was the first meeting of the year it was given over to reports by the members on their summer's work.

Prof. Schaffner spent the major part of his summer in Kansas studying the Myxomycetes. Some time was spent on the oaks of eastern Kansas. Prof. Schaffner also reported the results of his studies of the reduction division in the anthers of the Tiger Lily.

Prof. Landacre gave some observations that he had made on the nesting habits of the common catfish. The main part of the summer was given over to a study of the development of the sense organs of the catfish, especially the taste buds.

Mr. Griggs was at the Minnesota biological station on the southern coast of Vancouver's Island during the summer. Most of his time was spent in studying the Kelps of that region.

Mr. Hyde assisted Prof. Bownocker in mapping the Pittsburg and Meigs Creek coals during the fore part of the summer. During the latter part of the summer he worked on the Logan and Black Hand formations about Lancaster.

Miss Burr made a collecting trip through California. Miss Burr botanized especially on Mt. Lowe and the San Jacinto Mountains in Southern California.

Mr. William Moynan was elected to membership.

The club then adjourned.

Orton Hall, Nov. 6, 1905.

The meeting was called to order by Pres. Hine. The minutes of the last meeting were read and approved.

Prof. Hambleton, as chairman of the committee on nominations of officers, reported the following names: President, Robert F. Griggs; Vice President, Opal I. Tillman; Secretary and Treasurer, Zeno P. Metcalf.

On the motion of Prof. Osborn the report of the committee was adopted.

Mr. Griggs then took the chair.

On the motion of Prof. Osborn the Secretary was instructed to invite the Ohio State Academy of Science to hold its next meeting in Columbus.

The President's annual address was given by Prof. Hine on the "Economic Value of the Mosquito."

Prof. Hambleton reported the discovery of Puccinia malvacearum in an active growing condition as late as October 21st.

Mr. Griggs reported his work on the material collected in the western United States. A new genus of Kelps has been established. The type specimen for the genus is also new. The genus is a primitive one and is interesting, therefore, from an evolutionary standpoint.

Mr. C. W. McClure was elected to membership.

The club then adjourned.

Z. P. Metcalf, *Secretary.*

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NOTES ON THE FALL WEBWORM (HYPHANTRIA CUNEA) IN OHIO.*

E. W. BERGER.

The majority of the observations upon which this paper is based were made at Cedar Point, Sandusky, Ohio, during the past summer while the writer was at the Lake Laboratory of the Ohio State University. The webs of this caterpillar were abundant on all sides and those who had spent preceding summers at Cedar Point were under the impression that the Webworm was on the increase. After a few days of casual observation it was decided to make a more careful study of its habits, and, if possible, to determine whether it is double brooded at that place.

While a few specimens pupated in the laboratory during the latter part of July, none of them transformed into adults, and no positive results were obtained in regard to a possible second brood.

Acknowledgment is due Professor Osborn for his interest and generosity with valuable suggestions and facilities placed at the writer's command.

Food Plants.—The worms were observed upon the following trees: Walnut (*Juglans nigra* L.), Choke-cherry (*Prunus virginiana* L.), Common Wild Black Cherry (*Prunus serotina* Ehr), Willow (*Salix* sp.), Elm (*Ulmus americana* L), Box-wood (*Cornus florida* L), Hackberry (*Celtis occidentalis* L), and Wild Grape

* Abstract of paper read December 2. Cincinnati, Ohio State Acad. of Sci.

(*Vitis vulpina* L). The webs were abundant everywhere upon the choke-cherry and the common wild black cherry, some trees of the latter kind having nearly half of their foliage destroyed. Willows were also nearly always populated by a few or many broods. The few walnut trees were literally defoliated, and this will be the subject of the next topic. Elm, box-wood and hackberry were frequently infested but never to the same extent as the previously named trees. In only two instances did I observe the worms feeding upon the wild grape, and then only when the grape leaves grew in among the leaves of willow and choke-cherry. I did not observe a single instance of the worms feeding upon the poplars at the Point. This is quite at variance with other observations in which poplars of all kinds were generally much infested. Thus, in Riley's report upon the Webworm in Washington in 1886 ("Our Shade Trees and Their Insect Defoliators") *Populus balsamifera* L) and *P. tremuloides* Mx. are named among the trees that suffered most. Both these poplars occur at Cedar Point but no webs were observed upon them.

Following I give the first five trees named in Riley's list of 108 food plants for Washington. These are arranged according to the damage suffered. *Negundo aceroides* Moench (Box Elder), *Populus alba* L (European White Poplar), *P. monilifera* Aiton (Cottonwood), *P. balsamifera* L (Balsam Poplar).

The same report further states that poplars, cottonwoods and the ranker growing willows were the principal subjects of attack in 1886 in New England.

Of the species of trees attacked at Cedar Point, four, walnut, wild black cherry, choke-cherry and willow appeared to be the favorite food of the worms, and these are respectively 41, 75 and 14, in Riley's list. (The common wild cherry is not named in his list, and its place among the above figures is indicated by a question mark.) Again, of all the species of plants named by Riley forty-two genera and about twenty-six species are found at Cedar Point; but of these only eight were observed to be used as food by the worms.

Throughout the State generally, so far as my limited observations extend, and from a few other reports, the common wild black cherry is the tree most generally attacked; but walnut, elm, hickory, pear, apple, sugar and silver maple, all suffer more or less. Of these, walnuts, when attacked suffer most, as the following topic will show; and Mr. Cotton, Assistant Inspector of Orchards and Nurseries, has informed me of similar conditions in other parts of the State.

The following observation is interesting as it shows the discrimination with which the female moth selects the food plants upon which she deposits her eggs. One day I observed a web upon a hedge of osage orange, at Berea, Ohio. Closer investigation, however, revealed the fact that the web was not upon the osage orange at all, but upon a small wild cherry tree that grew in the hedge and which had escaped my notice.

Walnut Trees.—Only a few walnut trees exist at the Point, but the worms played havoc with these, while of all the great abundance of choke-cherry, only two instances were noted where the infection was at all so extensive. A clump of five walnut trees (each about six inches in diameter), became literally defoliated and about 150 nests were counted upon them. I have observed, however, that the number of webs does not necessarily indicate the number of broods, since a large brood may desert its old nest, and build a new one, or divide and form two new nests. (I use "nest" to distinguish the denser part of the web. See also *Other Observations*.)

When food became scarce the worms began to migrate down the trunks of the trees, here and there covering the limbs and trunks with web. This migration occurred chiefly at night, the worms generally resting, as usual during the day, in temporary webs frequently located at the base of the trees and of extraordinary size. In one instance I estimated that not less than two quarts of worms occupied a certain web.

In the early part of the forenoon I usually found some stragglers which had been overtaken by daylight, evidently en route from the trees. Many of these were found dead in small pits, from which, as experiment showed, they had been unable to extricate themselves, and had died from the excessive heat.

The worms migrated mainly eastward to a clump of choke-cherry nearby and westward to a large hackberry about forty feet distant. This migration continued during about ten days. In four days the number of nests in the choke-cherry bush increased from six to twenty-five and the bush was literally stripped as the worms advanced.

The migration to the hackberry was not so striking as that to the choke-cherry bush but even more interesting. At first the worms congregated in the crotches of the larger limbs but advanced upward from day to day and formed webs in the smaller branches. They soon began to strip the leaves and the webs could then be seen at some distance from the outside of the tree.

Mr. W. B. Herms, who remained at the Laboratory until August 31st, was kind enough to observe the worms for me and reported that after my departure the worms migrated only a little farther east into the choke-cherry bushes and became fewer in number. I presume that they were then mature and that they wandered away to pupate. The trees began to show new life and by the time Mr. Herms left were quite green again.

A small hoptree (*Ptelea trifoliata*) immediately beneath the webs in the walnuts was injured but very little, the worms having a decided aversion for it.

Feeding.—My observations in this direction clearly show that the worms feed but little if at all during the day. At night they leave the nests, or thicker parts of the webs, and move about freely. Some will even leave the protection of the thinner parts of the web and feed unprotected except by the darkness. (I do not mean to assert, however, that there were no threads of silk leading back from the worms to their web.)

Growth and Moulting.—By actual measurement of worms in a certain brood I found that they increased in length about one-fourth of an inch in twenty-two days, i. e., they increased in length from one-fourth to one-half inch. At that rate it would take about two months for a worm to mature, which appears to be about the time required at Cedar Point.

The observations that I succeeded in making upon moulting give me twelve to fifteen days as the interval, the interval from birth to the first moult included. Allowing five moults per season, this would again give us about two months for a worm to become mature. Mature worms probably average from three-fourths to one inch in length.

The heads moult first, the skin of the head drops off, and the worm then crawls out of the opening. The thorax rarely splits dorsally.

Other Observations.—I have previously remarked that a brood may divide, each part building a new nest. This I actually observed in several instances. Again, two broods may unite into one brood or a brood may desert its old nest and build a new one.

In one instance I cut out a nest while the worms were out feeding. Upon their return at daylight they wandered about aimlessly for a while, when one portion settled down and formed a new nest, while the rest returned to an empty nest nearby from which a part of the brood in question, a double brood, had come some days before.

Of three nests cut out and placed upon the ground near some bushes, the worms of one nest were back upon the bush in a new web the morning of the second day, while those of the other two nests gradually disappeared and apparently migrated to the bushes.

The appreciable economic loss from the webworm is probably not great, and but few trees are ever endangered; except small trees, which latter may easily become denuded of all their foliage by one or a few broods.

Biological Hall, O. S. U., Columbus, December 5, 1905.

CHECK LIST OF OHIO TREES.

John H. Schaffner

Ohio lies in the great deciduous forest region which extends from the Appalachian Mountains to the Mississippi River. This region was formerly one of the grandest woodland areas in the temperate zone. But the forest is rapidly disappearing before the civilization of the white man.

In the list given below the introduced species have been marked by the abbreviation "I.", and those which are usually small or shrub-like by "S. T." In attempting to separate "trees" from the larger "shrubs," one must necessarily be somewhat arbitrary, as nature draws no definite division line. A tree may be defined as a woody plant of any size which produces naturally one main erect stem with a definite crown of branches; while a shrub is a woody plant which produces small, irregular or slanting stems usually in tufts. The species may develop in various ways depending on the environment. Thus the writer has seen individuals of the poison ivy (Rhus radicans L.) develop as climbers, shrubs, and small "trees" in an area only a few rods in extent, the conditions being favorable for all three modes of growth.

In the present list, an attempt has been made to give the appropriate English name for each species. These have mostly been taken from Sudworth's "Check List of the Forest Trees of the United States." Hybrids and mere forms have not been included.

Of the 155 species listed as occurring in Ohio, 128 are native and 27 are introduced; about 106 are typical trees and 49 are small trees or shrub-like. Of the typical trees, 85 are native and 21 are introduced; and of those developing as small trees or shrubs, 43 are native and 6 are introduced.

Subkingdom, GYMNOSPERMAE.

Class, CONIFERAE.

Order, **Pinales.**

Family, *Pinaceae.*

1. Pinus strobus L. White Pine.
2. " virginiana Mill. Scrub Pine.
3. " echinata Mill. Yellow Pine.
4. " rigida Mill. Pitch Pine.
5. Larix laricina (DuR.) Koch. Tamarack.
6. Tsuga canadensis (L.) Carr. Hemlock.

Family, *Juniperaceae.*

7. Thuja occidentalis L. Arborvitae.
8. Juniperus communis L. Common Juniper. S. T.
9. " virginiana L. Red Juniper.

Subkingdom, ANGIOSPERMAE.

Class, DICOTYLAE.

Subclass, APETALAE.

Order, **Salicales.**

Family, *Salicaceae.*

10. Populus alba L. White Poplar. I.
11. " heterophylla L. Swamp Poplar.
12. " balsamifera L. Balsam Poplar.
    Also balsamifera candicans (Ait.) Gr. Balm-of-Gilead.
13. " dilatata Ait. Lombardy Poplar. I.
14. " deltoides Marsh. Cottonwood.
15. " grandidentata Mx. Largetooth Aspen.
16. " tremuloides Mx. American Aspen.
17. Salix nigra marsh. Black Willow.
18. " amygdaloides And. Peachleaf Willow.
19. " lucida Muhl. Shining Willow S. T.
20. " pentandra L. Bay Willow. I. S. T.
21. " fragilis L. Crack Willow. I.
22. " alba L. White Willow. I.
    Also alba vitellina (L.) Koch.
23. " babylonica L. Weeping Willow. I.
24. " fluviatilis Nutt. Sandbar Willow. S. T.
25. " discolor Muhl. Pussy Willow. S. T.
    Also discolor eriocephala (Mx.) And.
26. " bebbiana Sarg. Bebb Willow. S. T.
27. " purpurea L. Purple Willow. I. S. T.

Order, **Juglandales.**

Family, *Juglandaceae.*

28. Juglans nigra L. Black Walnut.
29. " cinerea L. Butternut.
30. Hicoria minima (Marsh.) Britt. Bitternut (Hickory).
31. " ovata (Mill.) Britt. Shagbark (Hickory).
32. " laciniosa (Mx. f.) Sarg. Shellbark (Hickory).
33. " alba (L.) Britt. Mockernut (Hickory).
34. " microcarpa (Nutt.) Britt. Small Pignut (Hickory).
35. " glabra (Mill.) Britt. Pignut (Hickory).

Order, **Fagales.**

Family, *Betulaceae.*

36. Carpinus caroliniana Walt. Blue-beech.
37. Ostrya virginiana (Mill.) Willd. Hop-hornbeam.
38. Betula populifolia Marsh. American White Birch.
39. " nigra L. River Birch.
40. " lenta L. Sweet Birch.
41. " lutea Mx. f. Yellow Birch.
42. Alnus incana (L.) Willd. Hoary Alder. S. T.
43. " rugosa (DuR.) Koch. Smooth Alder. S. T.

Family, *Fagaceae.*

44. Fagus americana Sw. American Beech.
45. Castanea dentata (Marsh.) Borkh. Chestnut.
46. " pumila (L.) Mill. Chinquapin. S. T
47. Quercus rubra L. Red Oak.
48. " palustris DuR. Pin Oak.
49. " schneckii Britt. Schneck's Red Oak.
50. " coccinea Wang. Scarlet Oak.

51. " velutina Lam. Quercitron Oak.
52. " nana (Marsh.) Sarg. Bear Oak. S. T.
53. " marylandica Muench. Black-Jack (Oak.)
54. " imbricaria Mx. Shingle Oak.
55. " alba L. White Oak.
56. " minor (Marsh.) Sarg. Post Oak. S. T.
57. " macrocarpa Mx. Bur Oak.
58. " platanoides (Lam.) Sudw. Swamp White Oak.
59. " prinus L. Rock Chestnut Oak.
60. " acuminata (Mx.) Houd. Chestnut Oak.
61. " alexanderi Britt. Alexander's Chestnut Oak.
62. " prinoides Willd. Scrub Chestnut Oak. S. T.

Order, **Urticales.**

Family, *Ulmaceae.*

63. Ulmus americana L. White Elm.
64. " racemosa Thom. Cork Elm.
65. " fulva Mx. Slippery Elm.
66. Celtis occidentalis L. Common Hackberry.

Family, *Moraceae.*

67. Morus rubra L. Red Mulberry.
68. " alba L. White Mulberry I.
69. Toxylon pomiferum Raf. Osage-orange. I.
70. Broussonetia papyrifera (L.) Vent. Paper-mulberry. I.

Subclass, CHORIPETALAE.

Order, **Ranales.**

Family, *Magnoliaceae.*

71. Magnolia acuminata L. Cucumber Magnolia.
72. Liriodendron tulipifera L. Tuliptree.

Family, *Anonaceae.*

73. Asimina triloba (L.) Dun. Papaw. S. T.

Family, *Lauraceae.*

74. Sassafras sassafras (L.) Karst. Sassafras.

Order, **Rosales.**

Family, *Hamamelidaceae.*

75. Hamamelis virginiana L. Witch-hazel. S. T.
76. Liquidambar styraciflua L. Sweet-gum.

Family, *Platanaceae.*

77. Platanus occidentalis L. Sycamore.

Family, *Rosaceae.*

Subfamily, *Pomoideae.*

78. Sorbus americana Marsh. American Mountain-ash.
79. " sambucifolia (C. & S.) Roem. Elderleaf Mountain-ash.
80. " aucuparia L. European Mountain-ash. I.
81. Pyrus communis L. Pear. I.
82. Malus angustifolia (Ait.) Mx. Narrowleaf Crab-apple.
83. " coronaria (L.) Mill. Fragrant Crab-apple.
84. " malus (L.) Britt. Common Apple. I.
85. Amelanchier canadensis (L.) Medic. Common Juneberry.
86. " botryapium (L. f.) DC. Swamp Juneberry. S. T.
87. " rotundifolia (Mx.) Roem. Roundleaf Juneberry. S. T.

88. Crataegus crus-galli L. Cockspur Hawthorn. S. T.
89. " punctata Jacq. Dotted Hawthorn. S. T.
90. " cordata (Mill.) Ait. Washington Hawthorn.
91. " oxyacantha L. English Hawthorn. I. S. T.
92. " coccinea L. Scarlet Hawthorn. S. T.
93. " rotundifolia (Ehrh.) Borck. Glandular Hawthorn. S. T.
94. " macracantha Lodd. Longspine Hawthorn. S. T.
95. " mollis (T. & G.) Scheele. Downy Hawthorn. S. T.
96. " tomentosa L. Pear Hawthorn. S. T.

Subfamily, *Drupoideae.*

97. Prunus americana Marsh. Wild Plum. S. T.
98. " angustifolia Marsh. Chickasaw Plum. I.
99. " cerasus L. Sour Cherry. I.
100. " avium L. Sweet Cherry. I.
101. " pennsylvanica L. f. Red Cherry.
102. " mahaleb L. Mahaleb Cherry. I. S. T.
103. " virginiana L. Choke Cherry. S. T.
104. " serotina Ehrh. Black Cherry.
105. Amygdalus persica L. Peach. I.

Family, *Fabaceae.*

Subfamily, *Cassioideae.*

106. Cercis canadensis L. Redbud.
107. Gleditsia triacanthos L. Honey-locust.
108. Gymnocladus dioica (L.) Koch. Coffee-bean.

Subfamily, *Papilionoideae.*

109 Robinia pseudacacia L. Common Locust. I.
110. " viscosa Vent. Clammy Locust. I.

Order, **Geraniales.**

Family, *Rutaceae.*

111. Xanthoxylum americanum Mill. Prickly-ash. S. T.
112. Ptelea trifoliata L. Hoptree. S. T.

Family, *Simarubaceae.*

113. Ailanthus glandulosa Desf. Tree-of-heaven. I.

Order, **Sapindales.**

Family, *Anacardiaceae.*

114. Rhus copallina L. Dwarf Sumac. S. T.
115. " hirta (L.) Sudw. Staghorn Sumac. S. T.
116. " glabra L. Smooth Sumac. S. T.
117. " vernix L. Poison Sumac. S. T.
118. Cotinus cotinus (L.) European Smoketree. I. S. T.

Family, *Ilicaceae.*

119. Ilex opaca Ait. American holly. S. T.

Family, *Celastraceae.*

120. Euonymus atropurpureus Jacq. Wahoo. S. T.
121. " europaeus L. Spindle-tree. I. S. T.

Family, *Staphyleaceae.*

122. Staphylea trifoliata L. American Bladdernut. S. T.

Family, *Aceraceae.*

123. Acer saccharinum L. Silver Maple.
124. " rubrum L. Red Maple.
125. " saccharum Marsh. Sugar Maple.
126. " nigrum Mx. Black Maple.

127. " pennsylvanicum L. Striped Maple.
128. " spicatum Lam. Mountain Maple. S. T.
129. " negundo L. Boxelder.

Family, *Hippocastanaceae.*

130. Aesculus hippocastanum L. Horse-chestnut. I.
131. " glabra Willd. Ohio Buckeye.
132. " octandra Marsh. Yellow Buckeye.
Also octandra hybrida (DC.) Sarg.

Order, **Rhamnales.**

Family, *Rhamnaceae.*

133. Rhamnus caroliniana Walt. Carolina Buckthorn. S. T.

Order, **Malvales.**

Family, *Tiliaceae.*

134. Tilia americana L. American Linden.
135. " heterophylla Vent. White Linden.

Subclass, HETEROMERAE.

Order, **Ericales.**

Family, *Ericaceae.*

136. Rhododendron maximum L. Great Rhododendron. S. T.
137. Kalmia latifolia L. Mountain Kalmia. S. T.
138. Oxydendrum arboreum (L.) DC. Sorrel-tree.

Order, **Ebenales.**

Family, *Ebenaceae.*

139. Diospyros virginiana L. Persimmon.

Subclass, SYMPETALAE HYPOGYNAE.

Order, **Gentianales.**

Family, *Oleaceae.*

140. Fraxinus americana L. White Ash.
141. " biltmoreana Bead. Biltmore Ash.
142. " lanceolata Borck. Green Ash.
143. " pennsylvanica Marsh. Red Ash.
144. " quadrangulata Mx. Blue Ash.
145. " nigra Marsh. Black Ash.
146. Chionanthus virginica L. Fringetree. S. T.

Order, **Polemoniales.**

Family, *Bignoniaceae.*

147. Catalpa catalpa (L.) Karst. Common Catalpa. I.
148. " speciosa Warder. Hardy Catalpa. I.

Subclass, SYMPETALAE EPIGYNAE.

Order, **Umbellales.**

Family, *Araliaceae.*

149. Aralia spinosa L. Angelica-tree. S. T.

Family, *Cornaceae.*

150. Cornus florida L. Flowering Dogwood.
151. " asperifolia Mx. Roughleaf Dogwood. S. T.
152. " alternifolia L. f. Blue Dogwood. S. T.
153. Nyssa sylvatica Marsh. Tupelo.

Order, **Rubiales.**

Family, *Caprifoliaceae.*

154. Viburnum lentago L. Sheepberry. S. T.
155. " prunifolium L. Black Haw. S. T.

NOTE ON LIST OF OHIO MOLLUSCA, AND A SUGGESTION IN REGARD TO LOCAL FAUNAL LISTS.

V. Sterki.

A preliminary list of the Land and Fresh Water Mollusca of Ohio has been prepared by the writer and deposited in the Academy library. It is an abstract of a larger hand list, and contains nearly all the species seen from the State, or recorded, except some of Pleurocera and Gonioleasis which still must be worked up specially. A few species listed must be verified as to actual occurrence in the State, a few others as to exact identification, and there is no doubt that quite a number of additional ones will be found.

As stated elsewhere, I believe that "the Mollusca are the truest exponents of the geographical distribution of animals in a given region or district," and also that Ohio is a specially interesting territory in that respect. And therefore, a faunal list should not be published before the species, varieties and local forms from all parts of the State are fairly well known and their distribution can be shown by tables, charts, etc., approximately accurate, even if it take a few years' more work. Then, and only then, such a publication will be to the credit of the Academy and the State.

If a part of a research fund could be turned over to the collecting and working up of our Mollusca, for a year or two, it would help considerably, and also might make it possible to work up a special "Ohio Collection" containing the species and local forms from various parts of the State, carefully identified, to be deposited with some institution, e. g., the Ohio State University.

Local lists, also, might be worked up, of various parts of Ohio, where zoologists are studying the faunas. And in this connection a suggestion may be excused. Such a list, be it of Mollusca, or any other group of animals, or comprehensive, should not be confined to a county, except where the same is bounded by natural lines. Political outlines have nothing to do with the natural features of the county, but go across hills, valleys, rivers, etc. It is better to take up a certain naturally limited territory, a valley, a drainage system, a range or group of mountains or hills, regardless of county lines.

The same might be said of States, to a large extent. Yet, they comprise much larger territories, and for practical and routine reasons, will be considered separately, in general. Ohio is more naturally confined than most other States, and a faunal list of the State means somewhat of a unity. But even then, the lines should not be drawn too strictly.

THE CAUSE OF TREMBLES IN CATTLE, SHEEP AND HORSES AND OF MILK-SICKNESS IN PEOPLE.*

E. L. Moseley.

The mother of Abraham Lincoln died of milk-sickness. In many districts of the region extending from Michigan to Tennessee trembles and milk-sickness proved a veritable scourge to the early settlers. One of these districts was in northern Ohio in the western part of Erie and the eastern part of Sandusky County. Here forty-three persons are said to have died in a single year from this cause. Within the last thirty years Doctor Storey has treated nearly fifty cases in Townsend Township, which may be half of the whole number. The loss of domestic animals from trembles in the three Townships, Townsend, Margaretta and Perkins, since the first settlement, doubtless exceeds five thousand. On some single farms the number is more than a hundred. People who came from Pennsylvania with a view to settling here returned to their own State on learning of the peril of pasturing animals in Ohio. To this day many woods in this district are not pastured, because animals would soon die if turned into them.

Milk-sickness is known to be due to the use of milk, butter, cheese or meat of animals afflicted with the trembles, but what causes the trembles has not been well understood. It has long been known that only the animals allowed to run in the woods were affected, and experience showed that certain woods were very dangerous while others were safe. For a time many thought that the water was the cause of trembles but this idea was discarded long ago, as was also the hypothesis that the air of certain localities furnished the poison. Wm. Morrow Beach, of London, Ohio, in an article on Milk-Sickness in "Transactions of the Ohio Medical Society, 1884," mentions "five separate and distinct classes of advocates as to the causes of the disease," but he seems to have settled on nothing more definite than that the animals contract it by "remaining in the timber over night." Dr. J. A. Kimmell, of Findlay, in an article read at the International Medical Congress, Berlin, 1890, mentions white snake-root among other things supposed to cause the disease but his own belief was that it was of bacterial origin. Dr. Robert Hessler, of Logansport, Indiana, at the meeting of the Indiana Academy of Science, Dec. 1, 1905, exhibited drawings of an apparently new species of yeast he had found in the blood of a horse that had the trembles, and presumed to be the cause. Professor N. S. Townshend was convinced that white snake-root caused the trembles and his articles in the Ohio Agricultural

*Read at the Cincinnati meeting of the Ohio St. Acad. of Sci., Dec. 2, 1905.

Reports for 1858 and 1873 gave evidence to support this view, including a letter from W. J. Vermilya of Ashland County, who in 1856 had produced trembles and death of a mare by feeding her this weed, also a statement that Mr. John Rowe had fed it to cattle in Madison County, 1839, with the same fatal results. W. C. Mills informs me that Professor Townshend and some of his pupils intended to experiment in feeding this weed.

The principal objection to Professor Townshend's view appears to have been that white snake-root grows where animals have been pastured for many years without a single case of trembles and this seemed a serious objection to the theory.

The Eupatoriums are not palatable. Anyone who has tasted boneset will admit that this is true of Eupatorium perfoliatum. In the South I have observed that animals leave Eupatorium serotinum untouched even where they have been confined so as to eat almost every other green thing in reach. In northern Ohio I have found Eupatorium ageratoides, the white snake-root, growing abundantly in a number of woods where animals were pastured but no sign of their having eaten it. But if the pasture becomes poor, some are likely to eat it.

On the 8th of last October I visited a piece of woods in Sandusky County where there was nothing fit for an animal to eat, the principal herbs being nettle, white snake-root, poke and black nightshade, with some clearweed, basil, and bedstraw. Every plant of snake-root had been nipped off so that I did not see one more than about half the normal height. This had probably been done by cattle from the adjoining pasture which were doubtless accustomed to spend a portion of hot sunny days in the shade of the woods. A few weeks before my visit a man and his wife who had been using butter made from milk of cows in this pasture had milk-sickness and the wife died.

Elisha Haff, Townsend Township, Sandusky County, did not think trembles were due to any weed, until he found that western sheep which he turned in his woods ate the white snake-root and died of trembles. Sheep whose ancestors had long been in the region did not eat it and did not have trembles. Since that he has been destroying the weed.

James Fuller in the same township, in 1874, turned sheep into woods when the ground was covered with snow and all they had to eat was this weed. They contracted the trembles and forty of them died. George Sanford in the same township in January, 1881, lost a horse which could get nothing but snake-root in the woods. He tracked it and saw where it had eaten this weed. A number of dogs from the neighborhood fed on the carcass and all died of the trembles.

Mr. H. H. Lockwood of Sandusky, was the first to describe to me the plant which caused trembles and milk-sickness. His ancestors settled on the peninsula north of Sandusky Bay in 1812. For many years trembles occurred among the stock. He believes that from their own observation they concluded it was caused by their eating snake-root which they would do only in a dry season when the pasture was poor.

About 1872 Mr. David Barber in Margaretta Township, when he was hauling wood with a sleigh, left the gate open into the woods. Sheep got in and, though they were there hardly more than two hours, a number had trembles and some died. The snake-root was the principal plant in these woods. Mr. Barber did not notice that they ate it but supposed at the time that they were poisoned by something they found by pawing through the snow. These woods were notorious for the great number of horses, cattle and sheep which contracted the trembles in them. Mr. Barber told me that he had noticed this weed was abundant wherever trembles prevailed. I had already found this true of the woods I had examined.

In 1904 Louis Quinn had twenty-seven steers pastured in a large woods in Townsend. All had the trembles and nine died. The woods were known to be dangerous and so Mr. Quinn has been accustomed to leave stock there no later than June 1st. This time he left them about a week longer and had more of them than usual so that they were harder pressed for food. In these woods I found white snake-root more abundant than anv other dicotyl. I saw thousands of them in a walk of a few minutes while plants fit to eat were scarce. Nearly all the woods in that part of the township are considered unsafe and are pastured only early in the season if at all. In woods near Mr. Quinn's six lambs died of trembles this year. White snake-root was found abundant in all the woods examined in that region with one notable exception. In the woods of Orlando Ransom I could not find a single specimen, though a boy who was assisting me found one. June grass was growing in every part. Mr. Ransom told me the woods had been pastured for the past fifty years and no trembles had occurred. I also learned from several sources that trembles were unknown west of Pickerel Creek which is three miles west of Quinn's woods. I examined woods just east of this creek, but found no snake-root and learned that they were pastured with impunity. West of the creek I could find no snake-root in the first two woods examined, in the third after walking nearly a quarter of a mile I found four or five plants, in the fourth none, and in the fifth many in one place and a few others scattered about.

EARLY EXPERIMENTS IN FEEDING THE WEED.

About 1843 John Palmer Deyo, "a scientific investigator and prominent physician," living near Bellevue fed white snake-root to a calf which in consequence had the trembles and died. Mrs. S. M. Thomson, a niece of Mrs. Deyo who is still living, remembers that Dr. Deyo took pains to investigate the matter thoroughly at a time when people held conflicting views regarding the cause of trembles and was gratified when his efforts resulted in convincing them that white snake-root was the cause. She thinks that instead of feeding the weed directly to a calf, he fed it to a cow thereby producing trembles in both cow and calf and the death of the latter.

Dr. Cowell, a veterinary physician living near Bloomingville, Erie County, boiled the white snake-root in milk and gave the milk to pigs which soon died of the trembles. He asked another physician, "What ails those pigs?" "Trembles," was the reply. Then he told what he had fed them.

Dr. John Ray who lived at Whitmore, Sandusky County, steeped white snake-root and fed it to a calf which as a result died of the trembles.

I have been told of each of the three cases mentioned above by two old residents, who knew the experimenters personally and all six of my informants are reliable, though of course, they may be in error as to some of the details. There is no doubt that the weed experimented with was the white snake-root and that the experimenters were fully convinced that it was the cause of the trembles.

Mr. William Ramsdell of Bloomingville informs me that about 1842 when there was so much discussion of the subject the boys of the neighborhood used to assemble evenings at the old lime-kiln southeast of Castalia and experiment on dogs. They would boil or steep the white snake-root and putting the extract in milk give it to the dogs, in which it would induce the trembles; a large number were killed in this way. Some one experimented on sheep with the same result. He informs me also that a Mr. Redmond (who did not believe that the weed was the cause of trembles) chewed some of the weed and died after suffering for about four weeks.

About 1840 Thomas James of Bloomingville caused a calf to die of trembles by feeding it a weed he brought from the woods, which from the description given me by his daughter and also by Isaac Jarrett, I concluded was white snake-root.

Dr. Carpenter of Castalia, and B. F. Dwelle of Ottawa County, also experimented in feeding this weed and were convinced that it was the cause of the trembles.

RECENT EXPERIMENTS.

Cats.

No. 1. On November 26th my pupil, Oscar Kubach, using snake-root I had recently gathered, broke up the stems and leaves of two plants (possibly 3 or 4?) and soaked them over night in about a pint of milk, of which he gave about a gill at about 9 A. M. to his tom-cat. The cat took about one-half of it.

"About 9:30 it seemed to take effect and he tried very hard to vomit but could not. He took long, deep breaths. He was quiet and wanted to sleep very hard. All of a sudden he would tremble very hard, then again very little. A watery fluid passed from his eyes and mouth. He chose a spot in the sun and when driven away walked back in a staggering manner. He had no appetite. His senses seemed to be duller, as he did not care for anything. He went to sleep about 10:30 but did not sleep sound. He seemed to be in an unconscious state for the rest of the day. The next morning about 10:30 he walked about three rods and there died about noon."

Oscar lives in the country and I did not see the cat until he brought it to me dead. Weight estimated 4½ pounds. Post-mortem examination by Dr. H. C. Schoepfle and myself showed no lesion, inflammation, congestion or unnatural appearance of any organ. Brain not examined. Death followed more quickly in this case than in any of our other experiments. The cat was not fed the evening before giving the poisoned milk, so that digestion was probably rapid. As it was not taken from home and so was not kept in confinement, the case is especially interesting.

No. 2. A female kitten weighing after death thirty ounces, had probably never been handled by anyone until caught for this experiment. My pupil, Alton Fuchs, cut up about half a pound of snake-root I had gathered and boiled it about an hour in a quart of water. When the water had become reduced to a syrupy liquid, about one tablespoonful in volume, it was poured into the throat of the cat and the outside of the throat tickled so that it was all swallowed. "Soon after the decoction was administered the cat acted as if she wanted to vomit but did not vomit at any time. When first turned loose in room of barn it was very active, but after half an hour seemed rather stupid. After an hour she escaped, but was caught while trying to get through a fence, being less active than before poisoning." I first saw her about 2½ hours after extract was given, lying in natural position, eyes directed toward us, but rather dull, took notice of anything held near but indisposed to move. Respirations 38 and 36 per minute, doubtless increased by our presence. Movement of the back seemed greater than in normal breathing, and occasionally a spasmodic contraction ran along the muscles of the back. About noon the next day she took some milk. The symptoms continued much the same as the previous day, the spasms more frequent and pronounced, becoming worse in the evening, when at times two or three in close succession made a sort of trembling. Much duller than the evening before but would still move, if driven.

At 8 the next morning she shook all over, her head moving from side to side and the spasms continuing. At some of our visits that day we did not see real trembling. She took some milk and could still climb but showed weakness. At 5 P. M. the breathing was slow and barely discernible. The next morning, Nov. 29, she had taken some milk containing extract of snake-root that had been boiled 1¾ hours. Breathing deep but of normal rate—about 21 per minute. No trembling until after she was made to exercise. At 11:40 A. M. more trembling and violent paroxysms. At 12:30 Alton held her by the nape of the neck with her back resting in his other hand so that the legs were free. They quivered rapidly, continually and very plainly, the trembling being intensified by bending the legs with the hand.

At 3:40 on being held the same way, trembling did not show at first but soon became plain in one hind leg and then in both. Rectal temperature 101¾, the same also on Dec. 4, when the legs would still tremble somewhat but the eyes were normal, appetite good and she was active and restless. She had become tame and even familiar. No extract had been offered Nov. 30th and after that she would take no milk with it in, though her appetite was good. When held up some trembling could be seen, mostly in hind legs, as late as Dec. 7th, though in other respects she seemed well. She disappeared for a time and after her return showed no more trembling or effect of the poison except that she was entirely tame. She had at no time been given any of the snake-root except thoroughly boiled extract.

Dec. 14. The same cat was brought to me for further experiments. She showed no trembling or anything abnormal, took milk readily. The next morning I offered her milk in which snake-root had soaked. She would not drink it although it had been warmed and it was left with her about two hours. At 10 o'clock I gave her the heart, lungs, neck and back of thoracic region of a rabbit which had weighed 24 ounces and had died of trembles. She began eating it at once. At 11:30 she had eaten all and apparently wanted more. At 4:15 she seemed eager for food but would not take milk in which snake-root had been soaked, but ate the meat offered—half of liver, part of abdominal muscle and head of same rabbit. No trembling that day, but not examined after 4:15.

At 8:10 the next morning when lifted by nape of neck, hind legs trembled strongly and on a second trial, the right fore leg also (and the left a little?). When let out of box she found remains of the rabbit up on a window sill and ate part of the stomach which was filled with snake-root and parts of other viscera, including some liver, and might have eaten much more, if permitted. At 9 A. M. still trembled, but not so much; at 10:45 could see no trembling; at 4 P. M. very little trembling when held up until after exercise when it was plain. Dec. 17, temperature at 9:10 A. M., 103°, at 3:30 P. M., 103.2°. Trembling; at 9:10, none; at 10 o'clock, after considerable exercise, hind legs trembled and after drinking milk (she would take none with snake-root in it), the hind legs and right front leg trembled strongly when she was held up; at 3:30 trembling mostly in left hind leg and that not till she had been held some seconds. She continued active and appetite good. Killed Dec. 17, but not examined until Dec. 26, when the only abnormal appearance was a general venous engorgement (likely due to the CS_2 which killed her?). The experiments with this cat proved that trembles could be produced by thoroughly boiled extract of snake-root. The later experiments showed that she would no longer take milk containing the poison but would take meat greedily, also that this meat brought on the trembling again, but her first experience appeared to have effected some degree of tolerance of the poison, for she was not so strongly affected as a larger cat which ate a smaller quantity of meat from the same rabbit. This was

No. 3. A female cat, weight about $3\frac{3}{4}$ pounds; was fed like No. 2 with meat from rabbit, No. 6. A hind leg was given at 8 A. M., Dec. 14, but at 3:40 P. M. had not been eaten. At 7:50 the next morning she had taken this and some good milk. A fore leg and side were put in, but had not been eaten at 10 o'clock. At 4:10 P. M. the larger part had been eaten. No trembling that day. At 5:50 P. M. left her half of liver.

Of this piece about one-third remained the next morning and was given to No. 2, which had eaten other half of liver. After being out of box a few minutes she returned voluntarily. Then, for the first time I could feel trembling and on holding her up could see strong trembling of hind legs. 9 A. M., trembled some; at 10:45 did not tremble, had not eaten much of the meat left earlier, drank good cold milk and a few minutes later, when I held her up she trembled so that I could feel it and see it in her legs, three or four of them; 4 P. M., trembled some and, after a very little exercise, strongly. On putting her on window sill, 3rd floor, and letting her look out, trembling was quite noticeable even without holding up. After being let free on the floor a little while trembling was very strong; apparently indisposed to exercise. When returned to box began eating rabbit.

Dec. 17, 8:50 A. M., rabbit meat consumed except large intestine containing snake-root She seemed no worse; respirations 40 and 36 per minute, doubtless increased by fear; temperature at 9:45 A. M., $101\frac{3}{4}$°; trembling that day no greater than preceding. Dec. 18, less trembling than before. At 4 P. M. put in the whole of rabbit No. 7 of which we had made post mortem examination. She began eating it at once. Though the rabbit weighed 24 ounces she had at 8 o'clock the next morning eaten the greater part and seemed satisfied after such a hearty meal. All day she seemed to feel good and did not usually tremble except after exercise or drinking cold milk, when the trembling was very strong. More active than previously, had ceased to show much fear. The next morning she had taken the rest of the meat, the parts remaining being the skull, hind leg bones, considerable of the skin and the large intestine containing snake-root. She seemed no worse. Next day, Dec. 21st, 7:20 A. M., no trembling till after some exercise; temperature 102.9°. At 4:40 P. M. no trembling could be seen. She seemed entirely well. I began to wonder if eating second rabbit would have any effect. That day I offered her milk in which snake-root had been soaked but she took very little of it.

Dec. 22nd, she seemed pretty well and was put in a shed from which she escaped and I did not expect to see her again, nor care, as I had seen no reason to suppose she would show anything more of interest. She was not gone long, however, but adopted the shed for her home, spending most of the time in a basket with a flannel cloth in the bottom and paper under the handle partly covering her and helping to keep her warm. She evidently had not got rid of the rabbit and it was making her trouble. Constipation, though not complete, seemed to continue as long as she lived. The hind legs were spread apart more and more each day. She was allowed to go and come as she pleased and for a number of days I thought she would recover. On Dec. 28, she caught sight of a rabbit I had left on the grass and started to rush at it, being restrained with difficulty.

Meat and milk were kept by her much of the time but she took little or nothing except water and a little cooked potato at any time after Dec. 22nd. Dec. 30, she had been going about so much that I thought she was nearly well, but at 4:30 I found her temperature 103.9°, buttocks soiled, odor very bad. When held up by nape, hind legs trembled. After this I think she did not leave the shed but grew weaker, sometimes trembled when held up, at other times not. Jan. 2nd, she seemed too weak to tremble, had barely energy enough to crawl back into basket when put down near it. At 12:30 I noticed paroxysms of muscles about the shoulders. At 4 o'clock she seemed nearly dead, no struggling but quiet. At 5 she was getting cold. The next afternoon I opened the abdominal cavity and found two ounces or more of a perfectly clear amber colored liquid of slight acid reaction. No inflammation or congestion.

(To be continued.)

A STATE NATURAL HISTORY SURVEY.

At the Cincinnati meeting of the State Academy of Science the President in his annual address urged the effort to secure state support for a natural history survey. The Academy adopted a resolution endorsing the project and providing for a committee of three, to consist of the retiring President, the incoming President and the Secretary, to draft a bill and endeavor to secure its passage during the coming session of the General Assembly.

As a result of the efforts of this Committee a bill has been introduced by Hon. C. V. Trott of Mt. Vernon. This bill, after providing in the first Section for the establishment of the Survey, appointment of the Director by the Governor and authority to appoint necessary specialists and assistants, states in Sections 2 to 4 the objects of the survey as follows:

" SECTION 2. The Survey shall have for its objects: (1) An examination of the animal and plant life of the state with special reference to its distribution, abundance, increase or decrease, and facts of practical or scientific importance as a foundation for accurate instruction in the schools of the state. In particular shall facts relating to the organic purity of water supplies, the food supply of fishes, the game birds and animals, and forms affecting public health be considered. (2) The identification of birds, fishes, and other animals or plants sent in for the purpose by officers of the Fish and Game Commission, State Board of Health, City Boards of Health, or other State, County or municipal bodies calling for such information, or by the general public so far as they may be of public interest or value, and as the time of the officers may permit. Such investigations as may be especially desired by the State Board of Health in connection with the water supplies or the disease-producing or transmitting forms of life, or the Fish and Game Commission or other State Bureaus for the purpose of their work shall be given preference and pushed with all possible speed consistent with careful work. (3) The preparation of special reports with necessary illustrations and maps which shall embody both a general and a detailed description of the work of the survey.

SEC. 3. The collections made in pursuance of this act shall be deposited at the Ohio State University and shall be available for study by any person properly qualified, under such regulations made by officers of the Survey, as may be necessary for the permanent preservation and use of the collections.

SEC. 4. The Survey may from any duplicate material in its collections furnish sets to such colleges, museums, high schools, or township schools of the state as may be willing to pay the cost of labelling and transporting such specimens, and furnish evidence that such collections will be duly preserved and made available for the use of students and others interested. Preference is to be given in order of application to high schools offering courses in Nature Study, Zoology or Botany, and so located that no other collections of a similar nature are available for study and demonstration."

The Sections following (5 to 8) provide for publication which is on the same plan as the Geological Survey, for compensation of officers, expenses and accounting, and provides an annual appropriation of $5000 for carrying on the work.

It is believed by the Committee and others consulted that the bill would give an opportunity to push a much needed study of our native fauna and flora and it should meet the hearty support of all interested in the Natural History of the State as well as the members of the Academy. Letters endorsing the measure to be effective, should be sent as promptly as possible to individual members of the House or Senate or to Hon. C. V. Trott, House of Representatives, Capitol Building, Columbus, Ohio.

While an argument for the Survey seems altogether unnecessary for readers of the NATURALIST, a statement of some of the lines of study especially needed may be useful. It is particularly desirable that there should be a careful, systematic study of the Fauna and Flora, pushed as rapidly as possible to determine the present status and for comparison during future years. Such a scientific foundation is needed in many lines of study or practical work but perhaps from the standpoint of general knowledge would serve its greatest purpose as a help to teachers of Natural Science in the various schools. It will have all the greater service in this connection if these same teachers can have a hand in the work of the survey and in the distribution and use of the collections resulting from its work. A full knowledge of the aquatic life of the waters of the state is of direct and essential importance in matters of health and in the development of the fishing interests; moreover, the depletion or extinction of such life by sewage and factory waste that pollute our lakes and streams has economic as well as scientific interest.

The bill already has received approval and hearty endorsement from the presidents of a number of Ohio colleges and universities and of individuals acquainted with the need for such a survey. It is House Bill No. 363.

H. O.

SEXUAL AND NONSEXUAL GENERATIONS.

JOHN H. SCHAFFNER.

Recently a number of ideas have been put forward by various authors as to what is a sexual or nonsexual individual or generation. To the writer the case seems to be a matter of definition. The confusion appears to arise not so much in a misapprehension of the facts involved as in the extension of the meaning of the terms used. But in this case individuals and generations should be judged by what they produce.

A sexual generation is a gamete-producing generation. Any individual, therefore, producing cells which normally are to conjugate possesses sexuality provided the conjugation results in reproduction. If there is a differentiation of sex, the individual which produces female gametes directly is a female individual, and the individual which produces male gametes directly is a male individual. The gametes or male and female cells may be produced with or without a preceding reduction division, for the sexual generation may be either an "x" or a "$2x$" generation.

A nonsexual generation is a spore-producing generation, the spores being non-conjugating reproductive cells. The nonsexual generation may also be either an "x" or a "$2x$" generation. Sex terms are, of course, not to be applied to nonsexual generations or individuals.

An alteration of generations may be antithetic having an "x" gametophyte and a "$2x$" sporophyte. And certainly the generation which produces the sexual cells is to be called the sexual generation and the one producing the nonsexual spores the nonsexual generation. So in the higher as well as in the lower plants the gametophyte is the sexual generation and the sporophyte the nonsexual. An alternation of generations need not be antithetic. But both generations may have the "x" number of chromosomes. In such forms as Oedogonium and Coleochaete, for intsance, where the $2x$ number of chromosomes appears to be only in the zygote, the organism coming through reduction from the zygote is still the sporophyte and nonsexual generation for the reason that it finally produces nonsexual spores. It is possible that there are "$2x$," sporophyte generations producing their spores without reduction which would then occur before the formation of the gametes and we would then have an alternation of generations with a "$2x$" gametophyte and a "$2x$" sporophyte. Here again the gametophyte is the sexual and the sporophyte the nonsexual generation. In other words, sexual and nonsexual individuals or gametophytes and sporophytes are not determined by an x number or a $2x$ number of chromosomes but by the fact that the first produce gametes and the second nonsexual spores.

NOTE ON ANTHURUS BOREALIS.

D. R. Sumstine.

Of the six species of *Anthurus* only one is known from the United States, *Anthurus borealis.* This species was described by E. A. Burt in 1894. (Mem. Boston Soc. Nat. Hist. 3:504.) It was reported by him from New York and Massachusetts. I have not seen it reported from any other place since and consequently this note may add another station for this interesting fungus. During the summer William Marshall collected for me some fungi growing in the vicinity of Ravenna, Ohio. Among these was a specimen of this plant. Clare Jennings of Olena, Ohio, also sent some fungi to the Carnegie Museum and in the collection were several specimens of *Anthurus borealis.* The plants agree well with Burt's description. Some of the plants had only five arms, others had six. The specimens are all in the herbarium of the Carnegie Museum, Pittsburg.

Wilkinsburg, Pa., Jan. 2, 1906.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, Dec. 4, '05.

The Club was called to order by the President, Mr. Griggs. The minutes of the last meeting were read and approved.

The major paper of the evening was by Dr. C. B. Morrey on "Some Pathogenic Protozoa." Dr. Morrey reviewed briefly the known species of parasitic Protozoa and gave notes on their habits, occurrence, distribution and life histories in general. Parasitic Protozoa occur mainly as internal parasites of animals, only one form being known to occur on plants. Parasitic Protozoa are classified as beneficial, nonpathogenic and pathogenic. Nearly all the orders of Protozoa have representatives among the parasites, but they are especially abundant among the Sporozoa.

Professors Osborn and Landacre gave brief reports of the Zoological Papers presented at the Cincinnati Meeting of the Ohio State Academy of Science. Professor Schaffner reported on the Botanical Papers presented at the same meeting.

The following persons were elected to membership: Edna McCleery, Edith Hyde, Mary A. DeCamp, H. S. Hammond, E. W. Berger, Oscar Himebaugh, W. B. Herms, R. L. Shields, J. G. Wittenmyer, C. R. Stauffer, F. B. Grosvenor, E. I. Lichti, W. E. Evans, G. D. Hubbard, A. C. Workman, C. F. Jackson and Mrs. C. F. Jackson.

The club then adjourned.

Z. P. Metcalf, *Secretary.*

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TABLE OF CONTENTS.

NEW AND RARE OHIO PLANTS.

WALTER FISCHER.

Since the last annual report on the State Herbarium was written, ten new plants have been added to the flora of the State. The following is a list of these plants with the names of their first collectors, date and locality of collection and a few remarks as to their occurrence and distribution:

50*a*. *Marsilea quadrifolia* L. Franklin County, W. Fischer, 1905. This plant was placed in the botanic garden at the University several years ago and is now spreading in a small stream on the University farm.

154*a*. *Panicum Gattingeri* Nash. Cuyahoga County, Otto Hacker, 1901; Washington County, W. A. Kellerman, 1902; Franklin and Warren Counties, W. Fischer, 1905. This Panicum is not so abundant as *P. capillare* but, is found side by side with the latter and, like it is common throughout the State.

154*b*. *Panicum cognatum* Schultes. Lake County, Otto Hacker, 1901.

553*a*. *Agave Virginica* L. Lawrence County, E. B. Willard, 1905. This is a southern plant and was found growing on a hillside near Ironton, probably one of the northernmost limits of its range.

626*a*. *Salix alba x lucida*. Ashtabula and Logan Counties, R. F. Griggs, 1905.

626*b*. *Salix alba x babylonica?* Ashtabula County, R. F. Griggs, 1905.

664*a*. *Quercus imbricaria x rubra.* Franklin County, W. Fischer, 1895. This interesting tree, now growing on a vacant lot in the city of Columbus, was discovered by the writer in September, 1895, and regarded at that time as a cross between *Q. rubra* and *Q. imbricaria.* Specimens in the herbarium, however, have always been labeled *Q. imbricaria x velutina.* If this oak is to be regarded as a hybrid of the shingle oak and some one of the red oak group, the evidence is certainly in favor of *Q. rubra* being one of its parents. A few small entire leaves, the pubescence on the under side of all the leaves, and the size of the fruit are probably characters inherited from *Q. imbricaria;* while the form of the majority of the leaves and of the acorn, especially the cup, also the habit and general aspect of the entire tree all point strongly to a *Q. rubra* ancestry.

1160*a*. *Croton monanthogynous* Michx. Franklin County, W. Fischer, 1905. Quite a patch of this western plant was found along a railroad track at North Columbus.

1593*a*. *Perilla frutescens* (L.). Warren County, W. Fischer, 1905. Around an old deserted dwelling and barn near Loveland, where it has been doing well and multiplying for the past fifteen years.

1960*a*. *Coreopsis lanceolata* L. Franklin County, W. Fischer, 1905. Escaped from gardens at Marble Cliff, where is has been spreading the last four or five years.

While botanizing during the past summer and fall a few other plants more or less rare were added by the writer. Some of these had not been in the herbarium before, although previously reported for the State.

Another hybrid oak, probably *Q. imbricaria x velutina*, was discovered in Warren County near Loveland. This tree is remarkable for having an aspect entirely that of *Q. imbricaria.* The leaves are medium in size and almost entire, the majority being wavy in outline, while lobed ones are very scarce. The fruit resembles that of *Q. velutina* more closely than that of any other of the red oak group.

Aster sagittifolius urophyllus (Lindl.) and *A. Lowrieanus* Porter, from the dry wooded hills of Fairfield County; and *A. puniceus lucidulus* A. Gray and *A. junceus* Ait. on Cranberry Island, Buckeye Lake, Licking County, the last named also in streams in Franklin County.

Helianthus Maximiliani Schrad. and *H. mollis* Lam., both western sunflowers, the former reported for Lake County in 1900 and the latter for Erie County in 1895, were found growing in considerable quantities near Marble Cliff in Franklin County.

THE CAUSE OF TREMBLES IN CATTLE, SHEEP AND HORSES AND OF MILK-SICKNESS IN PEOPLE.

E. L. Moseley.

(Continued from p. 470.)

No. 4. A tom-cat weighing 5 lbs., 10 ounces. Had been liable to fits of coughing and vomiting, when fed meat. He made a poor subject. I gave him milk in which stems without leaves had been soaked, and after two days milk in which leaves had been soaked. He soon contracted diarrhoea which probably prevented much of the poison being absorbed into the blood. After four days he would not take any more poisoned milk. He was watched a good deal but was seen to tremble only a few times and then under conditions which might possibly have produced trembling without the aid of any poison. However, single tremors were noticed a number of times, two or three times a paw or foot when raised or stretched out by himself was seen to tremble. Occasionally the head trembled a little. A slight trembling of the ears and tail continued for a considerable time and most persistent of all a motion of the loins. This is the part in which trembling is said to be most noticeable in cattle. Respirations at one time 35 per minute.

When he would take no more poisoned milk I gave him a leg of rabbit No. 6. The next day while he was drinking cold milk I noticed strong trembling.. Earlier in the day he had eaten greedily another leg and side of the rabbit. The next day, when held up by the nape his hind legs trembled and when put down he trembled all over. The meat seemed to affect him more than the milk. He ate readily all that was given and if I had had enough of it, would probably have been killed by it. As it was, he shared the fate of No. 2 and post-mortem examination at the same time showed nothing more.

Dog.

No. 5. A small cur, was given, Nov. 25, at 8:15 A. M., milk mixed with a water extract of snake-root and at 11:45 the leaves and tops of several herbs broken up and mixed with hash, also a chicken's liver dipped in the extract. No effect was noticed that day but at 3:30 the next morning Mr. Reinheimer says the dog shook hard all over so that he thought it was dying. At 10:10 A. M., as it lay on its side in the sun, it stretched out its legs as if yawning and trembled in a very unnatural manner. After dinner also we noticed some trembling of the legs especially when he changed his position. He showed some weakness, dullness and less disposition to bark than usual at sounds. Nevertheless, he was not so different from usual except in the early morning but what all these things might have escaped notice if he had not been watched. He was dull enough at any time.

Nov. 27, he seemed natural. At 9:30 P. M. he was given six tablespoonfuls of strong extract. All next morning he "lay extended on the floor, seemed indisposed and ate very little. At 6:30 P. M. he ate a little of the snake-root mixed with potato. Nov. 29, rather lively, if anything, actions all natural." After this he showed little, if any, effect of the poison.

Boy.

"On Monday evening at 9:30 P. M. while I held the dog's mouth open a friend poured the extract into the dog's mouth. The dog choked and coughed the extract into my face and mouth. I was in the room while the mixtrue was steeping and also on the previous evening. At 10:30 I was taken with a fit of cramps and the following day was nauseous. Several times during the three following days I had fits of trembling, always accompanying the extension of limb."

—Bartelle H. Reinheimer.

While another of my pupils was preparing a decoction of snake-root, although it did not affect him, yet on his mother, who was not well, it had a sickening effect, though she was not in the same room.

Rabbits.

No. 6. A rabbit, weighing about 1½ lbs. Alton Fuchs began feeding snake-root Dec. 9, 9 A. M. It was kept supplied most of the time and given nothing else except on one occasion, a few lettuce leaves. On the afternoon of Dec. 12 I was surprised on looking in its box to see the rabbit dead for we had seen no trembling nor anything the matter with it. Probably if we had watched it that day we would have seen it tremble.

From our experience with Cat No. 2 we had expected to see the legs tremble when unsupported, but later experience with rabbits showed that they are not affected in this way. This rabbit had taken altogether about 2 ounces of snake-root, mostly leaves and branches, likely much more than necessary to kill it. The stomach and large intestine were found well filled. No inflammation or congestion.

No. 7. The mate to No. 6, was fed by Oscar Kubach, the first snake-root being given in the morning of Dec. 13. He noticed some trembling in the evening and more the next evening. On Dec. 16 it was more pronounced. The rabbit died that afternoon between 1 and 3, the interval from the first feeding being about the same as in the case of No. 6. It took both water and milk; these were not offered to No. 6. It had eaten leaves and branches of about 35 plants. No inflammation was found.

No. 8. A female rabbit, weight after death 1383 grams. With aseptic precautions A. E. Guenther, Ph. D., Professor of Physiology in the University of Nebraska, injected under the skin of her back about 1¼ cubic centimeters of an extract of snake-root made by boiling five ounces of the plants in two quarts of water until the liquid was reduced to about two ounces, after several days kept at boiling temperature again for an hour and heated to boiling a third time just before using. I was not looking for immediate results but three minutes after the injection was made, while I was still holding her on my knee I could feel her tremble and in a minute more we could see trembling of the loins very plainly. Half an hour later she showed less decided trembling, breathing rapid and deeper than before the injection, at times a twitching of loins or sides repeated not rapidly enough to call trembling but quite unnatural; also a vibration of the flesh over the angle of the lower jaw, the last, perhaps, not caused by the poison. She moved about freely and ate lettuce and cabbage. The visible effects of the poison lessened through the day and the following day seemed entirely gone, except the temperature, which gradually approached the normal. The injection was made at 12:15 P. M., Dec. 31. 11:30 A. M.—temperature 104.8°; 1:30 P. M.—104.2°; 3:30 P. M.—105.1°; 5:30 P. M.—106.°; 7:30 P. M.—105.8°; 9:30 P. M.—106.°. Although taken fourteen times between the afternoon of Dec. 29th and the time of injection it was in no instance above 104.8°. Forty-eight hours after the injection the tempertaure had become normal.

Jan. 3, 7:50 A. M., I began feeding her white snake-root of which she took the leaves and branches readily. I kept her pretty well supplied each day with snake-root, giving also some good food. The effects on her actions and appearance were not striking and might have escaped notice if I had not looked for them. Deep breathing, sometimes rapid, especially noticeable in the loins, with some diminution of strength were noticed. She would move about without urging but less rapidly than a normal rabbit. Her temperature taken several times each day showed no marked influence of the poison. On the whole it was below normal, exceeding 103.8° only on the day she began to eat the weed, i. e., before it was digested, and about 23 hours before she died, when it was 104.3°. Jan. 7, her appetite was not so good and her eyes dull. In the evening deep breathing was noticeable and trembling resembling shivering. Next morning I found her lying on her side, as if dead. When laid on top of box she gasped for breath, not violently but with increasing energy, so I thought she might revive. At the last were a few kicks. Half an hour after she had expired an auricle was still beating. The stomach, caecum and colon were filled with partly digested snake-root. Bladder filled, although she had drunk no water or milk for several days. Viscera appeared natural. We were not sure whether the veins were a little engorged. There had been no constipation of any consequence. Total amount of snake-root consumed was between two and three ounces. Death occurred 120 hours after first feeding of snake-root.

No. 9. Female rabbit weight 33 ounces, taken from her home, Dec. 23. Temperature in next three days taken only five times, ranged from 99.8° to 101.9°. At 3:30 P. M., Dec. 26, I gave her in milk about ¼ ounce of extract from same bottle as that used for the injection of No. 8. It had already been twice boiled for a long time. I gave her some of this with milk or cabbage or lettuce on each of the three succeeding days, about one ounce altogether. Dec. 27, 7:30 A. M., temperature 102.2°; 11:35 A. M., temp., 103.5°; 2:10 P. M., temp., 103.8°; 4:30 P. M., temp., 103.5°.

From Dec. 27 to Jan. 14 her temperature was taken several times each day, ninety times altogether. Only twice was it found below 102.2°, the maximum being 105.3°. No other effect of poison manifest until Dec. 28 when I noticed a tremulous motion of her sides, and rapid and irregular breathing. The motion of the sides seemed a sort of panting, the rate in the afternoon about 96 per minute. The next day the panting was not noticeable and never became very distinct again, except when there was external cause for excitement. Jan. 4, 11:40 A. M., I began giving each day some milk in which snake-root leaves had soaked. Jan. 6, 9:30 P. M., she showed a sort of trembling the motion being backward and forward. This has been noticed infrequently since, also a little panting and lessening of strength. Otherwise she has seemed well. She has been well fed all the time. No change of temperature can be attributed to withholding the poison after Dec. 29 or giving it again in different form Jan. 4–7 and 11–12. No constipation.

No. 10. A female rabbit, weight 11 ounces. Jan. 11, began giving her milk in which snake-root had soaked, one third as much each time as to No. 9, her weight being one-third as great. She has shown similar effects. Her temperature changes help to understand those of No. 9. Before removing her from the warren her temperature at 3:30 P. M. was 102.9°, about like that of others of her size but lower than in the larger rabbits. She was carried a mile in the sleeve of a laboratory apron most of the way on a warm car. In twenty minutes her temperature had fallen to 99 and at 9:30 P. M. to 98.4°. It was higher every afternoon but did not rise as the days went on and, although well fed and allowed to stay part of the time with rabbit No. 9, nothing availed to bring her temperature up to 102°, until she was given milk in which snake-root had soaked. This was on the evening of Jan. 11 and the following days. Jan. 12 her temperature reached 101.8°; Jan. 13, 102.6°; Jan. 14, 104.3°.

Further experiments with rabbits have shown that, like cats, they may acquire some degree of tolerance of the poison, also that one ounce gathered in January is not sufficient to kill a large rabbit. One weighing 3½ pounds ate 28 grams of snake-root January 21–27, with a little good food. Twitching was noticed January 27–30, during which time she was well fed. Then she ate nine grams more of snake-root but survived. Another weighing nearly four pounds was made to tremble or twitch by injections of a decoction of snake-root January 21, 22 and 30, and by eating of the leaves and branches 67 grams, February 1–5, but survived.

Sheep.

No. 11. Saturday morning, Jan. 6, 1906, I went into the country and selected from a flock a healthy female lamb of about forty pounds weight and brought it home on the electric cars. In the afternoon I gathered in the woods 88 ounces of white snake-root of which I gave her 8 ounces at 4:45, on the next day 34 ounces and the remainder Monday and Tuesday morning. She took it more readily than I had expected, in fact, after being without other food not very long she ate the snake-root leaves quite greedily, but the coarse stems would not eat at all, even when cut into rather small pieces and soaked over night in water. The total amount consumed was about 29 ounces. Other food was withheld only until Monday when at 5 P. M. I gave her about a pint of bran all of which she ate. Water was offered several times every day but only a few ounces taken altogether.

Until Tuesday evening I saw nothing wrong with her whatever though Tuesday noon I noticed that she had not cleaned out the box containing the snake-root leaves quite so well as before. If she had been watched long at this time quite likely some effect of the poison would have been noticed. I did not see her again till after dark. Then having weighed out some freshly gathered snake-root to give her I noticed that she stood facing away or to the side instead of manifesting eagerness for it as heretofore. Then I noticed deep and unnatural breathing, an almost spasmodic movement of the sides. After taking a few steps, she lay down as if unable to stand. When pushed she arose, walked a few steps and sank down again. I went for H. H. Lockwood who had seen sheep affected by trembles and

H. A. Winters who had lost many sheep and other animals from trembles. On returning I saw a little trembling of the flesh at the hips. After watching her awhile they both felt sure that she had the trembles and in conversation with me the next day Mr. Winters said the symptoms were unmistakable. She ate some bran while lying down, stopping to let her head rest on the corner of the box. She raised her hind quarters but failed in attempting to straighten her front legs and so ate while kneeling. At 10 P. M. she was lying still, her respirations rather deep and about 16 per minute. She gave no heed to the lantern.

The next morning she was unable to rise or even to stand when lifted onto her feet. Nor would she eat. Breathing spasmodic but no trembling. At noon she was still lying in the same place, her breathing deeper and about 25 per minute. Without any urging she struggled as if to rise and this doubtless increased the respirations somewhat. Whether she had done this at frequent intervals I could not tell. No trembling but the breathing quite laborious and unnatural. At 3:40 P. M. still in same position. Respirations labored, irregular, 33 per minute after a fit of kicking, then after a short interval 30 per minute. About 4:20 there was violent struggling involving not only the legs but the abdominal and other body muscles. At 4:40 I found her dead. Post mortem examination the next morning showed that the kidneys were enlarged to double the normal size. One of them weighed 50.3 grams, one obtained from a lamb of about the same size at a market and another from a lamb about half again as heavy weighing 25.5 and 26 grams.

No other organs were found enlarged, inflamed or congested or in any way unnatural in appearance with the possible exception of the brain which some thought slightly congested. The abdominal cavity contained several ounces of liquid, "due to feeble circulation preceding death." Besides H. C. Schoepfle, M. D., and Dr. Hinkley, a veterinary physician, I had three butchers, one at a time, examine the body. There had been no constipation. The rumen was well filled with snake-root. Death would likely have come almost as soon had she eaten none of it after Sunday. The quantity given Saturday afternoon and Sunday was 42 ounces, of which 14 may have been eaten. Likely enough a small fraction of this would have sufficed to produce trembles, though death might not have come so quickly—four days from the time of first feeding.

Meat from this sheep was fed to four animals. A large cat ate six ounces of the liver about 5 P. M. and the next morning trembled violently, less as the day went on and, after that, none. A cat of the same size ate six ounces of muscle from a hind leg, but showed no effect for two days or so when it became sick, losing its appetite but not trembling. It has recovered. A rather small cat took four ounces of liver and running off with it was not seen again for three days when she seemed quite sick but could not be caught. A dog (No. 5) ate four ounces of liver showing no effect for two days when he became dull. The fourth day, having apparently recovered, he was given the heart and spleen. After about 24 hours fits of trembling affected his limbs, some of it still noticeable the next day, after which he was all right.

All our experiments were with weeds gathered after many hard frosts and nearly all with weeds gathered from woods that have long been pastured without a single case of trembles, so far as the owners know, ever having occurred in them. In gathering it I did not notice a single plant that had been nipped off. The absence of inflammation in the animals that we experimented on as well as in those that contract the trembles in the pasture shows that the poison is not an irritant. The quickness of its action and the fact that trembling is a characteristic effect indicate that it acts on the nervous system.

THE LIFE CYCLE OF A HOMOSPOROUS PTERIDOPHYTE.

John H. Schaffner.

The Homosporous Pteridophytes constitute the lowest subkingdom of vascular plants. They and all plants above them have a true fibro-vascular system and true leaves and roots in the sporophyte generation except in a few cases where leaves or roots have been lost through an adaptation to some peculiar environment. No plants below the Homosporous Pteridophytes possess true leaves, roots, or vascular system. These plants are called homosporous because in them there is only one kind of nonsexual spores produced while the three higher subkingdoms of vascular plants have two kinds of nonsexual spores and are thus called heterosporous.

The known fossil record of Homosporous Pteridophytes does not extend below the Silurian Period although they must certainly have flourished in previous geological times. They were exceedingly abundant in the Devonian and Carboniferous and were among the important coal forming plants. Many were of the tree type while at present they are mostly low geophilous perennials, although in tropical countries tree ferns are still quite abundant.

There are about 2,800 known living species of Homosporous Pteridophytes. They fall naturally into three distinct classes—ferns or Filices with 2,600 species, horsetails or Equiseteae with 25 species, and lycopods or Lycopodieae with 155 species.

The ferns are divided into two distinct subclasses called the Eusporangiatae and Leptosporangiatae. The eusporangiate ferns have the spore bearing tissue of the sporangium developed from hypodermal cells while in the leptosporangiate forms the sporangia arise from epidermal cells. The other Homosporous Pteridophytes are eusporangiate. The leptosporangiate ferns appear after the Paleozoic Era and are at present by far the most abundant. There are two orders of Eusporangiatae, the Ophioglossales and Marattiales. Some authors have attempted to associate the Ophioglossales with the Lycopods, but from a consideration of all their characteristics it does not appear that there is any evident relationship. The Leptosporangiatae are a

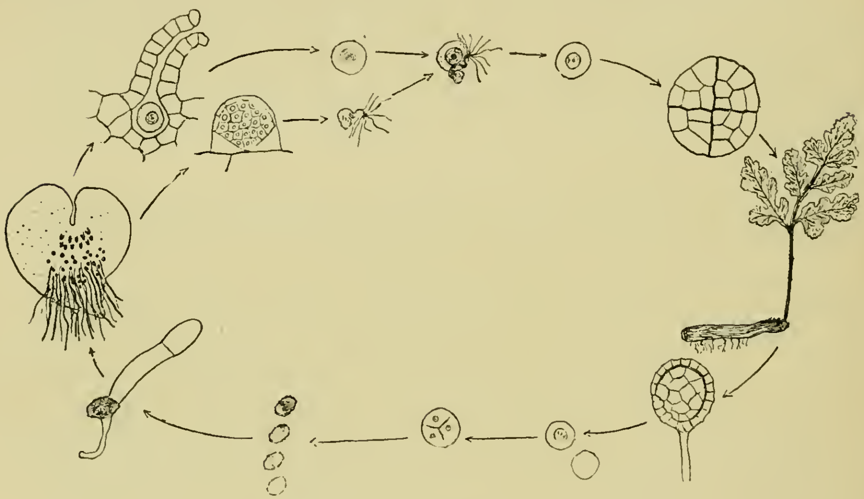


Fig. 1. Diagram of Life Cycle of Ordinary Fern.

compact group consisting of but one order, the Filicales. The ferns usually bear large, much compounded leaves but occasionally the leaves are simple and entire.

The horsetails are rush-like geophilous perennials with jointed, mostly, hollow, simple or branched, aerial stems and leaves reduced to toothed sheaths at the nodes. Some are highly impregnated with silica and are hence called scouring rushes. They are closely related and constitute but a single order, the Equisetales, with a single family and genus.

The lycopods are small herbaceous often geophilous plants with numerous small scale-like, lanceolate or subulate, simple leaves. There is but one order, the Lycopodiales, consisting of two families.

There is considerable similarity in the life cycles of the three classes. The general account given below of the life history of a leptosporangiate fern will hold good for any of our common species of Adiantum, Asplenium, or Dryopteris, but other groups may show important differences in details. In no subkingdom is the antithetic alternation of generations more clearly marked and each generation lives independently for a part of its life. The sporophyte or nonsexual generation is the conspicuous plant although the gametophyte is usually of some size and easily distinguishable except in the Ophioglossales and some Lycopodiales where it is entirely subterranean.

The sporophyte of our common ferns has a horizontal rhizome and compound leaves which commonly form a rosette above ground. The stem consists of a general ground tissue containing closed concentric fibro-vascular bundles. The stem and root tips have definite apical cells. In the Ophioglossales the bundles are open and arranged as in the higher plants, forming a ring of wood and central pith. There is also a definite cambium layer outside of the xylem cylinder.

The younger leaves of the ferns are sterile but later rosettes of spore-bearing leaves are produced. The rosette of sporophylls corresponds to the fertile or spore-bearing parts of a flower in the higher plants. In some of the lycopods there are also simple zones of spore-bearing leaves alternating with the zones of sterile foliage leaves, the growth of the stem not being stopped when the sporophylls are developed. But in other lycopods and in the horsetails the sporophylls are arranged in closely crowded cones which terminate the branches, their growth in length being permanently checked. In these groups, therefore, we have true primitive flowers—modified and specialized spore-bearing shoots. The three essentials of a flower are (1) a stopping of the growth of the floral axis, (2) a shortening of the floral axis and consequent crowding of the floral organs, and (3) a modification of the spore-bearing leaves into specialized sporophylls.

The sporangia are produced in clusters called sori, often very numerous. Each sporangium produces a number of cells which become free and more or less spherical in the sporangial cavity. These cells are called sporocytes. Each sporocyte divides twice, producing a tetrad of cells. These four cells finally separate and give rise to four nonsexual spores. During the first division in the formation of the spore-tetrad the number of chromosomes in the nucleus is reduced one-half, or from a $2x$ number to an x number. The x number of chromosomes is continued through the entire subsequent history of the following gametophyte generation. The sporangia are stalked and are provided with a peculiar ring of cells by whose contraction the cavity of the sporangium is torn open on one side and the spores thrown out.

When the spore germinates it gives rise to a short filament or protonema from the end of which a flat dorsiventral more or less heart-shaped thallus develops. The development of the gametophyte therefore falls normally into two distinct stages. In the first the plant body is a linear aggregate, in the second it is a solid aggregate. The thallus is supplied with abundant chlorophyll and is attached to the earth by means of numerous unicellular rhizoids. The thallus is hermaphrodite and develops a number of antheridia or spermaries and archegonia or ovaries on the lower side. These organs are partly imbedded in the tissues of the thallus. A number of large spirally coiled, multiciliate spermatozoids are developed in each antheridium. These finally escape, when the thallus is covered with water, through a rupture in the outer part of the antheridial wall and after swimming around for a while enter the necks of the archegonia. The spermatozoids of the horsetails are also spirally coiled and multiciliate but those of the lycopods are small and biciliate. A single oosphere or egg is produced in each archegonium. The mother cell of the egg divides giving rise to the incipient egg and the ventral canal cell. The ventral canal cell and the cells in the neck of the archegonium dissolve and at the same time the cells at the end of the neck of the archegonium, the so called lid cells, separate leaving a passage from the outside down to the egg. A spermatozoid passes down the neck to the egg and conjugates with it. This is fertilization, and during the union of the two cells their nuclei also unite, thus doubling the amount of chromatin in the cell. The fertilized egg or oospore, therefore, contains potentially $2x$ chromosomes which appear when germination takes place.

The egg germinates in the venter of the archegonium. First there is a diagonal or nearly vertical division into two cells and these each divide again, more or less at right angles to the first division, giving rise to the first four cells which are the incepts of the four regions present in the developing sporophyte embryo. One cell gives rise to the root tip, the second to the nourishing foot, the third to the stem tip, and the fourth to the first leaf. The developing embryo is entirely parasitic on the parent gametophyte which continues to manufacture food for a considerable length of time. Finally the embryo breaks through the wall of the enlarged venter of the archegonium and the root tip grows downward into the ground while the first leaf grows upward toward the light. Thus the pteridophyte embryo always passes through a bryophyte stage. The embryo passes gradually from a parasitic life and becomes completely independent when the gametophyte dies. When normal conditions are present the development of the embryo always results in the death of the parent gametophyte.

During the juvenile stage the young sporophyte usually has a type of leaves different from those of the mature condition, but gradually it becomer more and more like the mature fern and finally takes on the form normal to the species, in which condition it may live to an indefinite age. The horizontal rhizome continues to develop and branch at the tip and if decay takes place at the back end vegetative propagation is accomplished and the result is a larger and larger number of independent individuals.

The four main stages of a fern are therefore as follows:

1. The sporophyte or fern plant proper.
2. The nonsexual spores produced as the result of a reduction division.
3. The gametophyte or thallus plant.
4. The oospore produced as the result of the conjugation of the egg and sperm.

An interesting deviation from the usual type of alternation of generations is present in some ferns. In a few species a thallus may develop by vegetative propagation from the tissues of the sporophyte. This is called apospory. Or the sporophyte may develop directly from the tissues of the gametophyte and not from an egg. This is known as apogamy. The details of apogamous and aposporous structures have not been investigated to any great extent and there is still doubt as to whether or not a conjugation or a reduction takes place.

But if these important processes are omitted the change from gametophytic to sporophytic characters or vice versa may be explained in the following manner. It is evident that every cell in the gametophyte, or at the least the reproductive ones, must also contain the hereditary characters which are present in the sporophyte; but these characters are for the time being dormant. In the same way every cell in the sporophyte must also possess the hereditary characters peculiar to the gametophyte. Now, in ordinary cases gametophytic characters become active and assert themselves only as the result of a reduction division and sporophytic hereditary tendencies are only apparent after the conjugation of the egg and sperm. But there may be other stimuli able to induce the change, a response to which in the case of apogamy causes the gametophytic hereditary tendencies to become dormant and the sporophytic tendencies to become active, thus producing a sporophytic shoot; or in apospory, causes the sporophytic tendencies to become dormant while the gametophytic tendencies resume activity.

There is a difficulty in regard to the probable influence of the x and $2x$ number of chromosomes in determining the gametophyte and sporophyte generations, but the double or half number of chromosomes may not be the important factor in determining the generation. The solution of the problem must rest until the cytology of the tissues involved has been thoroughly established. However these phenomena may be explained, they must be regarded as only incidental deviations which have arisen in plants belonging to a highly specialized group originally possessing a typical alternation. The presence of apogamy and apospory has nothing to do with the normal evolution of the alternation of generations in the higher plants.

A LIST OF ISOPODA FROM THE STATE OF OHIO, PRESERVED IN THE MUSEUM OF THE CINCINNATI SOCIETY OF NATURAL HISTORY.

Josua Lindahl.

This list was read at the Cleveland meeting of the Ohio Academy, in November, 1904, but was not turned over to the Secretary for publication at the time. Now since we have such an exceedingly good treatment of the subject in "A Monograph on the Isopods of North America" by Harriet Richardson (Bull. 54, U. S. N. M.) it appears appropriate to publish the list in the Ohio Naturalist to encourage the search for more species in the State, as there surely must be more than I have collected. Indiana has some species of Asellidae which are not in my list.

Fam. *Asellidae.*
- Mancasellus macrourus Garman, Hamilton Co.
- Asellus communis Say, Hamilton Co., Sandusky (E. L. Moseley).

Fam. *Oniscidae.*
- Cylisticus convexus De Geer, Hamilton Co., Springfield (Mrs. Eva Engstrom), Columbus (H. Osborn).
- Porcellio laevis Latreille, Cincinnati.
- Porcellio rathkei Brandt, Hamilton Co., Springfield, Columbus (H. Osborn).
- Porcellio scaber Latreille, Hamilton Co., Springfield.
- Metoponorthus pruinosus Brandt, Hamilton Co., Springfield, Columbus (H. Osborn).

Fam. *Armadillididae.*
- Armadillidium vulgare (Latreille), Hamilton Co., Springfield.

The collection of Isopoda in the museum, comprising, at present, 19 genera, 36 species, has lately been revised by Dr. Harriet Richardson, the eminent Carcinologist of the U. S. National Museum in Washington.

Cincinnati.

A PSEUDOSCORPION FROM GUATEMALA.

E. W. Berger, Ph. D.

This Pseudoscorpion was collected by Professor James S. Hine just to the west of Gualan, Guatemala, January 15, 1905. The writer has identified the same as *Atemnus elongatus*, Bks. Mr. Banks sums up its (I, 1895) occurrence in the following lines: "Beaten from dead hickory wood in April near St. Lucie Riv., Indian River, Florida, by Mr. Hubbard; also at Sand Point and Enterprise, Fla., Punta Gorda, Fla., (Mrs. Slosson). A young specimen taken by myself at Runnemede, Fla., may belong to this species;" etc. To this should. of course, now be added Gualan, Guatemala. The chief interest to me of this find is, that it is another instance illustrating the extended north and south distribution of certain species of the Pseudoscorpionidae. In a previous paper (II) I made note of the fact that many species have a far north and south distribution, but not a very extensive one east and west. Thus none of the native eastern species were found to occur upon the Pacific Coast, and vice versa, while several of the species in the Eastern States are reported from Jamaica (II) to New York, and no doubt will be found farther north. For illustration I mention *Chelanops oblongus*, Say, and *Chthonius pennsylvanicus*, Hagen, each of which have the distribution mentioned.

The *Atemnus elongatus* was found to the east of the highlands of Guatemala, but whether it occurs to the west of these Professor Hine did not determine.

The specimens were collected from under the dead bark of an inclined tree, the under half of which was still alive. The animals were found in groups of a dozen, more or less, and apparently very much involved in some threads of silk, presumably of their spinning. This was also the condition of the preserved specimens. I was surprised at the manner in which these were tangled up into a bunch with threads of silk, until Professor Hine explained to me the condition in which he had found them. The significance of this condition I do not understand. It occurs to me that they may have been in some condition of rest for the season, which is dry at that period of the year. The animals, however, were not torpid and scattered when disturbed and this manner of congregating in groups may be nothing more than a regular habit. The fact, however, that several other species of larger arthropods were observed congregated into groups, literally by the hundred, seemingly in some condition of rest approximating hibernation, makes the belief, that the pseudoscorpions were in a similar condition, not improbable. Among these other "arthropods" were hundreds of harvestmen collected together in shallow hollows beneath the overhanging banks of a small stream. These were arranged in close proximity to one another with their long legs bent upward, thus making a very peculiar appearance. There were several species of these, but each species was congregated by itself. Several species of Hesperidae were also observed to be collected in a similar manner, clinging close together, to overhanging hollows beneath the bank, each species for itself.

The characters of the *A. elongatus* from Guatemala tally very nicely with the description by Mr. Banks (I) and I deem it unnecessary to give any extensive description here, except to state that they measure three millimetres in length and are dark brown with the legs much lighter.

I tried to determine the sexes of the specimens collected (22 in number), but was not successful. I had concluded that the specimen figured was a male, but a study of sections made from this after having completed the drawing showed it to be a gravid fertilized female (Plate X). I counted from thirty-five to forty apparently well developed eggs in the ovary, and I estimated that a bunch of spermatozoa found in the oviduct, just inside the genital opening, consisted of not less than two hundred individuals, and there may have been twice that number. These facts clearly show that the female is fertilized prior to the laying of her eggs and that the spermatozoa may be retained by the female at least for some short time (if not for a longer time) before the eggs are fertilized and laid.

All the longer hairs upon the figure (Plate XXXI) are exactly as in nature. All hairs upon the dorsal scutae, the top of the cephalo-thorax (a few very small ones omitted), the edges of the cephalo-thorax and the mouth parts, or chelae, are exactly as in nature.

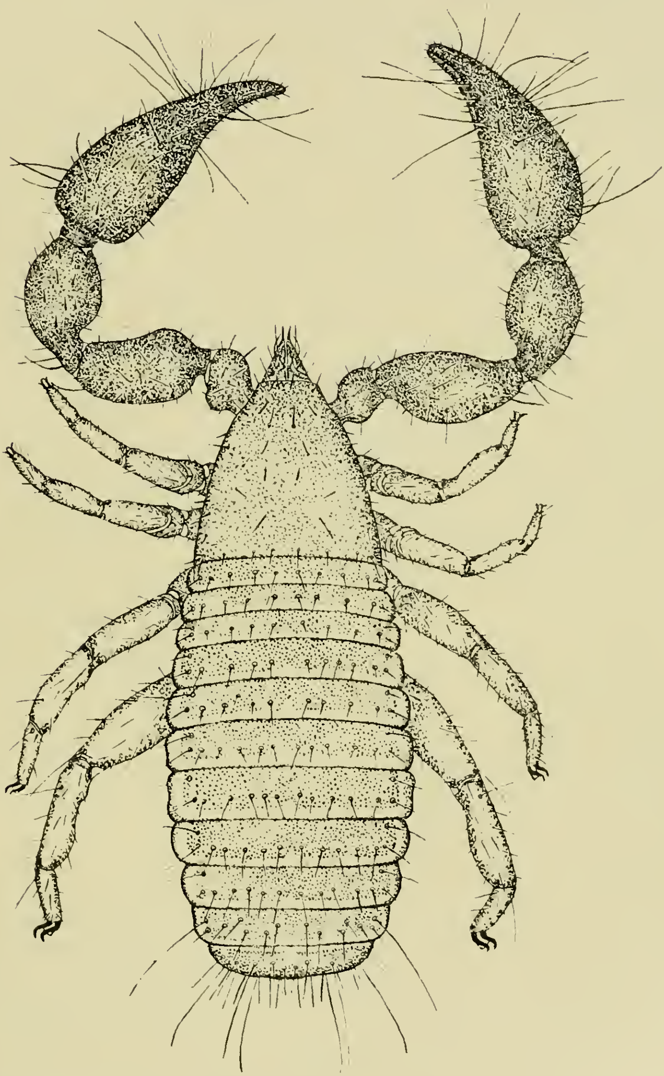
Specimens of pseudoscorpions will be gratefully received and exchanges made when possible.

Biological Hall, Ohio State University, Columbus, February 14, 1906.

LITERATURE.

I. Nathan Banks, 1895. Notes on the Pseudoscorpionidae. Journ. N. Y. Entom. Soc., Vol. 3, No. 1.

II. Berger, E. W. 1905. Habits and Distribution of the Pseudoscorpionidae, Principally Chelanops Oblongus, Say. The Ohio Naturalist, Vol. VI, No. 2. Contributions Dept. Zool. and Entom. Ohio State Univ., No. 23.



E. W. Berger, del.

Atemnus elongatus, Bks.

SOME NEW OR NOTEWORTHY SPECIES REPORTED FOR OHIO IN RECENT BOTANICAL LITERATURE.

OTTO E. JENNINGS.

Having in mind the considerable extent of the current botanical literature relating to the flora of the northeastern United States one is justified, perhaps, in assuming that very few of the botanical readers of the NATURALIST have access to more than a small part of such literature as might occasionally contain references to the flora of Ohio. For this reason it has seemed desirable to call attention to some new or otherwise interesting species which have more or less recently been accredited to Ohio, in order that Ohio botanists may be placed on the look-out for such species and further desirable information thus be brought to light concerning their distribution and occurrence.[1]

1. *Eriophorum viridi-carinatum* (Engelm.) Fernald.

Mr. Fernald distinguishes this species from *E. polystachyon* L., with which it appears to have been variously included by many American botanists, as follows:

"*Midrib of the scale prominent only below the membranaceous tip; leaves triangular-channeled above the middle; the upper sheaths dark-girdled at the summit.*" *E. polystachyon* L.

"*Midrib of the scale prominent, extending to the tip; leaves flat, except at the very tip; the sheaths and bracts not dark-girdled.*"
E. *viridi-carinatum* (Engelm.) Fernald.

For the range of his new species Mr. Fernald gives "Bogs and wet meadows, Newfoundland to Saskatchewan and British Columbia, south to Connecticut, New York, Ohio, Michigan, Wisconsin, and said to follow the mountains to Georgia." Among the many specimens designated as typical there is one, without a definite locality, for Ohio, "Ohio (Sullivant)." It is highly probable that other specimens of this speeies are to be found in Ohio collections.

In his interesting article on Certain Polygonaceous Genera,[2] Prof. Greene says: "A diligent study of much material from almost all parts of the United States, occurring in the herbaria under the name of *Polygonum Muhlenbergii*, more recently denominated *P. emersum*, has shown that this also is an aggregate of species, some of them strongly marked, others less so. They differ one from another markedly as to leaf outline and also as to the attitude of the foliage, the leaves in some spreading

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1. Fernald, M. L. The North American Species of Eriophorum. Part I. Synopsis of American Species. Rhodora, 7: 81–92. May, 1905.
2. Greene, Edward L. Certain Polygonaceous Genera. Leaflets, I : 17–50. January 5 and March 12, 1904.

away from the stem almost divaricately, but in the greater number being ascending or suberect. As to the pubescence they exhibit not only different degrees but different kinds of hairiness; and that of the midvein beneath invariably differs from that of the superficies of the leaf. In both the form and the indument of the bracts of the spikes one finds also another set of specific characters."

Among the new species named in this connection are several which from the localities reported are likely to occur in Ohio but only one is definitely accredited to the State, as follows:

2. *Persicaria laurina* Greene.[2]

"Of the size and the slender decumbent habit of *P. remota*, (*which see below*) but leaves elliptic-lanceolate and about seven inches long including the one-half inch petiole, thin, sparsly and minutely strigose on both faces, more pronouncedly and densely so on the midvein, especially beneath; ocreae, as also the lower internodes of the stem, sparsely appressed-hairy; spikes very slender, 1 to 2 inches long, on slender glandular-hirtellous peduncles; bracts rhombic-ovate, hairy, not ciliate."

"Catawba Island, in Lake Erie, northern Ohio, 5 Sept., 1897, E. L. Moseley; the type specimens in the U. S. Herb. Leaves with the outline and venation of those of *Laurus nobilis*."

P. remota Greene, referred to in the aobve description, was described from Maine in the same article, partly as follows: "Stem rather slender, 1 to 2 feet long, decumbent, the nodes enlarged, internodes 1 to 2 inches long, glabrous, many angled."

As the writer knows from past experience, Ohio is particularly rich in forms usually designated as *Polygonum emersum* (Mx.) Britt., or closely allied species, and in the abundant material available in and about the many ponds, reservoirs, streams, canals, swamps, marshes, and along Lake Erie, there is a fine opportunity for some Ohio botanist to do some excellent systematic work.

3. *Sisymbrium officinale leiocarpum* DC.[3]

Dr. B. L. Robinson calls attention to the fact that the eldest DeCandolle recognized two distinct forms of *Sisymbrium officinale* and that these two forms are present in the United States.

Sisymbrium officinale Scop. "Rather copiously pubescent on stem and leaves; the inflorescence and pods even at full maturity subtomentulose; whole plant bluish or grayish green."

S. officinale leiocarpum DC. "Sparingly pubescent with stiffish slightly retrorse hairs; the inflorescence nearly smooth;

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2. Greene. Edward L. Certain Polygonaceous Genera. Leaflets, I : 17–50. January 5 and March 12, 1904.

3. Robinson, B. L. Two varieties of Sisymbrium Officinale in America. Rhodora, 7 : 101–103. June, 1905.

pods glabrous or with a few scattered hairs; plant inclining to yellowish-green."

Dr. Robinson notes that the variety is the common American form, the opposite being true in Europe, and that the true species is as yet chiefly established in the United States in California, although it has now been found in Maine. The writer would here report having collected specimens of the true species along Mill Creek, Sandusky, Ohio, July, 1905.

4. *Ribes Cynosbati glabratum* Fernald.[4]

"Leaves pubescent only with scattered hairs, becoming glabrate in age." * * * "Ohio Painesville, 1871 (*H. C. Beardslee*); Oberlin, June, 1894 (*Hicks*)."

Mr. Fernald points out that *Ribes oxycanthoides* L. has distinct characters of pubescence on certain calcareous soils which he designates as *R. oxycanthoides calcicola* Fernald, and further states that "A striking difference in the degree of pubescence, suggesting that shown in Ribes oxycanthoides is found also in Ribes Cynosbati." The "typical form of *R. Cynosbati*, with soft-pubescent leaves extends through the St. Lawrence basin to the Great Lakes and beyond, and southward in the Eastern States. An extreme with leaves quite as glabrate as in the true *R. oxycanthoides* is found on the south shore of Lake Erie and on the slopes of some of the higher Alleghanies. Whether this smooth-leaved extreme is, like the typical smooth-leaved *R. oxycanthoides*, confined primarily to the less calcareous soils, the data at hand do not clearly show; but the very glabrate phase of the plant seems worthy of distinction."

While at O. S. U. the writer recalls having on several occasions, although with inward misgivings, designated certain very glabrous specimens as *R. Cynosbati* L., particularly specimens collected by himself along the Huron River in the western part of Huron County and also along the Big Darby between Franklin and Madison Counties. It will be noticed that both these localities are practically in the Devonian limestone outcrop and as nearly as the writer can recall the specimens, which are probably to be found in the State Herbarium at O. S. U., correspond exactly to Fernald's description of *R. Cynosbati glabratum*.

5. *Aloites farinosa* Greene.[5]

Prof. Greene would accept the genus *Aloites* of Rafinesque for certain of the North American species usually placed in the genus *Gentiana* in our present manuals. He describes among others a new species as follows:

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4. Fernald, M. L. Some Lithological Varieties of Ribes. Rhodora, 7 : 153–156. Aug., 1905.

5. Greene, Edward L. On certain Gentianaceae. Leaflets, I : 91–95. Dec. 31, 1904.

Aloites foliosa Greene. "Habit of the last, (*A. mesochora* Greene, *which see below*) with very ample foliage: leaves 2½ inches long, half as broad; umbellate flower clusters all subtended by a pair of well developed leaves like an involucre; flowers smaller than in the last; calyx-tube broader, segments partly subulate, partly exactly lanceolate, all very acute, the longest half as long as the corolla, sinuses open, rather obtuse; segments of corolla with short setaceous point."

"Known only from along Vermillion River, northern Ohio; E. L. Moseley, 1898."

Partly as a further explanation to the last species and partly because from its distribution it might possibly be expected to occur in Ohio it may be well to note also:

Aloites mesochora Greene.

"Larger plant than the last (A. occidentalis (Gray) Greene—Gentiana quinquefolia occidentalis (Gray) Hitchcock) with larger foliage and larger flowers but of less branching habit, large plants often simple save as to the axillary pedunculiform branches; calyx with extremely narrow tube, the unequal segments partly linear, partly lanceolate, all setaceously acuminate, the longest of notably less than half the length of the corolla, the sinuses not closed, acute; corolla lobes with unusually long and slender acumination."

"Northern Indiana, also adjacent Michigan and westward to Illinois and Dakota."

The plant here referred to as *Aloites foliosa* Greene is evidently the same as the one referred to by Prof. Moseley in his Sandusky Flora as "Gentiana quinqueflora Lam. Vermillion River; frequent on the east fork. Margaretta Ridge; rare," and in this connection one is led to think that perhaps some of the specimens in the State Herbarium at O. S. U. and reported in the Fourth State Catalogue of Ohio Plants as *Gentiana quinquefolia* L. may also be Prof. Greene's new *Aloites foliosa.*

Carnegie Museum, Dec. 26, 1905.

KEY TO OHIO CATALPAS IN WINTER CONDITION.

Allen McOwen.

Catalpa Scop. Trees with gray or brownish gray robust twigs; axillary buds small and flat, single, opposite or in threes; terminal bud self-pruned; lenticels large, scattered; pith large, solid, cylindrical, white; leaf scars large, oval or circular, concave, distinct, not united by a connecting line; stipular scars none; bundle scars numerous, in an ellipse or a ring; fruit a long bean-like capsule, persistent; seeds flat, winged, the wings ending in white thread-like hairs.

1. Twigs of the season coarse pubescent, bark of twigs not strong scented nor bitter; bark of trunk rough; capsule very slender, 3 lines in diameter, 6–10 inches long; seeds 6 lines long. *Catalpa ovata* Don. Japan Catalpa.
1. Twigs of the season glabrous; capsule large, 12–20 inches long; 5–10 lines thick; seeds 15–20 lines long, 3–4 lines wide. 2.
2. Wings of seed usually narrowed at the ends; bark of trunk thin and flaky; an irregular tree with spreading branches; bud scales rather open and spreading. *Catalpa catalpa* (L.) Karst. Common Catalpa.
2. Wings of seed usually broad, the threads running parallel; bark of trunk thick and rough; a large erect tree; bud scales rather close. *Catalpa speciosa* Ward. Hardy Catalpa.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, Jan. 15, 1906.

The Club was called to order by the President, Mr. Griggs. The minutes of the last meeting were read and approved.

Mr. Herms presented the paper of the evening. He gave the results of his work carried on at Cedar Point.

Prof. Osborn reported the meeting of the A. A. A. S. which was held at New Orleans. He reported especially the papers that were presented on Yellow Fever and the Boll Weevil.

Mr. Cotton talked very interestingly of the papers read before the section of Economic Entomologists.

Mr. Griggs reported his work on Ascaris. It has been held that there was a double longitudinal splitting of the chromosomes, but Mr. Griggs has shown that it is a single longitudinal split, a folding and a transverse split which gives the appearance of a double longitudinal split.

The Club then adjourned until February.

Z. P. Metcalf, *Secretary.*

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TABLE OF CONTENTS.

DESCRIPTIONS OF TWO NEW CICADAS FROM LOUISIANA.

HERBERT OSBORN.

The species of Cicadas described here have come to me from Louisiana and inasmuch as one of them appears to be of economic importance and the other to possess points of special biologic interest, it seems desirable that they should be described.

Cicada erratica n. sp.

Apparently closely related to *Cicada nigriventris* Walk but differing in details of opercula and in coloration. Sordid green with fuscous and blackish markings. Length to tip of abdomen 21 mm., to tip of folded wings, 36 mm., width of humeri, 9 mm.; width of eyes, 8 mm.

Head scarcely as wide as pronotum, vertex scarcely longer at middle than next to eye, pronotum with marginal keels slightly expanded posteriorly. Elytra reaching half their length beyond the tip of abdomen.

Color,—green, tinged with yellow; a transverse band from eye to eye the posterior projection including ocelli, upper surface of front its central portion between the transverse bars, tip of clypeus, a central divided stripe on pronotum, some lateral patches, marginal patch on posterior lobe, four cuneiform marks, base of scutellum at sides, terga of abdomen except hind margins, apex of rostrum, tarsal joints, basal segment of female, central patch on last ventral segment, ovipositor and tip of pygofer, dark fuscous or black. Elytra, transparent, veins green to about the middle, black on apical half, veins of wings black to a point somewhat nearer the base.

Genitalia,—Last ventral segment of female deeply emarginate, pygofer with sinuate borders the sides meeting a little in front of apex of ovipositor. whole margin pallid, the surface and the tip of sheath hairy.

Male ventral segment narrowing posteriorly, subtruncate apically with about ten close ridges, anal plate about as long as broad, outer portion flattened, central stripe black, claspers strongly curved back, polished.

The male agrees closely with the female in size and coloration, the opercula are broader than long, curved posteriorly, inner edge not meeting the hind border, extending only to border of abdominal segment.

This species is reported by Mr. Newell as depositing eggs to such an extent as to cause serious injury to cotton, corn and some other plants. A detailed account of its habits is given in the report of the Association of Economic Entomologists for 1905. This species has been taken at Shreveport, June 19, '05, and Logtown, La., June 19, 1905.

I have also in my collection two specimens of males collected by Mr. F. W. Mally at Shreveport, La., July 2, 1891. These specimens were determined as possible examples of Cicada nigriventris Walk. but with a larger series of individuals this reference seems impossible. Prof. Uhler has kindly compared with his sordidata and agrees with me that it cannot be referred to that species. Seven males and three females.

Cicada delicata n. sp.

Similar to *pallida* Distant, but differing in elytral marking and in coloration, length to tip of abdomen, 18 mm., to tip of elytra, 27 mm., width of head and eyes, 8 mm.

Head including eyes nearly as wide as widest point on pronotum, head produced anteriorly, the front with about nine transverse ridges each side. Pronotum with narrow marginal carina expanding slightly into the posterior angle. Cross veins of elytra quite oblique and deeply infuscated.

Color,—Light green, especially pronounced on front; legs, except tarsi, hinder margin of pronotum, basal portion of elytral veins, vertex, hinder portion of pronotum and disc of meso-thorax, opercula and abdomen below ochery-yellow, dorsum of abdomen tinged with testaceous. A transverse irregular band produced backwardly to occiput and including the reddish ocelli and dorsal portion of front and eyes, black. The anterior portion of pronotum is marked with two spots extending from the black margins of the vertex. The anterior part of mesothorax includes four cuneiform black spots, the outer portion is also infuscated becoming a fairly distinct black posteriorly and there are two distinct black points just in front of the elevated x of the scutellum. The tip of the rostrum and claws of tarsi and spines of hind tibiæ are blackened but otherwise under portion is pallid.

Genitalia,—Last ventral segment of female rather short, shallowly emarginate behind with shallow rounded notch at centre and bare callous spot each side, pygofer short, borders barely meeting beneath, a short sharp spine dorsally. Male ventral segment narrowed abruptly behind, apex slightly convex, a few transverse furrows, anal plate narrowed, borders strongly reflexed, apex obtusely pointed, claspers short and blunt. Male is very similar to female in size and coloration, the opercles broad, sinuate laterally, reaching second abdominal segment posteriorly, inner margins narrowly touching.

This is a very handsome little species collected at the Gulf Biologic Station, Cameron, La., by Prof. J. S. Hine and Mr. J. B. Garrett. It occurs among the growth of Iva frutescens which abounds in lowland or swampy areas near the coast and doubtless oviposits in this plant. While resembling pallida in size and to some extent in coloration, it differs distinctly from that species in sexual characters. The light green color, prominent smoky margin on the oblique veins of elytra and the testaceous upper surface of abdomen as well as shape of opercula, form distinctive characters. Described from five males, one female.

ECOLOGICAL OBSERVATIONS ON THE FLORA OF THE SHALE BLUFFS IN THE VICINITY OF COLUMBUS, OHIO.

WALTER FISCHER.

The Ohio and Olentangy shales crop out in various places in this state, from the shores of Lake Erie in a line extending through the Scioto valley to the Ohio River. During the past summer and fall the writer has had an opportunity to study a few of these exposures, which are found north of Columbus along the Olentangy River and in the deep ravines leading into it from the east. The district studied embraced an area about ten miles in length by two in width and includes some of the best outcrops in the state.

The prevailing type of vegetation on the high dry land near the bluffs is the open white oak forest which contains also red and chestnut oaks, hickories, poplars and ashes. The undergrowth consists of straggling groups of papaw, Crataegus, black haw and blackberry. Further back beech forests, more or less mixed with other trees become quite frequent. Closer to the edge of the bluffs, in the dry usually well drained clay soil, the vegetation is decidedly xerophytic. This is readily seen from the list of herbaceous plants found here:

Agrostis hyemalis (Walt.)
Danthonia spicata (L.)
Poa compressa L.
Potentilla Canadensis L.
Linum Virginianum L.
Polygala verticillata L.
Euphorbia corollata L.
Hedeoma pulegioides (L.)
Pedicularis canadensis L.
Houstonia purpurea L.
Lobelia inflata L.
Hieracium venosum L.
Hieracium scarbum Michx.
Solidago ulmifolia Muhl.
Solidago nemoralis Ait.
Antennaria plantaginifolia (L.)
Gnaphalium obtusifolium (L.)
Achillea Millefolium L.

Such shrubby plants as *Rhus glabra*, *Rubus nigrobaccus* and *R. procumbens* with lichens and xerophytic mosses, are also always to be found here.

The slopes of the old ravines in which sufficient humus has collected, are clothed with a mesophytic growth of usually not very large trees, chiefly oaks, with a luxuriant shrubby and herbaceous undergrowth. In the more open ravines this herbaceous undergrowth is decidedly vernal, whereas in the narrower and deeper ravines, which are much more shady and moist, it consists mostly of ferns, and of these, *Dryopteris marginalis* is by far the most common. Here too, the beech takes the place of the oak, as it does at the base of the more open ravines.

The following are some of the commoner plants found in this mesophytic forest area:

Trees.

Juglans cinerea L.
Carpinus caroliniana Walt.
Ostrya Virginiana (Mill.)
Fagus Americana L.
Quercus rubra L.
Quercus velutina Lam.
Quercus coccinea Wang.
Quercus alba L.
Quercus acuminata (Michx.)
Amelanchier Canadensis (L.)
Prunus serotina Ehrh.
Aesculus glabra Willd.
Acer rubrum L.
Tilia Americana L.
Fraxinus Americana L.
Fraxinus quadrangulata Michx.
Cornus florida L.
Cornus alternifolia L. f.
Nyssa sylvatica Marsh.

Shrubs.

Ribes Cynosbati L.
Hamamelis Virginiana L.
Euonymus obovatus Nutt.
Staphylea trifoliata L.

Herbs.

Adiantum pedatum L.
Dryopteris marginalis (L.)
Dryopteris spinulosa (Retz.)
Filix fragilis (L.)
Filix bulbifera (L.)
Arisaema triphyllum (L.)
Carex albursina Sheldon
Carex Pennsylvanica Lam.
Unifolium Canadense (Desf.)
Salimonia biflora (Walt.)
Actaea alba (L.)
Hepatica acuta (Pursh).
Hepatica Hepatica (L.)
Syndesmon thalictroides (L.)
Thalictrum dioicum (L.)
Caulophyllum thalictroides (L.)
Sanguinaria Canadensis L.
Bicucula cucularia (L.)
Arabis laevigata (Muhl.)
Heuchera Americana L.
Aralia racemosa L.
Washingtonia Claytoni (Michx.)
Washingtonia longistylis (Torr.)
Mitella diphylla L.
Mitchella repens L.
Galium concinnum T. & G.
Nabalus altissimus (L.)
Solidago caesia L.
Solidago flexicaulis L.
Aster cordifolius L.
Polymnia Canadensis L.
Senecio obovatus Muhl.

It was interesting to watch the destruction of this mesophytic flora and the transition through the various stages of xerophytic life back to the mesophytic stage again. When a ravine has found its lowest level it begins to widen, a process which takes place very rapidly when a slight shifting of the current turns the streams against one of the soft shale banks for, as the shale is very brittle, a slight undermining causes it to break and slide. This strips the forest of its entire undergrowth; the light humus going first, carrying with it the herbaceous plants, followed by the shrubs, leaving the larger trees with their securer holdfasts until last. The erosion may cease at this point, or it may go on until the slope becomes precipitous and is swept of its last vestige of vegetation. In either case, the plants mentioned as being in the xerophytic zone above, may begin to creep down as soon as sufficient earth has been washed down to enable them to thrive.

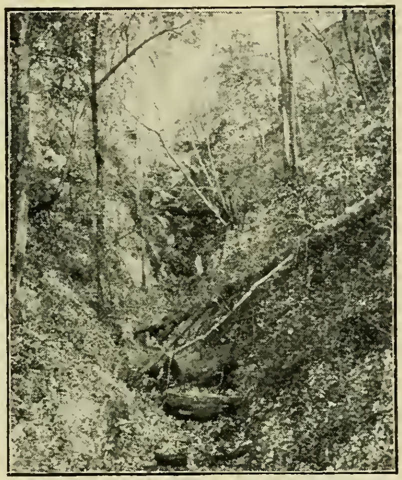

Fig. 1. View in upper end of a narrow ravine showing character of the vegetation.

Owing to the great isolation of the different ravines, there is less uniformity in the succession of the different plant societies than might otherwise be expected. Especially is this true of the earlier stages. Some of the first plants to appear on the pure exposed shale are the annuals *Anychia dichotoma*, *A. Canadensis* and *Oxalis stricta*. In some places nearer to civilization, *Melilotus alba* is one of the earliest occupants of the naked cliffs. In the shrubby thicket which follows, there is usually a great dearth in the number of species. *Rubus nigrobaccus* may be uniformly relied upon to appear first, while *Vaccinium vacillans*, *Gaylussacia resinosa*, *Amelanchier Canadensis* and *Acer rubum* are always found in the dryest, hottest and most exposed shales; and these, with a carpeting of lichens, mosses and Danthonia, may immediately be followed by a young sturdy growth of white and red oaks.

In ravines where the shale is kept moist by springs, or on the dry, southern and western exposures. *Solidago caesia*, *S. flexicaulis*, *Aster macrophyllus*, *Rubus occidentalis*, as well as *R. nigrobaccus*, *Hamamelis Virginiana*, with ferns, mesophytic mosses and liverworts obtain a foothold here, perhaps earlier than usual and are quite abundant.

An interesting plant society was found on a bluff at High Banks on the Olentangy River. This magnificent bluff is over one hundred feet in height, exposed to the rays of the afternoon sun, and in places so steep and the rock so loose that no vegetation has been able to gain a foothold. But few trees are found on this exposure; straggling and shrubby red and white oaks, junipers, red maples, service-berries and hop hornbeams are the only representatives. The xerophytic thicket association, however, is well developed and consists of the following species:

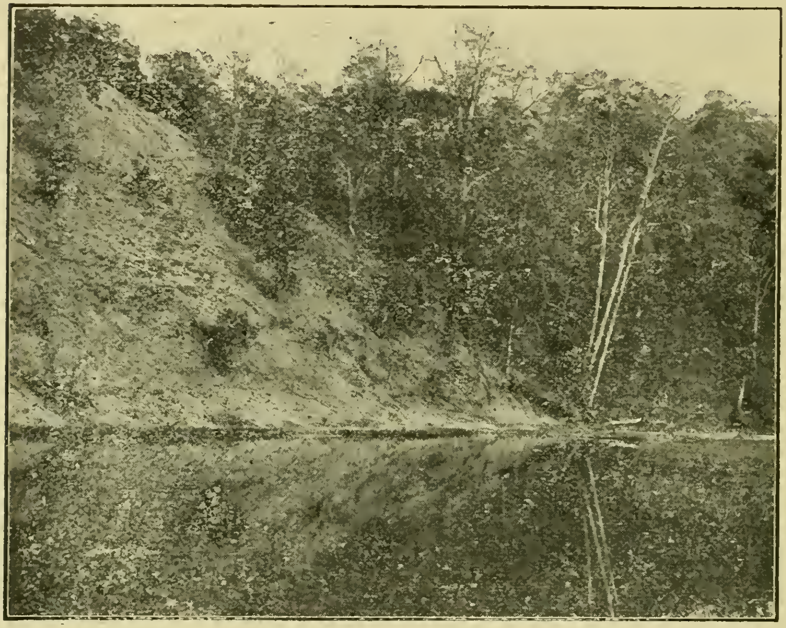

Fig. 2. A shale bank which has suffered from erosion. Here the vegetation has nearly all disappeared. A few trees still standing, indicate the type of the original forest.

Shrubs.

Rubus nigrobaccus Bailey.
Rubus procumbens Muhl.
Rosa humilis Marsh.
Aronia nigra (Willd.)
Rhus glabra L.
Rhus radicans L.
Euonymus atropurpureus Jacq.
Parthenocissus quinquefolia (L.)
Rhamnus lanceolata Pursh.
Vaccinium vacillans Kalm.
Gaylussacia resinosa (Ait.)
Polycodium stamineum (L.)
Diervilla Diervilla (L.)
Lonicera glaucescens Rydb.
Viburnum acerifolium L.
Viburnum prunifolium L.
Cornus candidissima Marsh.

Interspersed with and adjoining the above, were the following herbaceous perennials:

Andropogon scoparius Michx.
Andropogon furcatus Muhl.
Sorghastrum avenaceum (Michx.)
Muhlenbergia diffusa Willd.
Allium cernuum Roth.
Comandra umbellata (L.)
Euphorbia obtusata Pursh.
Taenidia integerrima (L.)
Aster laevis L.
Solidago ulmifolia Muhl.
Helianthus divaricatus L.

and the annuals:

Anychia dichotoma Michx. Oxalis stricta L.
Anychia Canadensis (L.)

The appearance of solitary specimens of such plants as *Hicoria microcarpa*, *Vitis vulpina*, *Carpinus Caroliniana* and *Fraxinus Americana* in this thicket, probably indicates a return to a mesophytic stage. This will never fully develop however, until the slope of the bluff has become such that sufficient humus can accumulate for the support of this type of vegetation.

Washington, D. C.

CORRECTIONS TO THE KEY TO LIVERWORTS.

Edo Claassen.

The Key to Liverworts in the Ohio Naturalist Vol. V, No. 6, should be *changed* in items 21-25 inclusive, as follows:

21. Leaves bilobed and bidentate or emarginate and short-bidentate. 22.
    Leaves entire (sometimes retuse). 23.
22. Leaves bilobed and bidentate; underleaves bidentate; perianth free. *Lophocolea.*
    Leaves emarginate and short-bidentate: underleaves entire; perianth connate with the calyptra. *Harpanthus.*
23. Underleaves often wanting or entire or nearly so. 24.
    Underleaves 2-4-parted. *Chiloscyphus.*
24. Underleaves subulate, fugacious. *Jungermannia.*
    Underleaves lance-subulate, entire and subdentate or wanting (except on gemmiferous shoots), broadly oval, entire and subdenticulate. 25.
25. Underleaves lance-subulate, entire and subdentate. Involucral leaves 2, connate at base, entire. Leaf-cells roundish, 5-7-angular, cell walls much thickened, each cell appearing as if surrounded by about 6 smaller, 3 or more angular ones. Stem without runners. *Mylia.*
    Underleaves wanting (except on gemmiferous shoots), broady oval, entire or subdenticulate. Involucral leaves 3-ranked, bifid or bilobed. Leaf cells round, surrounded by much thickened cell walls. Stem with runners. *Odontoschisma.*

In the second to last line of the Key the word "Sphaerocephalus" should read "Sphaerocarpus."

NOTES ON THE FORMER OCCURRENCE OF CERTAIN MAMMALS IN NORTHERN OHIO.

E. L. Moseley.

Mr. Porter W. Wright has killed more big game than any other man of my acquaintance in this region. He owns a good deal of land in Sandusky County near the west end of Sandusky Bay, and has lived there since 1836, when he was two years old. Along with notes made at his house last year I will give some others obtained previously from old residents, some of whom are no longer living.

Mr. Wright often saw fifteen or twenty deer at a time and they used to eat much of the corn in the fields. Men cut brush to keep them out of the corn fields. They would eat within twenty rods of a man and some were shot from the houses. They were plentiful enough to furnish all the meat desired, and there was no market for them. The last was seen about 1859.

In Erie County deer were often seen on the Oxford Prairie feeding, and were plentiful as late as 1830.

In Paulding County, W. H. Todd killed a deer in 1881. In Wood County, on Scotch Ridge, Isaac Ward shot a deer in the Fall of 1893.

Mr. Wright does not know of any bison in his time, but he saw many of their horns, and bones near Castalia.

Elk antlers have been reported found in Erie County.

Bears were seen in various places in Sandusky County but were scarce after 1845. Mr. Wright thinks there were none of these animals after he began to hunt deer in 1849. On Put-in-Bay when Daussa's Cave was being enlarged in order to make it accessible to the public, part of the lower jaw bone of a bear was found. W. H. Todd told me a bear was killed in Paulding County in 1881.

Mr. Wright remembers having seen panthers when he was a boy. Mr. Gurley says that years ago there were many wild cats in Erie County. A wild cat was killed in Wood County about 1878.

Mr. Wright killed three otters about 1874. His wife thinks the last one was caught there about 1879. Near Sugar Rock, Catawba Island, one was seen swimming July 8, 1897, by Mr. Coville; and I was told that about the same date otters were caught occasionally near Toussaint, Ottawa County.

Wolves killed several sheep near Clyde in 1835 or 1836. Mr. Wright thinks the last one south of the Sandusky River was seen about 1854, but that there were some in Ottawa County later. In the museum at the Indiana State House is a mounted specimen of a wolf killed in Jasper County, Indiana, in 1904.

He saw many porcupines, the last about 1870. Mr. Julius House killed a porcupine in Wood County about 1879.

In Daussa's Cave, Put-in-Bay, half of a lower jaw-bone of a beaver was found. Mr. Wright knows of no living specimens in his time.

Concerning mammals still common, a few notes may be of interest. In the fall of 1899, Burt Todd killed 13 raccoons, 27 skunks and 18 opossums, nearly all within three miles of his home in the eastern part of Erie County. In 1900 he killed 15 raccoons, 28 skunks and 20 opossums.

About 1892 Charles Dildyne and his brother trapped 74 mink in one winter in the West Huron Marsh in Erie County.

Sandusky.

WINTER BUDS OF OHIO TREES AND SHRUBS.

John H. Schaffner.

In a region where plants are exposed to severe winters and great variations of temperature, the development of proper protective devices for the delicate stem tips becomes of considerable importance. Winter buds are usually protected by various kinds of scales, by pubescence, or by gummy and resinous excretions. These devices are not developed to keep the tip warm nor to prevent freezing, but to check evaporation.

In cold weather, when the temperature of the cells is reduced to or below the freezing point, water is driven off and solidifies as ice crystals in the intercellular spaces, outside of the cell wall. Now, as is well known, if some frozen plants while thawing out are submerged in water only a few degrees above freezing, they may recover completely, because the normal turgidity of the cell is thus restored. In much the same way, if a frozen bud is properly protected by suitable coverings, when the ice melts the water will be retained and reabsorbed by the protaplasm of the cells, while if it were freely exposed the water would evaporate and the cells could not regain their normal condition since little or no water is being absorbed by the roots.

A very perfectly protected winter bud is found in Platanus occidentalis. After the protective cap, formed by the base of the petiole, falls away with the leaf, the bud is exposed for the first time since its inception. It is completely covered by a single smooth outer scale. Beneath this is a gummy layer and on the inside a large amount of dense coarse pubescence. One could hardly think of a more perfect arrangement for keeping in moisture.

Winter buds may be without definitely developed scales, as in Asimina triloba, Hamamelis virginiana, and Rhus glabra.

Such buds are said to be naked although usually well covered by a silky or felty pubescence. Among the conifers Thuja occidentalis and Juniperus virginiana have naked buds.

Our species of Pinus, Abies, Tsuga, and Picea and most of our woody dicotyls have scaly buds. The bud scales may be fleshy as in Tilia americana or more commonly dry, at least on the outside, as in Fagus americana and AEsculus glabra. The buds may he covered on the outside by a single scale, as in the various species of Salix and in Platanus occidentalis, or there may be several to many scales exposed. In Fagus and AEsculus the scales are imbricate and numerous while in Liriodendron and Magnolia they are connate and represent pairs of stipules.

The buds are sometimes prominently stalked, as in Hamamelis virginiana and the various species of Alnus. In certain trees the buds are hidden under the leaf scar, as in Robinia and Gleditsia; in others they are minute and hidden under the short petiole bases, as in Cornus florida and in Philadelphus. In Gymnocladus dioica the buds are sunken and protected by a protuberance of the bark. The buds may be single in the axils, as in Morus and Ulmus, or there may be two or more in an axil. Frequently there are three side by side, as in Amgdalus persica, Prunus serotina, and Acer rubrum, and occasionally they are clustered. Quite frequently the buds are superposed. This is normally the case in Juglans, Hicoria, Menispermum, Gymnocladus, Ptelea, Gleditsia and Cladrastis. In Quercus the buds are prominently clustered at the tip of the twig.

In many trees and shrubs the terminal bud is self-pruned or withers away. This is the condition in Morus, Ulmus, Diospyros, Tilia, Cercis, Staphylea, and many other genera. In these plants the axillary bud or pair of buds near the morphological tip of the twig may be called end buds. In some species, as for example Rhus glabra, a considerable part of the end of the twig is deciduous. Plants with prominent terminal buds are the various species of Fraxinus, Malus, Amygdalus, Juglans, and Hicoria. In the genus Prunus, so far as the writer knows, all the cherries, both wild and cultivated, have terminal buds while the plums and apricots do not.

Winter buds may be of a reddish or violet color, as in Tilia americana and Cercis canadensis. They may be glabrous, as in Liriodendron and Liquidambar, or they may have various types of pubescence, as in Populus alba, Sorbus aucuparia, Xanthoxylum americanum, Juglans cinerea, and Corylus americana. Some buds are stellate pubescent, as in Hicoria alba, and others are prominently covered with peltate or scurfy scales, as in Hicoria minima and in Lepargyraea. Among our trees with gummy or resinous buds Aesculus hippocastanum, Populus balsamifera, and Populus deltoides are prominent.

Finally some winter buds show a very distinct vernation—conduplicate, involute, revolute, plicate, or convolute—although this is usually well shown only while the leaves are expanding in the spring. The conduplicate vernation is very distinct in the winter buds of Liriodendron tulipifera and the involute arrangement in the buds of Populus balsamifera.

ASCOCHYTA PISI,—A DISEASE OF SEED PEAS.[1]

J. M. Van Hook.

During the season of 1904 and 1905, there was an exceptional blighting[2] of peas from *Ascochyta pisi* Lib. The disease was general throughout the state and occasioned loss especially where peas are grown in large areas for canning purposes.

My attention was first called to this trouble June 24, 1904, on French June field peas, which had been sown with oats as a forage crop. Most of the peas at this time, were about two feet high and just beginning to bloom. The lower leaves were, for the most part, dead. A few plants were wilting after several days of sunshine following continuous wet weather. Other stunted peas grew among these, some of which never attained a height greater than a few inches.

Appearance on stems, leaves, pods and seed.—A close examination of the plants showed that the stems had been attacked at many points, frequently as high as one and one-half feet from the ground, though most severely *near* the ground where the disease starts. In the beginning, dead areas were formed on the stem in the form of oval or elongated lesions. At a point, from the top of the ground to two or three inches above the ground, these lesions were so numerous and had spread so rapidly as to become continuous, leaving the stem encircled by a dead area. In some cases, the woody part of the stem was also dead, though the greater number of such plants still remained green above. This was due to the excessive amount of moisture in the soil and atmosphere previous to this time. On the leaves, were orbicular or oval dead spots, one-fourth to one cm. in diameter. These areas are darker at the circumference. Below, the leaves were badly spotted, causing them to die. In the greenhouse, the spotting of leaves failed to develop, though the attack at germination and at the base of the stem was more severe than out of doors. The dead areas at the base never extend much above the surface. Such plants as are not killed

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1. Presented at the Cincinnati meeting, Ohio State Academy of Science.

2. The disease has been erroneously termed "Club root" by canners, since, on examining the roots for cause of dying, nodules common to members of the family Leguminosae, have been observed.

by the fungus by the time of flowering, develop pods in proportion to their vigor. The pods are badly attacked and exhibit spots quite similar to the ordinary anthracnose of the bean. In a case of *Ascocyhta pisi* on Egyptian-peas, Lochhead[3] describes the spots on pods to have "rings of black specks more or less concentric." No such appearance was found in connection with any of the peas examined. However, the Egyptian-pea belongs to a different genus from any host found by the writer to be affected with *Ascochyta pisi.*

Perhaps the most important thing in connection with the life history of the fungus, is, that it grows through the husk into the seed. Frequently, when the pod contains no seed, the mycelium will grow through, forming similar spots on both sides of the pod. When the mycelium passes into the seed, brown spots are formed on the surface. In the worst cases, half of the surface is frequently discolored and the seed adheres to the husk. These areas are much more striking on *green* peas such as the Market Garden than on the yellowish varieties as the Admiral. Peas affected with the mycelium of the fungus, can not always be told by an ordinary microscopic examination. A considerable amount of mycelium sometimes fails to color the pea and no spot is developed until the pea is exposed to considerable moisture for a short period.

The fungus.—The pycnidia of the fungus are formed on the dead areas of the stems, leaves, pods and seed and even on dead stems and branches where the effects of the fungus are not easily noticeable. They are ordinarily brown, have a circular opening and measure 125 to 160 μ in diameter. On the seed, they are formed on the outer surface, but frequently this is cracked away and fruit bodies occur below. Here they are often of a yellowish or amber color and occur in numbers from a few to several dozen and are sometimes so crowded as to form almost a solid mass for as much as five or six mm. in diameter.

The spores are oblong, usually 2-celled and slightly constricted at the septum. Those of the field-pea (French June), measured 12 to 16 x 4 to 6 μ. One measurement of spores on pea seed showed them to be 8 to 11 x 5 to 7 μ and practically all continuous; while those on a specimen of Market Garden seed, were 10 to 20 x 3 to 5 μ and a few, even, were 2-septate, measuring as much as 23 μ long. Lack of maturity was the chief cause of the continuous spores, though some of these never become septate. Lochhead[4] reports only a few 2-celled spores found in some material of Egyptian-peas affected with *Ascochyta pisi*. *Ascochyta pisicola* (Berk.) Sacc., which is perhaps identical with

3. Ont. Agr. Coll. and Exp. Farm. An. Rep. 1903, pp. 17–33, figs. 13.
4. Lochhead, l. c., p. 27.

A. pisi Lib., is described as being either 1-septate or 1-celled. *A. Bolthauseri* Sacc.,[5] found on the leaves of bean, is often 2-septate.

Cultures.—Halsted[6] who was first (so far as the writer is able to learn) to note and to figure the pea seed affected with *Ascochyta pisi*, states that seed "apparently healthy when placed in the ground, soon show patches and spots of a dark color, which are also the spore bearing places of Ascochyta."

Krueger[7] noticed the presence of the fungus by soaking seed for twenty-four hours in water, when dirty spots would appear. When left for forty-eight to seventy-two hours, the mycelium grew out into the water forming a white mass of radiating threads similar to those of *Saprolegnia*. All these results of Halsted and Krueger were verified.

If one places such diseased peas in a seed germinator for several days, a heavy coat of white mould will be formed about them. On removing these to a covered dish where less moisture is present, numerous reddish-brown pycnidia are formed all through and over this white fluffy mass of mycelium. (Of course this mycelium must not be confused with a similar growth of some such fungus as Fusarium which often contaminates peas and beans, when not kept dry,—especially just before harvesting.) Peas which failed to germinate in the ground, were removed, with the result, that they too, soo developed pycnidia on the mycelium surrounding them. The germination of such seeds is very poor. Krueger found the germination of very badly affected seed to be 20%. In similar experiments conducted by the writer the germination was only 6%. Such peas seldom reach maturity when they do germinate, as the fungus affects the base of the young plant. Hiltner[8] records the sudden dying of peas from such attacks at the base of the stem. The fungus was carried over to the young plants by the seed, a fact determined through experiments by Jarins[9]. The result of these early attacks by the fungus, is all sizes and vigor of plants. Plants of equal age, range in height from two inches to four feet. In the struggle between the fungus and host, the latter may not noticeably increase in size for a long period, or it may succumb at any time. Young plants six inches high, affected with the fungus, were planted against healthy ones of the same size, with the result, that the latter became diseased in a few days. Later, fruit bodies formed abundantly.

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5. Bolthauser-Amrisweil. Blattflecken der Bohne. Zeit. f. Pflanzenkr., p. 135.

6. Halsted, Some Fungous Diseases of the Pea. N. J. Rept., pp. 357-362. 1893.

7. Krueger, Ungewoenliches Auftreten von Ascochyta pisi Lib. on Erbsenpflanzen. Centl. f. Bak. u. Par. 2, I., p, 620. 1895.

8. Hiltner, Erbsenmuedigkeit. Sachs. landw. Zeitung., 1894, No. 18.

9. Jarins, Ascochyta pisi bei parasitischer und saprophyter Ernahrung. Bibl. Bot., Heft 34, 1896, c. tab.

Seed treatment.—Many experiments in seed treatment by immersion were carried on during 1904 and 1905, but all proved unsuccessful. The presence of the mycelium and spores *within* the seed, has, so far, rendered treatment impossible, since any solution strong enough to kill the fungus, also kills the pea germ. In fact, the fungus is the less susceptible of the two. Still it was hoped to kill such spores as might be merely adhering to the outer seed coat of the peas and thereby increase the per cent. of germination. The chief chemicals used were formalin and mercuric chloride. These were used in several strengths and for various lengths of time. The seed was then planted in soil (in the greenhouse) or put into a seed germinator. The results, for the most part, were not only unsuccessful, but negative. Liquid treatment, especially when the seed was immersed for a considerable period, seems to increase the bacterial rot[10] which is also responsible for the failure of some of the seeds to germinate. Direct immersion in hot water as well as immersing in hot water after soaking, was tried by Krueger, with the result that the vitality of the seed was injured, while the fungus was not. Dry heat was also applied with similar results. Though Krueger found seed treatment with Bordeaux mixture ineffective, experiments carried on by the writer during the present season, showed a slight increase in germination over check plots, when seed was soaked for an hour in water rolled in Bordeaux dust and immediately planted. The following table gives the average results obtained by this treatment. The figures show the number of grams produced from one foot of row; also the gain or loss in per cent. The peas were drilled in rows three feet apart and not sprayed:

TABLE I.

Variety.	Early Planting.			Late Planting.		
	Tr.	Untr.	%G orL	Tr.	Untr.	%G orL
Market garden	21.9	21.6	+ 1.4	4.9	4.3	+14.0
Admiral	29.0	27.8	+ 4.3	4.2	3.4	+23.5
Telephone ..	14.8	11.5	+28.7	*...	....	....
French June .	21.6	21.4	+ .9	....	....	....

* No late planting.

The result of tying up vines, of spraying with Bordeaux and of omitting the last spraying, is shown in the following table. The per cent. of gain or loss of sprayed over unsprayed, is computed for the early planting only, as the late crop of unsprayed was planted somewhat later than late planting where spraying was done. Moreover, the almost complete failure was due, in large part, to powdery mildew, which failed to develop in

10. Halsted, Failure of Pea Seed to Grow. N. J. Rept., 1893, pp. 359–362.

the least on the sprayed crop. Though the sprayed rows and those tied up, produced, in general, more than the checks, the gain was scarcely sufficient to warrant such treatment merely to increase the quantity of peas. The object, however, of such treatment, is more for the purpose of growing uninfected seed peas in order that so great loss may not be experienced from a poor stand and to start a crop free from the disease. This, on soil free from the disease, ought to improve the situation. Although a test of the per cent. of germination of the 1905 seed has not yet been completed, the seed from tied up and from sprayed peas, was much freer from the fungus than that from the check lots. Notwithstanding the great care in spraying, the results are certainly not what they would be under more favorable conditions of weather. The almost daily rains rendered it impossible to keep a coat of Bordeaux on the plants.

TABLE II.

VARIETY.	SPRAYED.								UNSPRAYED		% G. or L. in sp. in early planting.
	Tied up.	Not t. up	% G. or L.	Sprayed late.	Not sp. late.	% G. or L.	Not t. up nor sp. l.	% G. or L.	Early pl.	Late pl.	
French June	24.2	25.9	‡ 6.6	12.6	9.5	†32.6	14.7	†29.1	21.4	*....	†21.0
Market Garden......	26.3	20.3	†29.5	9.6	8.2	†17.1	19 9	‡17.2	21 6	4.5	‡ 6 0

* No late planting made. † Gain. ‡ Loss.

The early training up of peas seems to be an important factor in securing healthy seed peas, since the fungus makes its first attacks near the ground and gradually works itself up the stem, branches and leaves. The height (on the plant) to which the fungus will attain in a given time, is therefore dependent, to a certain extent, upon how much of the vine lies upon the ground.

Hosts.—All the varieties of the common pea examined during the past year, were found to be affected with *Ascochyta*, though some much more seriously than others.

The following is a list of those carefully examined:

French June........Very badly.
Market Garden..... " "
Admiral...........Badly.
Dwarf Telephone....Very badly.
Telephone ....Badly.
Prosperity..........Badly.
American Wonder ...Very badly.
Advancer...........Badly.
Alaska..............Slightly.

So far as the writer is able to learn, no investigations have been made as to the susceptibility of varieties. Aside from the genus *Pisum* however, it has been found to attack *Medicago sativum*[11], *Cicer arietinum*,[12] *Phaseolus vulgaris*[13] and *Vicia vil-*

11. Lagerheim, Bihang till K. Svenska Vet.—Akad. Handlingar. 1898. Bd. XXIV Afd. III, No. 4, 21p.
12. Rostrup, "Tidskrift for Landrugets Planteavl" V, No. 14, Kjobenhavn 1898.
13. Carruthers, Jour. Roy. Agr. Soc. Eng. Ser. 10 (1899) pts. 4, 678-688.

losa.[14] A critical examination of the species of *Leguminosae* grown at the station in 1904 and 1905, showed all of these to be free. Following are the results from the various *Leguminosae* grown on the Station variety plots in 1904 and 1905:

Host.	Examined July 22, 1904.	Examined July 28, 1905.
Hairy Vetch	Free	Free.
Spring Vetch	Slightly on leaves	"
White Lupine	Free	*
Lentils	"	*
Grass Peas	"	Free.
French June Peas	Very bad	Very bad.
Scotch Gray Peas	Slightly on leaves	On leaves and stems
Velvet Beans	Free	*
Horse Beans	"	Free.
Medium Green Soy Beans	"	*
Mammoth Yellow Soy Beans	"	*
Beggar Weed	*	Free.
Yellow Lupine	*	"
Flat Peas	*	"
Alfalfa	Free	"
Egyptian Peas	"	"
Russian Blue Peas	"	"

No planting.*

Climate certainly determines largely the seriousness of attacks by this fungus. For example, Lochhead[15] describes a serious outbreak on Egyptian-peas in Ontario in 1903. Yet, while we have experienced an exceptional attack by the fungus during 1904 and 1905, Egyptian-peas have proved to be entirely free of the disease. Excessive moisture during these two years, is doubtless the chief factor in this outbreak. Added to this, is the continual growing of peas on the same ground. When peas have been planted on the same soil for two or more successive years, the loss may be considerable, even in ordinary seasons. Two years rotation in other crops, relieves the land of the trouble for the time at least, showing that the fungus lives over in the soil or compost as well as in seed peas.

Previous outbreaks have been reported. Krueger[16] states that in one place, the cultivated field crop was a complete failure in 1894. Combes[17] reports it as attacking pea stems so seriously as to cause a wilting of the tops, in 1879.

14. Ducomet, Prog. Agr. et Vit. (EdL'est) 22 (1901) No. 34, pp. 225–233.
15. Lochhead, l. c., p. 26.
16. Krueger, l. c., p. 621.
17. Combes, Crittogamia agraria, p. 473.

Botanical Laboratory, Ohio Agricultural Experiment Station,
November 23rd, 1905.

THE CLASSIFICATION OF PLANTS. III.

John H. Schaffner.

In a natural system of classification, plants are grouped according to their supposed relationships. Some groups have resemblances which leave little doubt as to the affinities of its members. Each subkingdom has a number of such groups. These greatest groups in the subkingdom are called *classes*. A class may then be defined as a group of plants in a subkingdom, the members of which show an evident relationship to one another because of similarity of morphological and physiological characters. This relationship must apparently be closer among the members of the group than to any other member in the subkingdom. The relationship of the class to other classes in the subkingdom is in many cases indeterminable at present, or at least so obscure that it gives rise to numerous disagreements among systematists. This obscurity indicates that most of the classes were segregated in primitive times, probalby before they had passed from the condition of the next lower subkingdom or stage of development. Thus classes and subclasses represent more or less parallel lines of development in the same stage of evolution. The class is not to be extended beyond one subkingdom, even though its missing links be found or generally assumed. Mere similarity of superficial morphological characters is, however, not sufficient to establish relationship; for as is well known, the same evolutionary tendencies may be operative in entirely distinct groups and bring about quite similar morphological results. The mere acquisition of some peculiarity or the loss of another can not be regarded as of any special importance in establishing a class. For example, it might turn out in the future that some Conifers or Angiosperms possess motile spermatozoids. But this peculiarity might persist in any of the higher groups and in itself could be of no importance in classification. All possible morphological characters must be taken into consideration in establishing a class, due weight being given to the possibilities and impossibiliites of derivation, for each structure involved, from its supposed ancestral type. Quite commonly relationships are claimed between groups where the derivation of the one from the other involves an improbable or impossible modification of the parts, and a profound credulity is required before assent to the proposition is possible. Unfortunately we are still far from possessing the necessary general knowledge of plant structures and developments to make a definite disposition of the larger groups. It is evident that there must continue to be considerable diversity of opinion as to the number and limits of plant classes. Yet properly comprehended, the class stands out as the large unit of classification and with a fair knowledge of structure and function there should be little necessity for the shifting of species from one class to another.

In some cases it is a comparatively easy matter to recognize the class while in others it is exceedingly difficult. In the Homosporous Pteridophytes there are plainly three distinct types of living species, lycopods, horsetails, and ferns, and these represent the three classes of the subkingdom. Whether the ferns could be regarded as reprensenting more than one phylogenetic branch may be a question with some. The quillworts show characters which exclude them from both the selaginellas and the eusporangiate ferns. For this reason they have been shifted about from one place to another without finding a permanent home.

Evidently in all such cases the proper procedure is to establish a distinct class and then the arguments as to their relationship with other classes may proceed pro and con ad infinitum.

In a general way one may recognize relationships between certain classes and if this is possible such a group of classes will constitute a *phylum*. A phylum then represents one of the great fundamental branches of the plant kingdom and consists of a number of classes supposed to be more closely related to one another than to other classes. The Angiosperms are no doubt such a phylum. They are not only the greatest group of plants but a very isolated group which appears to have come from a common ancient stock. The Gymnosperms are probably a polyphyletic subkingdom. The Cyanophyceae, Schizomycetes, and Myxoschizomycetes probably represent a phylum, the Schizophyta. A phylum may extend from one subkingdom to another. This is probably the case with lycopods, selaginellas and their fossil allies. But as a general rule the relationships between lower and higher groups have not been definitely determined. Too little is known of the morphology and geological history of plants to make possible the establishment of phyla with any great certainty.

Henry Shaler Williams, in his Geological Biology, makes the following important statements on this point:

"The arrangement into branches, therefore, is from a structural point of view highly artificial; and for purposes of tracing the history, or even from a taxonomic point of view, it is of little importance to deal with characters more ancient or of higher rank than the class characters."

"It may be convenient to associate the classes together into larger groups; but to reach the point of real union of their characters, in order to associate two or more classes in a common

OHIO NATURALIST. *Plate XXXII.*

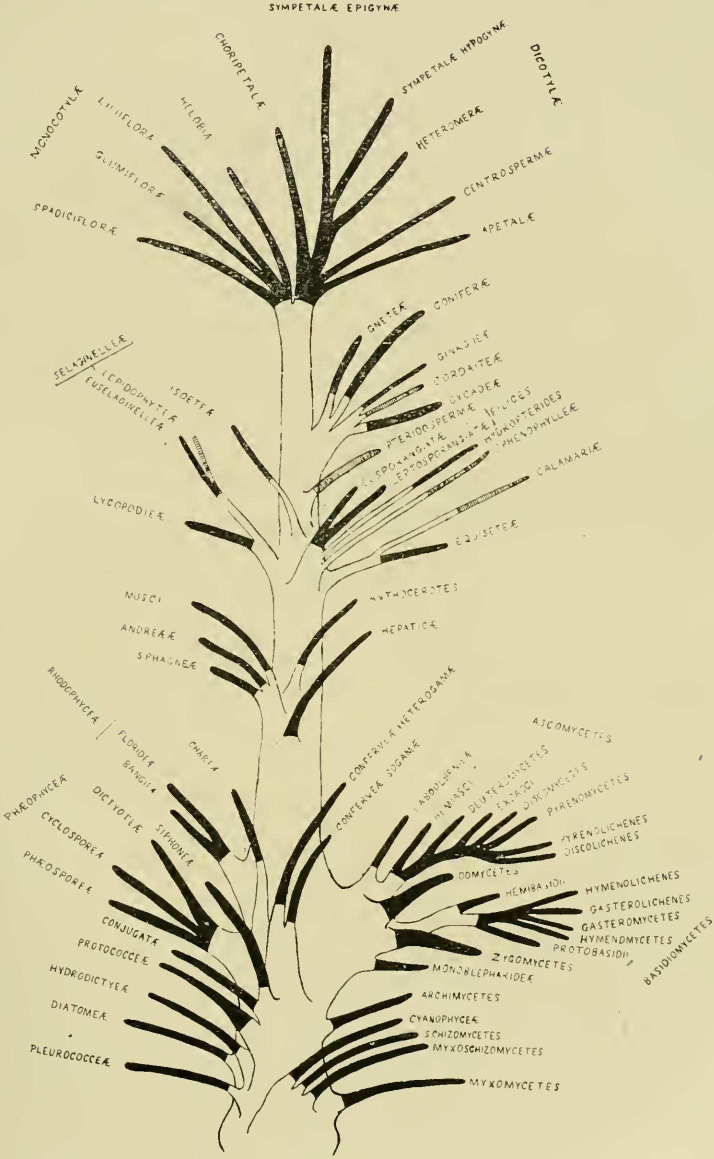

Diagram showing the approximate relationships of the classes and subclasses of plants.

group, leads us far back into the uncertain mists of earliest geological time, and into the similar mists of embryonic homogeneity. It is impracticable in the present stage of science to trace the evolutionary history of classes."

In some cases a class may fall into two or more well defined subordinate groups which are quite distinct and still show an evident relationship. These are called subclasses. The general subgroups of a class or subclass are the orders; the orders divide up into suborders and families; the families into subfamilies and genera; and the genera into species. The species may also be made up of subgroups which are at present still imperfectly understood and defined.

Phyla, classes, orders, and families and other subordinate groups then represent branches of closer and closer relationships, shown by similarities of essential structures and produced by segregation as the result of diversity of evolution and destruction of intermediate types; while series and subkingdoms stand for horizons or progressive stages of the evolution of the plant kingdom.

The main groups of plants rank as follows:

Groups representing stages of progressive evolution.	SERIES SUBKINGDOM.
Groups representing phylogenetic relationships..	PHYLUM CLASS (SUBCLASS) ORDER (SUBORDER) FAMILY (SUBFAMILY) GENUS SPECIES.

The orders are always to end in *ales* and the families in *aceae*. Definite endings should also be adopted for the classes, suborders, and subfamilies.

In the accompanying diagram all classes and subclasses recognized by the writer are given with their approximate relationship indicated by the branchings of the "tree." It was thought best not to attempt to indicate any definite relationships between the higher Algae and Fungi although some authors have in the past presented such schemes some of which may have more or less merit. In a future paper the classes given will be briefly defined in their proper order.

KEY TO OHIO ALDERS IN WINTER CONDITION.

William C. Morse.

Alnus Gaert. Shrubs or trees with alternate leaf scars, not 2–ranked, twigs brown with prominent scattered lenticels; terminal bud present with about 3 visible scales; axillary buds single, large and prominently stalked or minute and not stalked; leaf scars triangular to subcircular; bundle scars 3–5; stipular scars present; pith prominently 3 angled or Y-shaped; both staminate and carpellate catkins present all winter, carpellate catkins woody, cone-like.

1. Twigs glutinous, black or brown dotted, nearly glabrous or with a few large scattered hairs, buds 4–5 lines long, stalks of the buds 2–3 lines long; staminate catkins dark purple; peduncle of fruiting catkns 2–6 lines long. A tree reaching a maximum height of 75 feet and a trunk diameter of 2½ feet; introduced.
   A. glutinosa (L.) Medic. European Alder.
1. Twigs coarsely pubescent, with comparatively few brown dots; buds 2–3 lines long; stalks of buds ½–1 line long; peduncle of fruiting catkins 2–6 lines long. A native shrub or sometimes a small tree.
   A. rugosa (Du Roi) Koch. Smooth Alder.
1. Twigs finely pubescent; buds 2–4 lines long; bud stalks ½–1 line long; fruiting catkins sessile or nearly so. A native shrub or rarely a small tree. *A. incana* (L.) Willd. Hoary Alder.

FURTHER NOTES ON ANTHURUS BOREALIS.

W. W. Stockberger.

In a recent note on *Anthurus borealis* Burt, (Ohio Naturalist 6:474, 1906) D. R. Sumstine states that he has not seen it reported from any other places than those localiites in New York and Massachusetts recorded by Burt when he described the species in 1894.

Lloyd (*Mycological Notes*, No. 17, p. 183, 1894) acknowledges the receipt of some specimens collected by Beardslee near Cleveland, Ohio. Later a short account of the occurrence of *Anthurus borealis* in northern Ohio, by Beardslee, was published by the Ohio State Academy of Science (9th Ann. Rept. p. 19, 1901). The occurrence of this fungus at Granville, Ohio, was reported before the Ohio Academy at its annual meeting in 1901 (10th Ann. Rept. p. 20, 1902), and this station is further recorded in Lloyd's *Mycological Notes* (No. 19, p. 219, 1905) along with some previously unrecorded New England stations, one at East Hartford, Conn., one at Storrs, Conn., and several in Massachusetts.

Its further occurrence as noted by Sumstine would seem to indicate that this species of *Anthurus* does not occur so rarely as has been supposed, and that its occasional occurrence throughout Ohio may be safely predicted.

Washington, D. C., March 2, 1906.

CIRCULAR OF INQUIRY WITH REFERENCE TO THE PRESENT STATUS OF THE ENGLISH SPARROW PROBLEM IN AMERICA.

1. Are you familiar with Bulletin No. 1, The English Sparrow in America, published by the Agricultural Department in 1889; and do you agree with the facts there presented and with its conclusions?

2. Is the English Sparrow present in your locality? If so, are they increasing or derceasing in numbers?

3. What is being done with you to exterminate them? Please outline methods which you deem effective.

4. What influence have you observed the English Sparrow to have upon native birds?

5. Would public opinion in your locality favor the adoption of effective measures to exterminate this species?

6. Please state the facts and arguments, pro and con, which decide this problem in your own mind.

Please send replies as early as possible—before June 1—to the undersigned. It is hoped to gather a consensus of opinion from all parts of this country and Canada. The data will be published as soon as possible.

Signed,

March, 5, 1906. A. H. Estabrook,

(Newspapers please copy.) Clark University, Worcester, Mass.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, Feb. 5, 1906

The Club was called to order by the president, Mr. Griggs. The minutes of the previous meeting were read and approved.

The paper of the evening was by Mr. Griggs on "The Kelps of Vancouver's Island."

Mr. Burgess, Professors Schaffner, Hubbard and Hambleton took part in the discussion which followed.

Dr. Berger reported a formula for mixing alcohols which he had worked out.

D. D. C. Condit, Allan McOwen, A. F. Burgess, Misses Clara Orton Smith, Irene Fisher, May Dalbey, Ethel Smith, Ada Noyes, and Elizabeth Matthews were elected to membership.

The club then adjourned until March.

Z. P. Metcalf, *Sec.*

Date of Publication of April Number, April 14, 1906.

The Ohio Naturalist,

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The Biological Club of the Ohio State University.

Volume VI. MAY, 1906. No. 7.

TABLE OF CONTENTS

A REDUCING DIVISION IN ASCARIS.

ROBERT F. GRIGGS.

For a long time, comparatively speaking, Ascaris has stood in the way of a consistent rational interpretation of the phenomena of reduction. It has been regarded as the one case in which the divisions of oogenesis and spermatogenesis were *proven* to be equational and not qualitative. The growing appreciation of the bearing of Mendel's Law and the course of recent work on reduction have served to make it more and more of a stumbling block in the way of those who tried to understand the mechanism of heredity. So great is our faith in the uniformity of nature that it was impossible to believe that Ascaris was unique. Either the theories of reduction built on the observed facts must be insufficient or there is something yet unobserved in this form which would bring it into harmony with the law.

It was for this reason that Tretjakof (8) undertook the problem and published simultaneously two papers on the Oogenesis and spermatogenesis of Ascaris. His conclusions were similar to those reached in the present study and apparently he saw many of the same sorts of figures as has the present writer, but his drawings are not conclusive and as Gregoire (3) says,* simply open the question anew. The same may be said of the work of Moszkowski (7) whose paper is unillustrated except for four text figures.

It is, then, a matter of considerable satisfaction to be able to present what seems to the writer conclusive evidence that the reduction division of Ascaris is a true Reducing Division in Weisman's sense.

* * * " de plus il faut avouer que les figures de Tretjakof, sont fort difficiles à élucider et qu'il est malaisé de se faire une opinion d'après leur inspection.
" Les recherches de Tretjakof montrent que l'Ascaris n'etait pas encore completement etudié, mais elles ne me semblent pas elucider definitivement cet ojet difficile."

In carrying forward the work I have been greatly aided by two men who have "seen me through" it, and checked up and verified my observations as the work proceeded. They are Professor Francis L. Landacre of the department of Zoölogy and Professor John H. Schaffner of the department of Botany, of the Ohio State University. To both I wish to extend my heartiest thanks. The slides on which the work was done belong to Professor Landacre and have been used by the students in the Department of Zoology, studying principally the later stages, for several years. They are cut from a female of the variety *bivalens* and are arranged in series lettered backward from A which contains two-and four-celled embryos, to M in which are found the early stages but little removed from the resting nuclei of the oogonia. All of the nuclei drawn for the plate of this paper except fig. 12, were found in series M and L.

The difficulties in Ascaris are, I am inclined to believe of two sorts: first the problem of staining and second, the minuteness of the critical stages. The slides are stained with Heidenhain's Iron Alum Heamatoxylon. To find material in which the nuclei were properly stained it was necessary to select extremely faint slides in which all of the stain had been drawn from the cytoplasm and spindle leaving the nuclei standing out clearly by themselves. Even then the spirems are often so closely knotted together and deeply stained as to make resoulution impossible. In the matter of magnification I find that the 1–12 objectives which have been mostly used are far inferior for this work to the 1–16 which was used with a variety of oculars. Of these the 1–2 inch was the most saitsfactory. Lower oculars do not cut the plane of focus sharp enough to enable one to follow out the spirems.

The variety bivalens is a more favorable object for study than the variety univalens, for as Tretjakof remarks, the development of the two tetrads usually proceeds unequally so that one is often found in a much more advanced stage than the other. This frequently enables one to understand figures which without such aid would be difficlut of interpretation. In fig. 9, for example, one tetrad is clearly differentiated while the loop that will form the second is still much twisted. This might be interpreted in a number of ways were it not for its fellow which requires us to homologize the loop to a tetrad.

The process of tertad formation in Ascaris is in close agreement with that more recently described in "many Arthropods, Amphibia" (Montgomery (6) and the higher plants, though the appearances are quite different in the different cases. In all these there is a precocious longitudinal division of the spirem, which through subsequent contraction becomes more or less invisible. Contemporary with this or following it is a conjugation of the chromosomes (already longitudinally divided) two by two forming combinations of four members.

From the resting nucleus a continuous spirem is formed in the usual manner (figs. 1–3). In Ascaris the spriem is very closely wrapped so that it is a very difficult object to resolve and cannot be untangled and traced out with confidence. This however is a matter of no great moment in the present discussion since the occurrence of such a spirem is well known. In some cases (fig. 1–2) even before the spirem is formed the chromatin is distinctly separable into two masses. Such a separation may (fig. 5) or may not (fig. 3–4) be evident in the spirem.

Before the contraction of the spirem has proceeded far the granules which are strung along the linin thread become doubled (fig. 4). At first very difficult to observe, the distance between the doubled granules becomes greater and greater till the linin thread splits and two parallel sprimes are formed (fig. 5). It has been maintained recently by Berghs (1) that in the flowering plants these doubled granules arise not by a longitudinal splitting of the spirem as has hitherto been supposed but by the conjugation of the granules from two separate strands of linin. Whether the doubled spirem in Ascaris arises in such a manner or by a split does not seem to me susceptible of complete demonstration. I see, however, no reason for abandoning the older interpretation; while there are several indications that point toward a splitting rather than to a conjugation. (1) The spirem at the earliest stage where the doubling appears (i. e. earliest as judged by the relative state of contraction of the spirem) is of approximately the same length (fig. 4) as the single spirem preceding (fig. 3), while if a conjugation took place it would be of only half the length. (2) At the earliest stage where the doubling is visible, judged by the same criterion, the granules lie exceedingly close together and from this stage they *recede* up to a stage represented by fig. 5. while if they were the result of conjugation we should expect the opposite.

Very frequently in split spirems (fig. 5) the linin at one end is bent into the form of a square with a prominent granule at each corner. The granules are so much more prominent than the linin thread upon which they are strung that one might easily suppose that he was looking at the *end* of a set of granules doubly split instead of at the *side* of a continuous spirem. In the cases observed however there was no great difficulty in tracing the course of the spirem and showing that such was only a superficial appearance. The spirem in this stage often foreshadows quite plainly the tetrads destined to be formed from it. In its contraction it is often thrown into two loops each arm of which is double giving therefore two groups of four strands each.

The contraction of the spirem continues and is manifested not only by a shortening in length but also by a drawing together of the sprit glanules. This usually goes so far that the longitudinal split becomes very difficult or impossible to observe (figs. 6-8). The two loops destined to become the tertads now become more and more definite and begin to break apart (fig. 6) sometimes becoming twisted (fig. 7) in a way that is inconceivable were they due to a longitudinal split of the original thread. Sometimes (fig. 8) the two arms of a loop are of different lengths and this again seems to me fatal to any interpretation of their origin by a longitudinal split. In this stage the longitudinal split becomes visible again by the moving apart of the two strands so that we see anew the four chromatids which form the tetrad (figs. 8-9). So marked a contraction as is shown in figs. 7 and 8 is not universal. Sometimes the four strands are visible through the whole process. Fig. 10 represents a stage but little later than fig. 6, where the spirem has not yet broken as in that case though the granules are more closely packed together to form the four elements in each of the tertads; but the approximation of the two sides of the loop is still incomplete in the upper tetrad. The chromosomes now become more compact and gradually take their position in the tetrads (fig. 11.) All traces of the linin thread may have disappeared by this time or the original linin may persist between the two tetrads as in fig. 11 and by the attachment of its split ends show plainly which chromosomes are the result of conjugation and which of splitting. From a stage represented by fig. 11 it is an easy step to the mature tetrad ready for the first division (fig. 12). The only change consists in a further shortening of the chromatids.

In the process just described the ends of the loops which form the tetrads are connected by two double linin threads which twist or pass close together at a common point, corresponding to the bases of the two original loops. Because of their being thus drawn together the resultant tetrads nearly always stand at an angle to each other instead of extending in the same straight line, see especially figs. 6 and 7. This angle persists until just before the separation of the dyads in the first mitosis (fig. 12) and is very noticeable. While it cannot be regarded as positive evidence either way, it is not easy to explain such an angle on any assumption of double longitudinal splitting but it corresponds with and helps to corroborate the looping shown to take place in tetrad formation.

After the tetrads are well formed the facts of the process of reduction are so well known as to require no amplification here. From each tetrad by the two maturation divisions are passed out successively a dyad and a monad, leaving one monad from each of the tetrads to form the resulting female producleus. Since the tetrads arise by a conjugation of two longitudinally divided chromosomes, one of these maturation divisions is transverse and qualitive representing a true Reducing Division in Weisman's sense. There next arises the question as to which of the two divisions is the Reducing Division. This point the writer does not hesitate to say is very difficult, or perhaps incapable of complete demonstration in Ascaris. It has seemed to him that the presence of the Reducing Division was the all important fact and that the matter of deciding which division was qualitative was of much less importance. Because of this and because of the great difficulty of the matter I have not tried seriously to determine the question in the present investigation. The different chromatids in the tetrads are so similar and so difficult to find in favorable positions where all four of them can be seen at once that it is only with great reserve that statements as to the identity and origin of the separate dyads of the first division can be made. But in this matter the angle between the tetrads may give a clue, not, however, in my judgment amounting to proof. By inspecting such stages a figs. 9 and 10 it will be seen that if we take the nearest common plane of the two tetrads, that in which the angle between them would lie, were it a plane angle (the plane of the paper in the cases cited) then we find that the equivalent chromatids arising by a split, lie perpendicular to that plane and the dissimilar chromatids arising by a transverse break lie parallel to that plane. Applying this to fig. 12 in which the tetrads are oriented for the first division but not yet drawn out of their original angle we find that the first division would be the qualitative for it is the dissimilar dyads which lie on the different sides of the eauatorial plate of the spindle and will pass to the different cells in mitosis.

The results given above were arrived at after examination of many hundreds of nuclei in the critical stages. The ones selected for the figures are unusual only in their clearness and in the favorable position of the parts. Of all the nuclei seen about half were so strongly contracted as to be impossible of resolution. Of the others all but two or three were clearly interpretable as stages in the process outlined above. A few, about 1–3 per cent. should be interpreted either as products of folding or of a double longitudinal division. None were found which could be interpreted as products of the latter process which did not lend themselves equally well to the other interpretation.

Inasmuch as the results of the present investigation are diametrically opposed to those reached by Brauer (2) on the spermatogenesis of the same object, it might seem difficult to bring the observations of Brauer into harmony with those of the present writer. But such is not at all the case. One point which Brauer lays great stress upon and which is at first sight most convincing, is that the granules are sometimes clearly doubly split at a very early period. Whatever the significance of this group-ing of granules in fours may be, it is not necessarily a precourser of the reduction division. Such groups of four granules as Brauer shows (fig. 22–24) are frequently very abundant in the nuclei of the wall cells of the uterus which are not, of course, in preparation for a reduction division. He has several figures (35, 37, 41, 42) in which the doubled loops shown in my fig. 6 are very plain. He does not, however, follow the gradual approximation of the sides of the loops but supposes them to straighten out into a single semicircular band which by transverse division forms the two tetrads. During all these stages he supposes that the spirem is composed of the doubly split granules of the early prophases, believing, doubtless, that his inability to see them was due to the very unfavorable positions which such objects would inevitably assume. He does, however, show in small portions of figures 34, 36 and 41, places where the spirem is represented as composed of three or four strands instead of two which the present writer has invariably found. Beyond these points there is no greater difference in our observations than is probably due to differences in the sex cells of male and female animals.

Montgomery (6) has pointed out that the tetrads are of unequal size. My own studies have not been carried carefully into the maturation mitoses where Montgomery made his observations but what I have seen of these stages tends to confirm his statements. The earlier stages also offer strong confirmatory evidence of their truth. As has been mentioned one of the tetrads is almost always slower in its formation than the other, being derived apparently from longer more contorted segments of the spirem thread. His contention is that there is always a conjugation of *similar* chromosomes to form a tetrad. This would seem to be correct in the main but it appears to be not without exceptions, see fig. 8.

SUMMARY.

The foregoing observations seem to show conclusively that the tetrads in the eggs of *Ascaris megalocephala bivalens* arise not by a double longitudinal split of the original spirem thread but by a folding of adjacent segments together (conjugation of univalent chromosomes) together with what is believed to be a single longitudinal split. The two split loops which form the two tetrads appear very early in the contuinous spirem and in their later development simply break apart, shorten, thicken, and straighten out till the tetrads are formed.

Since of each tetrad only one component chromosome remains in the ripe ovum, there is a Reducing Division in Wesimann's sense by which paired chromosomes are separated from each other in the egg and the hereditary characters transmitted by the chromosomes, thereby modified.

Literature Cited.

With two exceptions, I have listed only the papers directly referred to in the text. The exceptions are Guyer's extremely important work published before the rennaissace of Mendel's Law, which have not received from writers on kindred subjects, the attention they deserve.

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8. Tretjakof, D. Die Bildung der Richtungskorperchen in den Eieren von Ascaris megalocephala. Archiv. f. Mik. Anat. u. Entw. **65** : 358–583. Pl 21. Die Spermatogenese bei Ascaris megalocephala. p. 383–435. Pl. 22, 23. fig. 1. 1905.

Explanation of Plate XXXIII.

The figures were drawn with a Leitz 1–16 oil immertion objective and a Bausch and Lomb 1–2 in. ocualr. They were drawn with the aid of a camera lucida and are reproduced 2–3 their original size.

Fig. 1. A nucleus just passing from the resting stage. The nuclear membrane is *extremely* faint, being on the verge of disappearance.

Fig. 2. The chromatin network well broken up and on the way to the formation of the continuous spirem.

Fig. 3. A continuous spirem. This is wrapped so tightly that it is not possible to be certain all the strands run exactly as drawn. The nucleus was, however, in this stage and about as drawn.

Fig. 4. Slightly later than the last, showing the first appearance of doubled granules on the still single linin spirem. As in fig. 3, the spirem is too complicated to be followed with certainty but it in the main as represented.

Fig. 5. A continuous spirem singly split. The spirem may be traced by focusing from the granules at the right around the elbow above and back on the left side where after crossing twice it turns and passes under the elbow to the granule next the starting point. In addition to this there can be traced from the first granule, a loop passing under the other large granules where its relations cannot be made out. It is not impossible that this loop is not linin at all but some cytoplasmic condensation. It is not like the rest of the spirem in appearance. On superficial examination the right portion might be mistaken for an end view of a tetrad with bridges between the rods but its relations to the whole clearly negate any such possibility.

Fig. 6. A split spirem doubled on itself to form the two tetrads. It has already broken apart at the upper end of the right tetrad leaving two loose ends, connected by a faint strand of dense sytoplasm.

Fig. 7. Spirem in which one strand is twisted entirely around the other in a manner impossible in a split rod. The two ends of the loops are beginning to break apart or perhaps have already broken but remain in close contact.

Fig. 8. One tetrad nearly formed, the other lagging. The relations of the four rods to the right are not possible to make out precisely. On the left the loop of the original spirem is still evident: This shows the longitudinal split faintly in the distal end. Such a figure as this might easily be interpreted as due to a double split. The loop looks at first sight like the incompletely separated ends of a longitudinal split. But at the point of junction the distal (left) arm turns up and then bends down to meet the other which in like manner turns down and then up making a rounded loop perpendicular to the plane of the paper. One arm of the loop is also much shorter than the other but does not seem to be cut off or disturbed.

Fig. 9. A nucleus in which one of the two tetrads is much more completely formed than the other. The right tetrad is seen to be composed of four rods two above the others. The spirem has completely broken across between the two arms of the loop and in one side the longitudinal split is also complete while in the other there remains a bridge across between the two portions. At the base of this tetrad both arms are seen to be continuous with the spirem which starting from one arm bends around and is twisted on itself in the position of the left tetrad, returning to the second arm of the right tetrad. In the parallel strands near the right tetrad are seen two pairs of small granules which may be chromatin or merely thickenings of the linin thread. Were it not for the evidence of the rest of the loop these might be taken to have arisen by a longitudinal split but such an interpretation is clearly impossible of the twisted spirem of which they are a part.

Fig. 10. A continuous split spirem of almost the same age as figure 6, in which the tetrads are clearly forshadowed though not yet differentiated. Contraction with consequent obliteration of the chromatin granules has gone further than in fig. 6, but the arm of the tertads have not approached closely nor has any break occurred. The linin connections which are very evident were largely lost in reproduction.

Fig. 11. A nucleus in which the four chromatids of each tetrad are clearly visible. The double linin thread may be traced into the overlying chromatids of the right tetrad which bend back and down to become continuous with the two underlying chromatids which in turn are continuous with the second pair of strands of linin thread. The connections of the left tterad with these linin threads is so indistinct as not to be exactly traceable. The left tetrad is in such a position that three of its chromatids are visbile while the fourth may be traced by focusing down. The different chromatids are much connected by bridges.

Fig. 12. A pair of tetrads fully formed and lying in the maturation spindle, showing the characteristic angle between them.

OHIO NATURALIST. *Plate XXXIII.*

GRIGGS on "Ascaris."

DESCRIPTIONS OF NEW MALLOPHAGA.

E. P. Durrant.

1. *Physostomum serratum* sp. nov. (Fig. 1, B.)

Female—Length, 4.7 mm., width, 1.3 mm.; wide marginal bands on abdomen with sinuous, dark central line in bands sharply reflexed at posterior part of each segment. Among the largest of the genus.

Head .88 mm. long, .86 mm. wide, evenly rounded at front, which is half as wide as occiput, lateral margins slightly convex, posterior angles incurved, occipital border broadly concave. Palettes rather large, palps extending slightly beyond margin of head, anterior sub-margin convex with a number of hairs. Antennal fossae with broad inner border; ocular notch slight, fleck conspicuous. There are three hairs on lateral border of head, one half way between fleck and angle, one near point of angle, and one as far in front of eye as eye is from angle.

Prothorax much broader than long, greatest width equal to that of head; posterior border convex, lateral margins rounded, with large bristle; marginal extensions narrow and of uniform width; metathorax much longer than prothorax; anterior rounded and slightly swelling, lateral border diverging posteriorly, large bristle at angle. Length of thorax .43 mm., width, .46 mm.

Abdomen with sides slightly swelling at middle, last segment broadly rounded with posterior part expanded; marginal bands broad, with dark-brown line in middle sharply reflexed toward median line at posterior part of each segment except seventh. This whole line, which is characteristic of the genus, has a serrate outline and seems to distinguish the species. The color of legs and head is tawny, except the darker inner border of antennal fossae and small blotches further forward, the abdomen and thorax each a shade darker.

Described from a single specimen in Professor Herbert Osborn's collection, taken from Desert Horned Lark (Otocoris sp.) at Ft. Collins, Colo., by J. H. Cowen.

2. *Physostomum sub-hastatum* sp. nov. (Fig. 1, A.)

Female—Length, 3.17 mm., width, .98 mm.; light fulvous, abdomen with dark bands near lateral borders, head and thorax with numerous markings of dark brown, legs same color as body.

Head, length .73 mm., width, .60 mm.; front broad and evenly rounded, margins diverging, slightly undulating, ocular notch small with two small hairs, fleck large; temple extended posteriorly, angle slightly out-turned, one short and two long bristles; occipital margin re-entering, occiput convex; labral lobes prominent, brownish incurved blotch back of lobes; antennal fossae well-marked, interior border with dark-brown band; two curved brown blotches between antennal fossae and those curving in from margin back of palettes; narrow sub-marginal occipital band, light brown; palpi scarcely extending to margin of head.

Thorax, length, .83 mm., width, .65 mm.; prothorax broader than long, narrower than head, lateral margins evenly rounded except at anterior part which is slightly incurved and has two small hairs and a bristle; long bristle at rounded posterior angle; anterior and posterior margins slightly concave; dark brown bands along lateral sub-margins; marginal extensions clear and of even width.

Metathorax longer and wider than prothorax, anterior part covered by it; margins diverging, large swelling near anterior part with three small hairs; large bristle and two small hairs at posterior angle; same width as first segment of abdomen; narrow brown lateral bands extending toward median line at front; similar incurved lines from lateral lines at middle. Legs large, of same color as head.

Abdomen, sides swelling, seventh segment narrowing, eighth evenly rounded; segments of nearly equal length, transverse margins straight, first, second, and third with one bristle, others with two bristles, at posterior angle; last segment with fringe of small hairs on posterior border; lateral line heavy and brown, broken at sutures with clear diagonal line; eighth segment paler than the others.

Described from specimen in Professor Herbert Osborn's collection, taken from Pipilo maculatus megalonyx (Baird) at Ft. Collins, Colo., by C. F. Baker. This species shows a considerable resemblance to P. subangulatum Car. in the lines of the thorax extending inward from the lateral line, but it is smaller and the lines are narrower and shorter.

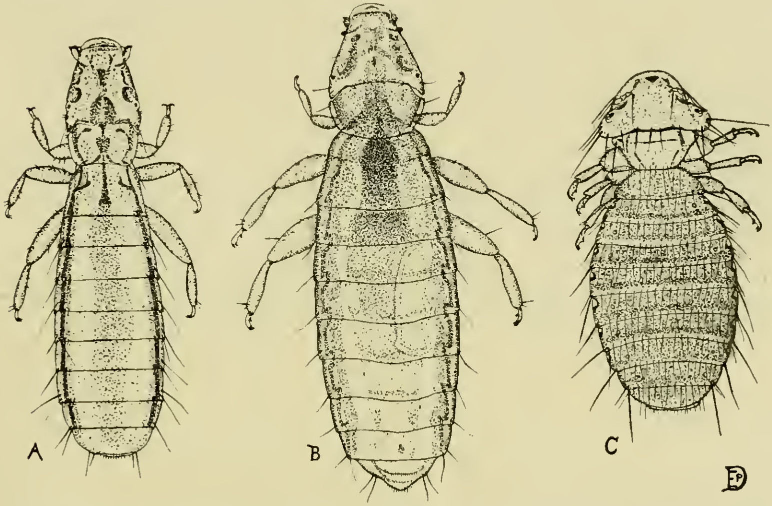

Fig. 1. A, Physostomum sub-hastatum, female from Pipilo maculatus megalonyx Baird. x 17. B, Physostomom serratum, female from Otocoris sp. x 13. C. Menopon aegialitidis, female from Aegialitis vocifera. x 33.

3. *Menopon aegialitidis* sp. nov. (Fig. 1, C.)

Female—Length, 1,30 mm., of golden-brown color, with darker transverse bands on abodmen, metathorax and abdomen having an oval outline, spiracles prominent.

Head, length, .29 mm., width, .48 mm.; front almost semi-circular, temporal lobes broadly rounded, posterior concave, antennae large and partly concealed in fossae, which have the broad inner border marked by a band of brown; ocular fleck large, notch shallow; palpi small; two large bristles in front of ocular notch, a row of fine hairs below it, and three large bristles on temporal lobes; large bristle at base of antennae and five along occipital border; head tawny, a triangular blotch in middle of anterior sub-margin; narrow occipital band.

Thorax, .31 mm. long, .47 mm. wide; greatly constricted at middle. Prothorax twice as broad as long, much narrower than head; anterior angle rounded, two small hairs with bristle between, two more bristles near posterior angle, several small bristles along posterior border; a narrow transverse band one-third of the way from front, with longitudinal bands near each end, diverging bands running half-way to front from posterior border. Metathorax shorter and broader than prothorax with straight diverging sides, also nearly straight anterior and posterior sutures; two long bristles at posterior angle, twelve long hairs along posterior border; a little darker than prothorax. Legs rather large especially the femur, and fulvous.

Abdomen with sides and posterior evenly rounded, wide transverse bands extending from side to side, sutures curved except last one; invaginations in the chitin of the lateral margins of all the segments except the last two produce clear notch-like spaces; one large and one small bristle at posterior angles of all but terminal segment; numerous long hairs on posterior borders of segments; fringe of fine hairs along sub-margin of last segment; last three sutures marked by clear spaces; first four segments have three small hairs on lateral margins.

Described from specimen in Professor Osborn's collection, taken from Aegialitis vocifera at Ft. Collins, Colo., by R. C. Stephenson.

This work was carried on in the Zoological Laboratory of Ohio State University under the direction of Professor Herbert Osborn, to whom the writer wishes to express his thanks for valuable assistance.

KEY TO THE SPECIES OF LIVERWORTS RECOGNIZED IN THE SIXTH EDITION OF GRAY'S MANUAL OF BOTANY.

Edo Claassen.

This key may be considered as a continuation of the one published last year in the Ohio Naturalist (Vol. V, p. 312.) Its purpose is therefore the same; it is intended to make the study of the liverworts and their determination more easy. It was thought to be necessary to put into the key more characters than are usually given. Rather than hamper the student in any way in his efforts to determine the liverworts, this extended key is believed to enable him to overcome the obstacles in his path.

Aneura Dumort.

1. Thallus narrow (about 2 mm. wide), palmately and pinnately divided or pinnate or bipinnate. 2.
   Thallus wider (4 mm. wide or more), simple or irregularly lobed. 4.
2. Calyptra smooth, not tuberculate, more or less hairy or squamulose, obovate-pyriform, about 3 mm. long. *pinnatifida* Nees.
   Calyptra more or less verrucose or tuberculate. 3.
3. Thallus biconvex with wide margin, formed by a single layer of cells (therefore in transverse section lens-shaped; calyptra cylindrical, 6–8 mm. long. *multifida* Dumort.
   Thallus flat, pellucid, with narrow margin (in transverse section of nearly equal thickness or planoconvex); calyptra pyriform-clavate. *latifrons* Lindb.

4. Thallus simple or slightly lobed; involucre short, lacerate; pedicel not folded upon itself. *pinguis* Dumort.
Thallus irregularly lobed; involucre none; pedicel 16–25 mm. long, sometimes folded upon itself and remaining within the calyptra, the capsule thus appearing sessile. *sessilis*, Spreng.

Anthoceros Micheli.
Thallus papillose; spores black, strongly muriculate and sharply angled. *punctatus* L.
Thallus smooth; spores nearly smooth, yellow, angular. *laevis* L.

Asterella Beauv.
Thallus forking and increasing by joints. Antheridia in sessile lunate disks. Peduncle bearded at base and apex. Spores large, tuberculate, nearly reticulately folded. *hemisphaerica* Beauv.

Bazzania S. F. Gray.
Plant robust; leaves from green to brownish, about 2 mm. long, somewhat deflexed with concave base, their apex 3-toothed; underleaves roundish–quadrangular, 4–6 toothed above and sinuate on the sides. *trilobata* S. F. Gray.
Plant much smaller; leaves yellowish or dark brown, about 1 mm. long, strongly deflexed, perfectly convex, their apex 2–3 toothed or entire; underleaves suborbicular, bifid, crenate or entire. *deflexa* Underw.

Blasia Micheli.
Thallus simple or forked or stellate, with sinuous margin; fruit from an oval cavity in the costa; involucre mostly none; capsule oval-globose; gemmae globose in flask-shaped receptacles; the scale-like underleaves broad-oval, coarsely dentate, in one longitudinal row. *pusilla* L.

Blepharostoma Dumort.
Stem flaccid, creeping, branched; leaves much smaller than the ramose, forking and awl-shaped involucral leaves; perianth ovate–cylindric. *trichophyllum* Dumort.

Cephalozia Dumort.
1. Perianth more or less 3–angled or 3–carinate; leaf cells large (mostly 25–50 μ broad;) plants medium sized. 2.
Perianth 3–6 angled; leaf cells small (14–20μ broad); plants small, often minute. 7.
2. Underleaves rarely present, except on fruiting branches. 3.
Underleaves usually present; leaves rarely subimbricate. *fluitans* Spruce.
3. Leaf lobes straight. 4.
Leaf lobes connivent or incurved. 5.
4. Dioecious, rarely monoecious; without runners; usually pale; leaf cells opaque; perianth large, widest above middle, unequally ciliolate. *virginiana* Spruce.
Monoecious; with runners; usually greenish or reddish; leaf cells pellucid; perianth linear–prismatic or fusiform, whitish, denticulate or ciliate. *bicuspidata* Dumort.
5. Leaflobes narrow, incurved. *curvifolia* Dumort.
Leaflobes broad, short, connivent. 6.
6. Leaves deucrrent; perianth linear–fusiform, 3–plaited, when young triangular only above, when mature. *multiflora* Spruce.
Leaves not decurrent; perianth large, oblong–cylindric, obtusely angled. *planiceps* Underwood.
7. Growing on the ground and on rocks; heteroecious; perianth linear or narrowly fusiform, prismatic, denticulate or subentire; leaves somewhat distant with acute lobes and an almost rec-

tangular acute sinus; underleaves often on sterile stems as also on fruiting branches. *divaricata* Dumort.

Growing on rotten wood; dioecious; perianth broadly oval to ovatefusiform. 8.

8. Perianth small, whitish, obovate or ovate-fusiform, obtusely 3-angled, the mouth setulose or ciliate; leaves with a broad or lunate sinus and broad-subulate, mostly acute lobes. *Macounii* Aust.

Perianth broadly oval or subobovate, obtusely angled, the apex slightly plicate, the mouth connivent, dentate, sometimes narrowly scarious; leaves imbricate, more or less serrate, the sinus and lobes subacute; underleaves present. *Sullivantii* Aust.

Chiloscyphus Corda.

1. Underleaves 4-parted; involucral leaves 2-cleft; perianth 2-3 lobed, the lobes long and lacerate-toothed. *adscendens* Hook. and Wils.

Underleaves bifid. 2.

2. Involucral leaves 2-toothed; perianth 3-lobed, the lobes spinose-dentate. *pallescens* Dumort.

Involucral leaves slightly 2-toothed; perianth 3-lobed, the short lobes nearly entire. *polyanthos* Corda.

Conocephalus Neck.

Thallus dichotomous, reticulate and porose. Antheridia imbedded in an oval disk, sessile near the apex of the thallus. Spores large, muriculate, brown. Dioecious. *conicus* Dumort.

Diplophyllum Dumort.

Stem acsending, nearly rootless; leaves closely folded and subdenticulate, with or usually without a pellucid line near the base, the lobes obtuse or acutish, the lower oblong-scymitar-shaped, coarsely dentate, the upper smaller, subobovate. *albicans* Dumort. var. *taxifolium* Nees.

Dumorticria Nees.

Thallus thin, soft, forking, usually with scattered hairlike rootlets beneath, naked or with a delicate, appressed pubescence above; peduncle chaffy at apex. Spores muriculate. Dioecious. *hirsuta* Nees.

Fimbriaria Nees.

Thallus simple or bifurcate, mostly conspicuously porose, with scales below, their hairlike ends surpassing the leafborder in shape of a long white beard. Antheridia immersed in the thallus. Spores roundish-angular, subreticulate. *tenella* Nees.

Fossombronia Raddi.

1. Plant minute; stem forked or fastigiately divided; spores pale fuscous, more or less tuberculate. *cristula* Aust.

Plant large or of medium size; stem mostly simple. 2.

2. Spores brown, depressed-globose-tetrahedral, crested, the slender (16-24) crests pellucid, rarely confluent. *pusilla* Dumort.

Spores reticulated and pitted. 3.

3. Spores yellowish brown, globose-tetrahdral, not depressed, deeply reticulated, the 7-9 reticulations large and deep, 5-6 angled and winged. *angulosa* Raddi.

Spores yellowish to dark brown, globose-tetrahdral, less deeply reticulated, and pitted, the 12-18 reticulations 4-6 angled and indistinctly crenate. *Dumortieri* Lindb.

Frullania Raddi.

1. Perianth smooth; leaves marked by a central moniliform row of cells or by a few large scattered cells; lower lobe cylindric-saccate. 2.

Perianth rough with tubercles or scales or smooth; leaves not marked by moniliform cells; lower lobe helmet-shaped, sometimes expanded, ovate–lanceolate. 4.

2. Leaves orbicular. 3.
   Leaves oblong from a narrowed base; lower lobe oblong–galeate. *fragilifolia* Tayl.
3. Pinnate; lower lobe near stem, oblong–clavate; underleaves oblong, 2–cleft, flat. *Asagrayana* Mont.
   Bipinnate; lower lobe distant from stem, oval or oblong; underleaves quadrate–ovate or obovate, emarginate, margin revolute. *Tamarisci* Nees.
4. Lower leaf lobe about ¾ the size of the upper. *Oakesiana* Aust.
   Lower leaf lobe much smaller than the upper. 5.
5. Underleaves scarcely wider than the stem, bifid, divisions entire, acute. 6.
   Underleaves 2–3 times wider than the stem, bifid, divisions entire or toothed, acute or blunt. 7.
6. Perianth pyriform, slightly compressed, repand, smooth, obscurely carinate beneath and gibbous toward the apex. *Eboracensis* Lehm.
   Perianth broadly oblong, bowl-shaped with very short mouth, papillose, abruptly broad–carinate beneath, 1–many-nerved each side of the keel, 2–angled. *saxicola* Aust.
7. Leaves lax, rather distant, lower lobes mostly expanded, ovate–lanceolate. Sporogonium unknown. *aeolotis* Nees.
   Leaves crowded or close–imbricate, lower lobe seldom expanded. Sporogonium known. 8.
8. Perianth tuberculate. 9.
   Perianth smooth. 10.
9. Irregularly branching; leaves ovate, lower lobe sometimes expanded into a lanceolate lamina; underleaves not toothed; perianth compressed pyriform, 2–4 carinate dorsally, 4–carinate ventrally. *Virginica* Lehm.
   Pinnately branching; leaves round, lower lobe not expanded; underleaves toothed; perianth obovate, retuse. *dilatata* Nees.
10. Underleaves cordate or rounded, sinuate–subdentate; perianth convex dorsally, strongly keeled ventrally. *squarrosa* Nees.
    Underleaves rather large, rounded; perianth sulcate dorsally, acutely keeled ventrally. *plana* Sulliv.

Geocalyx Nees.

Stem creeping with numerous rootlets; leaves ovate–quadrate, bidentate, light to bluish green; underleaves cleft to the middle, with linear–lanceolate divisions. *graveolens* Nees.

Grimaldia Raddi.

Thallus pale green, purple on the margin and below, with usually distinct whitish pores, the scales beneath often extending far beyond the margin and becoming whitish; peduncle barbed whitish and chaffy at base and apex. *barbifrons* Bisch.

Thallus bluish-green with membranous margins, purple below; peduncle sparingly scaly at base, barbulate at the apex. *rupestris* Lindenb.

Gymnomitrium Corda.

Stem simple or imbricately branching, thickened at the apex; leaves ovate, bifid, with a narrow scarious margin, bluish-green or brownish- or reddish-yellow to silvery-olive; no underleaves. *concinnatum* Corda.

Harpanthus Nees.

Stem filiform, decumbent, usually simple, leaves roundish ovate, their lobes acute; underleaves large, nearly 3–sided–lanceolate, mostly entire; perianth splitting above on one side. *scutatus* Spruce.

Herberta S. F. Gray.

Stem erect, nearly simple; leaves curved and one-sided, deeply lobed, lobes lanceolate. Perianth ovate-subulate or narrowly fusiform, 3–angled, deeply 4–8 lobed. *adunca* S. F. Gray

Jubula Dumort.

Subdichotomously branching; leaves dark olive green, obliquely ovate, acute, entire or subrepand; underleaves roundish, serrate or entire; involucral leaves bifid, serrate; perianth triangular–obpyriform.
Hutchinsiæ Dumort. var. *Sullivantii* Spruce.

Jungermannia Micheli.

1. Leaves complicate–concave, almost always equally bilobed. 2.
Leaves not complicate–concave. 4.

2. Stem densely covered with rootlets; leaves distant, oval with obtuse, almost rectangular sinus and acute lobes; involucral leaves 2–3 lobed, spinulose–serrate; perianth ovate, obtuse, the mouth contracted and ciliate. Monoecious. *Helleriana* Nees.
Stem sparsely covered with rootlets or frequently without any. Dioecious. 3.

3. Leaves erect, spreading, subsaccate at base, their dorsal part far overlapping the stem, subquadrate, with acute sinus, reaching ½ of the leaf, and acute, often incurved lobes; involucral leaves 2–3 lobed, denticulate above; perianth ovate–clavate, 5–6 plicate above, much contracted and long-fringed. *Michauxii* Weber.
Leaves very regularly arranged in 2 rows (thus giving the plant a comb-like appearance), keeled, the lobes acute to obtuse; involucral leaves larger, the inner ones trifid; perianth oval–oblong, the mouth somewhat contracted and ciliate–dentate. *miunta* Crantz.

4. Leaves entire or barely retuse. 5.
Leaves 2– or more lobed or –dentate. 7.

5. Underleaves present (not apparent on old stems), broadly subulate; upper involucral leaves laciniate. *Schraderi* Martius.
Underleaves wanting; involucral leaves like the cauline. 6.

6. Leaves orbicular, decurrent dorsally; perianth exserted, obovate–oblong, the mouth 4–cleft; capsule globose. *sphærocarpa* Hook.
Leaves ovate–elliptical; perianth fusiform, plicate above and denticulate; capsule oval. *pumila* With.

7. Leaves bilobed or bidentate. 8.
Leaves 3–6 lobed or dentate, seldom 2–dentate. 16.

8. Underleaves present. 9.
(Jungermannia alpestris and J. ventricosa may be sought here)
Underleaves wanting. 10.

9. Leaves vertical, bifid, the lower leaves with usually acute sinus and lobes, the upper much larger with rounded lobes and obtuse sinus; underleaves entire or the broader bifid; perianth without involucral leaves, dorsal. *Gillmani* Aust.
Leaves subvertical or spreading, emarginately bilobed, the lobes acute or the upper obtuse; underleaves somewhat obsolete or subulate, incurved; involucral leaves little larger, less deeply lobed; perianth terminal. *Wattiana* Aust.

10. Leaves 2–toothed. 11.
Leaves bifid or 2– 3–or more lobed. 13.

11. Leaf lobes obtuse with an obtuse sinus or acute in the upper leaves; perianth pellucid, reddish below. *Wallrothiana* Nees.
Leaf lobes acute. 12.

12. Plant green to reddish brown; leaves on the same stem hardly equal to each other in shape, often bearing red globules on the lobes of the upper leaves; perianth whitish. *alpestris* Schleich.
    Plant green to reddish green; leaves on the same stem similar in shape, often bearing yellowish globules on their lobes; perianth green to reddish. *ventricosa* Dicks.
13. Involucral leaves like the cauline; leaves roundish-ovate, 2–lobed with obtuse sinus and inequilateral, obtuse lobes; perianth long-oval to pyriform. *inflata* Huds.
    Involucral leaves unlike the cauline; leaves 2–6–cleft or–lobed. 14.
14. Usually purplish-black; leaves imbricate or distant on erect fertile stems with obtuse, wavy lobes; involucral leaves cristate–undulate, obtusely many-lobed; perianth long-clavate. *laxa* Lindb.
    Light to blackish and purplish-green; leaves horizontal or semivertical with acute or obtuse lobes; involucral leaves 3–5 cleft or lobed. 15.
15. Plant small (about 2 mm.), light green often with a purplish hue; leaves semivertical, erect-spreading; upper involucral leaves longer than wide; perianth oblong, pale, often banded and spotted with pink. *excisa* Dicks.
    Plant large (5–15 mm.), deep to bluish green; leaves horizontal, closely imbricate, the upper wavy-crispate; involucral leaves wider than long; perianth oval, whitish green. *excisa* Dicks. var. *crispa* Hook.
16. Underleaves none; leaves of irregular shape, 3–or more lobed with obtuse sinus and numerous, wide or narrow, always very acute, dentate lobes, thus giving the plant a crispate appearance. *incisa* Schrad.
    Underleaves present, sometimes obsolete. 17.
17. Leaves divided to ⅔ into 3 or 4 acute lobes and coarsely reflexed–dentate at their base; underleaves numerous, deeply bifid with ciliate–dentate base. *setiformis* Ehrh.
    Leaves divided to ¼ into acute or obtuse lobes and not dentate at base; underleaves entire or 2–toothed or often obsolete. 18.
18. Stem often with many vertical shoots, bearing loosely imbricate leaves; perianth oblong. *attenuata* Martius.
    Stem without shoots; perianth ovate. *barbata* Schreb.

Kantia S. F. Gray.
    Without ventral runners; underleaves bifid, lobes short oval–triangular, acute or obtuse. *Trichomanis* S. F. Gray.
    With ventral runners; underleaves minute, the upper orbicular, bifid, the lower twice 2–lobed, the primary lobes round–quadrate, the secondary ovate or subulate *Sullivantii* Underwood.

Lejeunia Libert.
1. Underleaves entire. *clypeata* Sulliv.
    Underleaves bifid or obsolete. 2.
2. Underleaves bifid. 3.
    Underleaves obsolete; leaves muriculate–denticulate. *calcarea* Libert.
3. Monoecious; stem long, somewhat branching; leaves roundish–ovate, obtuse; perianth obovate–clavate. *serpyllifolia* Libert. var. *americana* Lindb.
    Dioecious; stem filiform, pinnately branching; leaves ovate–triangular, rounded or obtuse; perianth broadly pyriform, 5–carinate. Plant minute. *lucens* Tayl.

Lepidozia Dumort.
    Leaves decurved, 3–4 cleft, the lobes lanceolate, formed by more than 2 rows of cells. *reptans* Dumort.
    Leaves incurved, 2–3 cleft or parted, the lobes subulate, formed by 2 rows of cells. *setacea* Mitt.

Liochlaena Nees.

Monoecious. Dark Green. Stem with brownish rootlets, closely creeping, usually branched many times; leaves imbricate, mostly decurrent; leaf cells large, roundish, with much thickened walls; involucral leaves vertical and saccate in their lower part, recurved and spread out flatly in their upper part. *lanceolata* Nees.

Lophocolea Dumort.

1. Leaves entire, emarginate and bidentate (often on the same stem), leaves 2-lobed, lobes more or less dentate. *heteropylla* Nees.
   Underleaves (all) distinctly bilobed. 2.
2. Underleaves 3 to 4 cleft or 2 and 3 to 4 parted. 3.
   Underleaves 2–lobed. 4.
3. Underleaves 3 to 4 cleft, the inner lobes lanceolate, the outer ones linear; leaves acutely lobed. *bidentata* Dumort.
   Underleaves, the lower small, 2–parted, the upper larger with a signle tooth on each side or palmately 3–4 parted and the apical sublanceolate and narrowly bifid; leaves mostly obtusely lobed. *Hallii* Aust.
4. Leaves 2–lobed with obtuse sinus and lobes or retuse or entire; underleaves light-pink, the steaceous lobes spreading incruved. *Macounii* Aust.
   Leaves 2–lobed with acute lobes and acute or obtuse sinus. 5.
5. Leaf lobes with an obtuse (lunate) sinus, usually bearing yellowish globules, lobes of underleaves lanceolate, acuminate. Dioecious. *minor* Nees.
   Leaf lobes usually with an acute sinus; lobes of underleaves subulate. Monoecious. *Austini* Lindb.

Lunularia Micheli.

Thallus oblong with rounded lobes, aereolate and porose, innovating from the apex, with imbricate sublunate scales beneath; peduncle very hairy; antheridia in the apical sinus of the thallus. *vulgaris* Raddi.

Marchantia Marchant f.

Thallus large, forking, areolate, porose; receptacle divided into an uneven number of rays (mostly 9) and the involucres between them always one less in number. Antheridia immersed in a peduncled, disk-like, raidate, or lobed receptacle. Dioecious. *polymorpha* L.

Marsupella Dumort.

1. Leaves closely and vertically imbricate; stem minute (2–4 mm.), clavate with 4–8 pairs of oval leaves; leaves $\frac{1}{4}$–$\frac{1}{3}$ bilobed, lobes acute with an acute or angular sinus. *adusta* Spruce.
   Leaves spreading or loosely imbricate. 2.
2. Stem stoloniferous, rigid (10–40, sometimes 80–100 mm.), somewhat thickened upward; leaves usually broader than long, subquadrate, lobes obtuse or mucronate; sinus obtuse ($\frac{1}{6}$ or $\frac{1}{5}$ of the leaf); the two upper involucral leaves connate to the middle. *emarginata* Dumort.
   Stem not stoloniferous, erect, subflexuous (15–30 mm.); leaves obovate, their upper half slightly keeled, their lower half ventricose–concave; lobes roundish–obtuse, sinus narrow, acute or less obtuse than in the perceding ($\frac{1}{3}$ of the leaf); the two upper involucral leaves connate $\frac{1}{3}$. *sphacelata* Dumort.

Metzgeria Raddi.

1. Densely villous throughout. *pubescens* Raddi.
   Hairy on the margin and midrib beneath, smooth above. 2.

2. Midrib covered above and below with 2 rows of enlarged cells; hairs very long, divaricate and hooked–deflexed, the marginal in twos, rarely with discoid tips. *hamata* Lindb.
   Midrib covered above with 2 rows of enlarged cells and below with 3–7 rows of cells. 3.
3. With 3–7 (usually 4–6) rows of cells below, smaller than the upper ones and often indistinct; midrib densely pilose beneath, hairs rather long, straight or nodding, the marginal mostly in clusters of 3–6, some of which have discoidal tips. *myriopoda* Lindb.
   With 3–6 rows of enlarged cells below; hairs rather long, straight, divaricate, the marginal usually in twos, very often disk-bearing. *conjugata* Lindb.

Mylia S. F. Gray.
   Stem erect, nearly simple, radiculose; leaves orbicular, purplish; perianth oval; calyptra finally long-exserted. *Taylori* S. F. Gray.

Nardia S. F. Gray.
1. Perianth exserted ,connate with the involucral leaves, subcampanulate and open, deeply laciniate, 6–10 plicate; rootlets purple. *fossombronioides*, Lindb.
   Perianth connate at base with the inner involucral leaves and somewhat surpassing them, 3–8 carinate, the mouth constricted; rootlets whitish reddish or purple. 2.
2. Marginal leaf-cells quadrate and much larger than the others; rootlets whitish. *crenulata* Lindb.
   Marginal leaf-eells about as large as the others. 3.
3. Branch leaves ovate or obovate, scarcely decurrent, half as large as the obliquely semi-circular or broadly ovate, decurrent stem leaves; fruit unknown. *biformis* Lindb.
   Branch leaves similar to the stem leaves; fruit known. 4.
4. Rootlets reddish (claret-colored); leaves roundish oval; involucral leaves closely appressed and connate with the lower third of the perianth, which is slightly exserted, obovate and narrowed to the 4–cleft mouth. *hyalina* Carring.
   Rootlets purple; leaves orbicular; involucral leaves connate (more or less) with the small, subobovate perianth, which is slightly or not exserted, rooting at base and triquetrous above, but becoming 4–7 plicate. *crenuliformis* Lindb.

Notothylas Sulliv.
   Thallus 5–15 mm. wide; capsule with a suture on each side; spores light yellowish-brown. *orbicularis* Sulliv.
   Thallus small; capsule often without suture; spores dark-brown, a half larger. *melanospora* Sulliv.

Odontoschisma Dumort.
   Underleaves mostly wanting; perianth subulate–fusiform, lacinate or ciliate; among mosses. *Sphagni* Dumort.
   Underleaves broadly oval, entire and sub-denticulate; perianth close–connivent above at length bursting irregularly; on rotten wood. *denudata* Lindb.

Pallavicinia S. F. Gray.
   Fruit arising from the costa, at first terminal, becoming dorsal; capsule cylindric, about 5 times longer than broad; involucre cup-shaped, short-lacerate. *Lyellii* S. F. Gray.

Pellia Raddi.
1. Thallus indistinctly costate, lobed and sinuate. Calyptra much longer than the involucre. Antheridia at the base of the involucre on the same thallus. *epiphylla* Raddi.

Thallus distinctly costate. Calyptra not surpassing the involucre. Antheridia on a separate thallus. 2.

2. Divisions of thallus broadly linear, the margin mostly undulate crisped. *endiviaefolia* Dumort.

Divisions of thallus, the early ones linear-oblong, the margins ascending and remotely sinuate, the later ones linear-pinnatifid. *calycina* Nees.

Plagiochila Dumort.

1. Leaves with 3–12 large, spinulose and distant teeth; no underleaves. *spinulosa* Dumort.

Leaves entire, repand or denticulate. 2.

2. Lower part of stem leafy to the base; underleaves 2–3 ceft, fugacious. 3.

Lower part of stem, forming a rhizome, bearing scales; no underleaves; mouth of perianth ciliate. *asplenioides* Dumort.

3. Leaves entire or slightly repand; mouth of perianth crenulate. *interrupta* Dumort.

Leaves entire, the uppermost repand-denticulate; mouth of perianth denticulate. *porelloides* Lindenb.

Porella Dill.

1. Stems bipinnate; leaves more or less remote, ovate-oblong, lower lobe minute, flat, as long but not half as wide as the ovate-rectangular entire underleaves. *pinnata* L.

Stems mostly simply pinnate (or bipinnate in P. platyphylla); leaves mostly closely imbricate, round-ovate or ovate. 2.

2. Leaves sub-erect, the straight ventral margin strongly involute towards the apex; cells punctate-stelliform. *Sullivantii* Underw.

Leaves flat or more or less concave at base or somewhat convex, the margin decurved or curved upwards. 3.

3. Upper leaf-margin curved upwards and undulate, mostly entire; lower lobe reaching half of upper, hardly deucrrent; underleaves semi-circular with strongly reflexed margins, entire. *platyphylla* Lindb.

Upper leaf margin decurved, more or less denticulate; lower lobe smaller, long-decurrent; underleaves suborbicular or quadrate-oval or quadrate, dentate or ciliately serrate. 4.

4. Underleaves suborbicular or quadrate-oval, the margins undulate and dentate; lower lobe acute, reaching $\frac{1}{3}$ of upper and half as wide as the dentate underleaves. *dentata* Lindb.

Underleaves quadrate, the margins sparsely dentate; lower lobe oblong, obtuse, longer but narrower than the underleaves, both with strongly recurved and sparsely denticulate margins. *Thuja* Lindb.

Preissia Nees.

Thallus large, sparingly forking, increasing by joints, ends of lobes subcordate, with white pores above and dark purple scales below. Antheridia in a peduncled disk-like receptacle. Dioecious or usually monoecious. *commutata* Nees.

Ptilidium Nees.

Stem subpinnate with short rootlets; perianth several times longer than the involucre. Antheridia in the base of closely imbricated leaves. Dioecious. *ciliare* Nees.

Radula Dumort.

1. Lower lobe small, rounded, more or less transversely adnate. *tenax* Lindb.

Lower lobe subquadrate, barely incumbent on the stem. 2.

2. Widely subpinnately branched; leaves imbricate, rounded; perianth obconic, compressed. Antheridia in the bases of 2–3 pairs of strongly imbricate tumid leaves. *complanata* Dumort.

Indeterminately branching; leaves somewhat remote, round–obovate; perianth clavate–obconic. Antheridia axillary on short lateral branches, arising near the terminal involucre. *obconica* Sulliv.

Riccia Micheli.

1. Terrestrial forms growing in rosettes or irregular dichotomous forms. Fruit immersed in the upper side of the thallus, mostly protuberant above. Thallus with or without air-cavaties. 2.
   Aquatic plants floating in water or with its retreat rooting in mud and there fruiting. Fruit immersed in the lower side or the central groove of the thallus. Thallus with air-cavaties. 12.
2. Thallus mostly without air-cavities. 3.
   Thallus with air-cavaties communicating with the upper surface. 11
3. Thallus naked, without cilia and scales on the margin and underneath. 4.
   Thallus with scales underneath, not ciliate or more or less ciliate at the margin and apices. 7.
4. Spores small (60μ or less). 5.
   Spores larger (75–95μ), dark fuscous with deep reticulations (about 8 across the convex turface); divisions of thallus narrow. *arvensis* Aust.
5. Thallus with wide divisions, thin and flat, with few rootlets; spores muriculate, spinulose. *tenuis* Aust.
   Thallus with narrow divisions and numerous rootlets. 6.
6. Thallus thin, fibrous–reticulate; spores obscurely muriculate. *Frostii* Aust.
   Thallus canaliculate above, carinate–thick-ened beneath; spores coarsely reticulate.
   (*fluitans*, L. var. *Sullivanti*, Aust.) *Huebeneriana* Lindenb.
7. Thallus with scales underneath, not ciliate. 8.
   Thallus more or less ciliate at the margin and apices. 10.
8. Scales and usually the thallus purple underneath; scales not exceeding the margin; spores light brown. *nigrella* D. C.
   Scales usually whitish; thallus green underneath. 9.
9. Scales reaching beyond the margin; spores light brown. *lamellosa* Raddi.
   Scales not reaching the margin; spores dark brown.
   (*sorocarpa* Bischoff) *minima* L.
10. Capsules usually in a single row; spores blackish, opaque, scarcely reticulated (*arvensis* Aust. var. *hirta* Aust.) *hirta* Aust.
    Capsules scattered chiefly near the base of the divisions (with a purple spot near them on the thallus); spores brown, reticulated with 7–8 areolae across the convex surface. *Lescuriana* Aust.
11. Upper surface of thallus strongly pitted, green or reddish to purplish; divisions of thallus rather broad, obtuse or often obcordate at the apex. *crystallina* L.
    Upper surface of thallus mostly smooth (except for the median groove), yellowish green; divisions narrow, linear, obcordate and convex. thickened at the apex. *lutescens* Schwein.
12. Thallus linear, dichotomous, floating or rarely terrestrial capsule protuberant from the lower surface. *fluitans* L.
    Thallus obcordate, floating or rarely terrestrial; capsule not protruding, at last exposed by a cleft in the central groove. *natans* L.

Scapania Dumort.

1. Lower leaf lobe equalling in size the upper or nearly so. 2.
   Lower leaf lobe (except those near the summit) about twice the size of the upper or 3–4 times its size. 3.

2. Leaf lobes roundish–obtuse and denticulate on outer margin; perianth much exceeding the involucral leaves, denticulate. *subalpina* Dumort.
   Leaf lobes broadly-ovate, obtuse or apiculate, entire; perianth small, entire. *glaucocephala* Aust.
3. Lower lobes (except those near the summit) about twice the size of the upper. 4.
   Lower lobes (except those near the summit) 3–4 times the size of the upper. 7.
4. Leaves broader than long; upper lobes rounded or blunt. 5.
   Leaves longer than broad; upper lobes more or less acute. 6.
5. Leaves lax; lobes roundish, equal at the summit of the stem, entire or ciliate–denticulate; perianth oblong–incurved, nearly entire, twice as long as the involucre. *undulata* Dumort.
   Leaves somewhat rigid, lobes rounded, submucronate, the lower appressed, the upper convex with incurved apex; perianth ovate, denticulate. *irrigua* Dumort.
6. Lower and upper lobes ciliate–dentate, the upper acute; perianth densely ciliate. *nemorosa* Dumort.
   Lower lobe coarsely dentate and with deep purple spur-like teeth on the keel, the upper roundish and less dentate; perianth usually dentate. *Oakesii* Aust.
7. Lobes ovate, acute, serrate; perianth incurved, entire. *umbrosa* Dumort.
   Lobes, the lower ovate, acute or bidentate, concave, the upper small and tooth-like; perianth oblong, 5–plicate, the mouth 5–dentate. *exsecta* Aust.

Sphaerocarpus Micheli.

Thallus orbicular, lobed, in small rosettes; the clustered inflated involucres (3 or 4 times as long as the capsule) mostly dispersed over its whole surface. *terrestris* Smith.

Trichocolea Dumort.

Stem pinnately decompound without rootlets; antheridia large, in the axils of leaves on terminal branches. Dioecious. *tomentella* Dumort.

ADDITIONS TO THE FLORA OF CEDAR POINT, I.

W. A. Kellerman and H. H. York.

A general list of the flowering plants and ferns of Cedar Point was published in the Ohio Naturalist **4** : 186–190, 1904. During the summer of 1904, the following plants were collected on the point and should be added to the list:

Acer negundo L.
Allionia nyctaginea Mx.
Allium tricoccum Ait.
Avena sativa L.
Carpinus caroliniana Walt.
Ceratophyllum demersum L.
Chaetochloa viridis (L.) Scrib.
Fraxinus biltmoreana Beadle.
Fraxinus nigra Marsh.
Fraxinus quadrangulata Mx.
Hesperis matronalis L.
Hicoria minima (Marsh.) Britt.
Hordeum pusillum Nutt.
Hypericum perforatum L.
Ledipium campestre (L) R. Br.
Morus rubra tartarica Loud.
Rosa humilis Marsh.
Sassafras sassafras (L.) Karst.
Scirpus fluviatilis (Torr.) Gray.
Secale cereale L.
Scutellaria lateriflora L.
Spartina cynosuroides (L.) Willd.
Specularia perfoliata (L.) DC.
Typha angustifolia L.
Ulmus fulva Mx.
Virburnum cassinoides L.

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TERMINOLOGY OF ORGANS IN VARIOUS CONDITIONS OF DEVELOPMENT.

JOHN H. SCHAFFNER.

In describing organs which are undeveloped, defective, or reduced, one is sometimes at a loss as to the proper term to be applied. The words available are used in various ways by different authors. It becomes necessary, therefore, for each individual to make some selection for himself in order to avoid general confusion until a common agreement is reached either through general consent or through some authoritative body. Without going into details on special cases, one may consider the following types of organs representing various stages of individual development or of evolutionary progress.

1. Normal organs in the first stages of development in the individual are "incipient" organs and the beginning of such an organ is its "inception." The writer has proposed the term "incept" as a suitable noun to be used in the same way as the German "anlage." Thus one may say that a bud is an incipient flower, or the bud is the incept of the flower. An incipient organ is one in the embryonic condition but not necessarily an organ of the embryo. Primordium and rudiment have been used as special nouns for incipient organs but rudimentary is a general term and primordial from its paleontological flavor has rather a phylogenetic meaning.

Definition—Incipient organ, incept (Lat. inceptio, incipiens)—An organ in its first stages of development in the life of the individual; an organ in its embryonic condition.

2. Organs in the first stages of their evolution or such as have become specialized or fixed in a certain stage of evolution, while in related groups they have advanced to higher types, are

properly called "nascent" organs. Thus the lung of a reptile must at one time have been a nascent lung while gills were used to aerate the blood. The hypophysis of a moss is a nascent leaf whether it ever develops any further or not. Such organs were called "prophetic" by Agassiz in harmony with his theory of creation. If a noun is to be used it appears to the writer that "primordium" is the correct expression. Thus "primordial organ" becomes synonymous with "nascent organ" and should perhaps have the preference.

Definition—Nascent organ (Lat. nasci, nascens)—An organ at the beginning of its evolution or at the beginning of its development in the race; an organ in its first stages of evolution as compared with other homologous organs.

3. If an organ was developed in the past but is now continually imperfect or undeveloped in the individuals of a species it is called a "vestigial" organ or a "vestige." The three small sterile stamens in a Catalpa flower are vestigial. The splint bones in a horse and the dew-claws on a cow's foot are examples of vestigial organs. Such organs even if no longer functional may still be useful. Some undeveloped organs may however not be vestigial. The incepts may be present in the embryonic state of the individual and may or may not develop, depending on the sex determined during the development of the organism. Such organs may in some cases be vestigial or they may only be special cases of abortion.

Definition—Vestigial organ, vestige (Lat. vestigium)—An organ which was normally developed in the past history of the race but which has become permanently reduced, never developing completely in any individual.

4. If an organ normal in the species fails to develop properly in an individual it may be called an abortive organ. A microcephalic individual has an abortive head. A flower bud or a leaf may be abortive by reason of an unfavorable position on the stem. Abortive organs may sometimes be atavistic, the development having stopped at a stage representing a more primitive condition of the race. Abortive should not be used in the sense of vestigial.

Definition—Abortive organ (Lat. abortare, abortivus)—An organ normal in the species but which has failed to reach full development in the individual.

5. Organs properly developed in the individual sometimes become reduced through disease or other causes. Such organs are properly called "atrophied" organs.

Definition—Atrophied organ (Gr. a trophia)—An organ which is normal in the species and fully developed in the individual, but which has become reduced through pathological conditions or through disuse.

6. Imperfectly developed or reduced organs of all types may be called rudimentary organs or rudiments. So long then as the nature of any incomplete organ is unknown, or speaking generally, it may be called a rudimentary organ; but with complete knowledge, and speaking specifically, it will be called an incipient, a nascent, a vestigial, an abortive, or an atrophied organ as the case may be.

Definition—Rudimentary organ, rudiment (Lat. rudimentum)—An organ in the initial, incipient, or incomplete stage of development; or one that has become reduced either in the history of the race or of the individual.

There are still other types or conditions of organs which may be defined in a definite sense:

1. Atavistic organs are such as show in the individual a return to some ancestral type.

2. Retrogressive organs are such as are passing from a higher to a lower or less perfectly developed condition or state of organization.

3. Abnormal organs are those which deviate from the usual type in some extraordinary way, as in shape, size, number of parts, color or other character. Good examples of abnormal organs are shown in the following: a fasciated stem, a three-parted Fuchsia, or a "web-toed" man. Abnormalities are frequently inherited.

4. Under the term malformed organs, may be included such types as unusual growths due directly to some external condition in the life of the individual, as an insect bud-gall, or a leaf blade of a rhubarb grown in the dark. A good example is a pointed leaf which has become emarginate through some accident during its development. A malformation cannot be transmitted unless acquired characters so called are inheritable.

5. Transformed organs are such as show a change in the individual or the race from one type of structure or function to another. A stamen developing into a petal is a transformed organ. In such transformations there is a failure of the usual hereditary tendencies to assert themselves while other tendencies present in the same cells become dominant when they should be suppressed. Insect wings are probably transformed gills and reptilian lungs transformed air-bladders.

6. Under the term "juvenile organs" may be included all organs which appear on the young individual but which are absent in the adult. They may be special organs of the embryo, or normally developed organs which later drop off or are absorbed. The compound leaves of certain seedling Acacias which in the adult stage have only phyllodes are good examples of juvenile organs; the tail of a tadpole is a juvenile organ. The term embryonic organ may be used for the earlier stage whenever there

is a definite change of environment during development as in mammals, birds, or seed plants, while juvenile may be employed for the succeeding stages. Embryonic is however, the more restricted term and when there is a gradual transformation from the egg or spore to the adult form, the more convenient designation is "juvenile" stage or organ. In cases where there is a definite metamorphosis or succession of forms as in some mosses or in insects the special terms applied to these stages may, of course, be most advantageously used for the special organs of the stage in question.

ADDITIONS TO THE FLORA OF CEDAR POINT, II.

Otto E. Jennings.

The "Flora of Cedar Point,"[1] published in 1904, was intended to be a complete list of the flowering plants and ferns of that locality as collected during the summer of 1903 and as substantiated by definite prior reports of various other collectors. A list of 26 additions for 1904 was published in the May number of the Ohio Naturalist. During the 1905 session of the Lake Laboratory of the Ohio State University a further opportunity was afforded the writer following up this line of study. In the following list are given those species which were collected on Cedar Point in 1905 but which were not included in the former lists referred to.

The total number of species of flowering plants and ferns reported for Cedar Point is now 449,—original "Flora of Cedar Point," 387 species: additions 1904, 26 species; Prof. E. L. Moseley, 1904, 5 species; 1905, 31 species. Total, 449 species.

Apocynum hypericifolium Ait. Occasional near the Laboratory in the coarse sand of the upper beach.
Arabis laevigata Muhl. In the Ridge Section.
Blephilia ciliata (L.) Raf. Woods, Ridge Section.
Brassica arvensis (L.) B. S. P. At edge of Bay.
Brassica campestris L. Among driftwood at edge of Bay.
Carex bicknellii Britt.
Carex frankii Kunth.
Carex laxiflora Lam.
Carex lupulina Muhl.
Carex schweinitzii Dewey.
Carex vulpinoidea Michx. All the above **Carices** were collected in or about the marsh at the head of Biemillers Cove. **C. schweinitzii** Dewey is, I believe, new to Ohio.
Clematis virginiana L. Woods, southeast of laboratory.
Cornus obliqua Raf. This species and **C. amomum** Mill. here apparently intergrade.
Eleocharis acicularis (L.) R. & S. In excavated sand near the Lagoons.
Elymus hirsutiglumis Scrib. & Smith. Several points in the Dune Section.
Erigeron ramosus (Walt.) B. S. P. H. H. York, June 25, 1905. Not uncommon in Dune Section.
Galium palustre L. Woods, Ridge Section.

Galium trifidum L. Woods, southeast of Laboratory.
Juncus tenuis Willd. Edge of Bay near the Cedar Point Dock.
Lathyrus maritimus (L.) Bigel. This species, between Rye Beach and the Black Channel, was collected by R. F. Griggs, 1903, E. L. Moseley, 1904, and again by the writer, 1905. At Presque Isle, Erie, Pa., this species is very abundant.
Lemna minor L. Ponds, Ridge Section.
Lysimachia nummularia L. Near the lighthouse.
Monarda mollis L. The most common **Monarda** on Cedar Point.
Polygonum pennsylvanicum L. Marsh near Laboratory.
Potamogeton amplifolius Tuckerm.
Potamogeton foliosus Raf. Both the above species east of entrance to Biemillers Cove.
Potamogeton lucens L. Near the Black Channel.
Rumex altissimus Wood. Marsh north of "White House."
Sagittaria graminea Mx. Opposite Laboratory at western edge of Biemillers Cove and near the "Carrying Ground."
Thalictrum polygamum Muhl. Edge of marsh near the Black Channel.
Toxicodendron pubescens Mill.[2] On sand dunes near Laboratory.

Prof. E. L. Moseley[3] in listing the vegetation of the bar between the Black Channel and Rye Beach mentions the following species, none of which were included in the "Flora of Cedar Point":

Equisetum pratense Ehrh.
Gentiana andrewsii Griseb.
Liriodendron tulipifera L.
Muhlenbergia mexicana (L.) Trin.
Solidago canadensis L.

1. Kellerman, W. A. and Jennings, O. E. Flora of Cedar Point. Ohio Nat. **4** : 186-190. June, 1904.
2. Greene, E. L. Segregates of Rhus. Leaflets, **1** : 114-144. Nov. 24 and Nov. 29, 1905.
3. Moseley, E. L. Formation of Sandusky Bay and Cedar Point. Proc. Ohio State Acad. Sci., **4** : 179-238. 1906.

Carnegie Museum, March 28, 1906.

KEY TO THE FAMILIES AND GENERA OF THE ORDER THYSANURA.

C. F. Jackson.

The order Thysanura comprises on the whole, a group of very small insects, the largest of which do not much exceed 25 mm. in length. They may be found in almost every conceivable locality, under old logs, in moss and grass, along the margin of stagnant pools and even in our dwellings. Yet strange to say since the time of Degeer, Nicolet and Sir John Lubbock but little has been added to our knowledge of Thysanura and the study of this most interesting order of insects has till within the last few years been very much neglected.

As in all other branches of science, much confusion has arisen as to the identity of species. This is due partly to the fact that the descriptions given by the early writers are frequently so short and incomplete that the species, or even the genus, cannot be satisfactorily determined; and, partly from the fact that many of the species vary greatly as to color, or the young of one species resembling the adult of another. All this has had a tendency to discourage further research. Adequate keys have been prepared but the most of them have dealt only with Old World species.

The present key has not been thoroughly tested, but it is hoped that it will aid somewhat the research in American species. It has been adapted from "Die Gattungen und Arten der Apterygogenea (Brauer)," by Dr. K. W. v. Dalla Torre, published in 1895, but I believe it will apply to most of our genera.

I desire here to extend my thanks to Dr. L. B. Walton and Prof. Herbert Osborn for the valuable suggestions concerning the preparation of this publication. The accompanying plate has been made by my wife, who has given me the greatest assistance throughout the entire work.

NOTE—The following key has been prepared in advance of a more extended work on the Thysanura of Ohio. Any suggestions or specimens will be gladly received.

KEY TO THE FAMILIES AND GENERA OF THE ORDER THYSANURA.

A: Mouthparts well developed, palpi distinctly visible, antennae usually many jointed, caudal end of body usually provided with a pair of jointed filamentous or forceplike appendages and without a ventral sucker.

SUB-ORDER, I. CINURA.

B: Body covered with scales. Fam: 1. LEPISMIDAE.
  C: Eyes absent. Gen. 1 (1) **Troglodromicus.**
  CC: Eyes present'
    D: Eyes large, contiguous or nearly so. Gen. 2 (2) **Machilis.**
    DD: Eyes small and separated.
      E: Caudal appendages very short. Gen. 3 (3) **Lepismina.**
      EE: Caudal appendages nearly as long as body. Gen. 4 (4) **Lepisma.**
BB: Body not covered with scales.
  C: Abdomen without caudal appendages. Fam: 2. ANISOSPHAERIDAE
    D: A single genus. Gen. 1 (5) **Anisosphaerae.**
  CC: Caudal appendages, simple segmented filaments or sickle shaped.
    D: Caudal appendages sickle-shaped. Fam: 3. IAPYGIDAE
      E: A single genus. Gen. 1 (6) **Iapyx**
    DD: Caudal appendages many jointed filaments. Fam.: 4 CAMPODEIDAE.
      E: Two caudal appendages. Gen. 1 (7) **Campodea.**
      EE: Three caudal appendages. Gen: 2 (8) **Nicoletia.**

AA: Mouthparts retracted, palpi not distinctly visible, antennae usually 4-8 jointed, a forked sucker on the ventral side of abdomen, a saltatorial appendage usually near caudal end of abdomen. (See drawings.)

SUB-ORDER, II. COLLEMBOLA.

B: Saltatorial organ present.
  C: Saltatorial organ attached on the penultimate abdominal segment.
    D: Abdomen globular, only slightly longer than broad. Fam: 5. SMINTHURIDAE.
      E: Terminal segment of antennae short, with whorls of hairs. Gen: 1 (9) **Papirius.**

EE: Terimnal segment of antennae long, annulate.

F: Antennae with 8 segments, abdomen with 2 tubercles. Gen: 2 (10) **Dicyrtoma.**

FF: Antennae with 4 segments, abdomen without tubercles. Gen: 3 (11) **Sminthurus.**

DD: Abdomen clyindrical, longer than broad. Fam: 6, ENTOMOBRYIDAE.

E: Body naked or covered with hair.

F: Antennae of 6 segments. Gen: 1 (12) **Orchesella.**

FF: Antennae of 4-5 segments.

G: 2 ocelli on either side of head. Gen: 2 (13) **Sinella.**

GG: 8 ocelli on either side of head.

H: Dorsal portion of third and fourth abdominal segment approximately of equal length.

I: Central part of saltatorial organ not reaching over the ventral sucker. Gen: 3 (14) **Isotoma.**

II: Central part of saltatorial organ reaching beyond ventral sucker. Gen: 4 (15) **Corynothrix**

HH: Dorsal portion of fourth abdominal segment 3-4 times longer than third.

I: Distal end of saltatorial organ curved, without antiapical hooks. Gen: 5 (16) **Drepanura.**

II: Distal end of saltatorial organ simple, with antiapical hooks.

J: Ocelli irregularly arranged, not in 2 longitudinal and 4 transverse rows. Gen: 6 (17) **Entomobrya.**

JJ: Ocelli symetrically arranged in 2 longitudinal and 4 transverse rows. Gen: 7 (18) **Salina.**

EE: Body covered with flat scales.

F: Antennae of 4 segments.

G: Distal segment of antennae annulate.

H: Ocelli present. Gen: 8 (19) **Tomocerus.**

HH: Ocelli absent.

I: Antennae longer than body, saltatorial organ with long distal segment. Gen: 9 (20) **Tritomurus.**

II: Antennae half as long as body, saltatorial organ with very short distal segment. Gen: 10 (21) **Heteromurus.**

GG: Distal segment of antennae not annulate.

H: Ocelli absent. Gen: 11 (22) **Cyphodeirus.**

HH: Ocelli present.

I: Pronotum simple, head prominent.

J: Metathorax enlarged into hump. Gen: 12 (23) **Campylothorax.**

JJ: Metathorax simple.

K: Middle part of saltatorial organ spiny. Gen: 13 (24) **Dicranocentrus.**

KK: Saltatorial organ smooth.

L: Fourth abdominal segment almost 3 times as long as third. Gen: 14(25)**Pseudosira.**

LL: Fourth abdominal segment 4-5 times as long as third.

M: Fourth abdominal segment, 5 times as long as third, 6 ocelli on either side
Gen: 15(26) **Trichocorypha.**

MM: Fourth abdominal segment 4 times as long as third.

N: 8 Ocelli on either side.
Gen: 16(27) **Seira.**

NN: 4 Ocelli on either side.
Gen: 17(28) **Paronella.**

II: Pronotum extending over head and partially concealing it.

J: 8 Ocelli on either side.
Gen: 18 (29) **Lepidocyrtus.**

JJ: 6 Ocelli on either side.
Gen: 19 (30) **Calistella.**

FF: Antennae of 5 segments.

G: Eye-spot with 1 ocellus, terminal segment of antennae annulate.
Gen: 20 (31) **Templetonia.**

GG: Eye-spot with 8 ocelli, terminal segment of antennae simple. Gen: 21(32 **Strongylonotus.**

CC: Saltatorial appandege attached to antipenultimate abdominal segment.
Fam: 7. PODURIDAE.

D: Mouth-parts extending cone-like from front of head.
Gen: 1 (33) **Gnathocephalus.**

DD: Mouth-parts not appearing cone-like from front of head.

E: Antennae of 5 segments. Gen: 2 (34) **Deuterolubbockia.**

EE: Antennae of 4 segments.

Tarsus with 2 claws.

G: Abdomen without terminal spur.
Gen: 3 (35) **Achorutes.**

GG: Abdomen with terminal spurs.

H: Abdomen with 2 terminal spurs.
Gen: 4 (36) **Schoturus.**

HH: Abdomen with 4 terminal spurs.
Gen: 5 (37) **Tetracanthella.**

FF: Tarsus with 1 claw.

G: Ocelli, 14-15 on either side.
Gen: 6 (38) **Podurhippus.**

GG: Less than 14-15 ocelli on either side.

H: Terminal spur absent.

I: Saltatorial organ long, curved, extending from posterior end of body.
Gen: 7 (39) **Podura.**

II: Saltatorial organ short, simple, not reaching the posterior end of body.

J: Legs long, distinctly visible from above.
Gen: 8 (40) **Pseudachorutes.**

JJ: Legs very short, not visible from above. Gen: 9 (41) **Brachysius.**

HH: Terminal spur present.

I: 2 terminal spurs. Gen: 10 (42) **Xenylla.**

II: More than 2 terminal spurs.

J: 3 terminal spurs. Gen: 11 (43) **Friesae.**

JJ: 4 terminal spurs. Gen: 12 (44) **Oudemansia.**

BB: Saltatorial organ absent. Fam.: 8 APHORURIDAE.

C: Mouth-parts not placed cone-like under the head.

D: Tarsus with 2 distinct claws. Gen: 1 (45) **Aphorura.**

DD: Tarsus with 1 distinct claw.

E: Post-antennal organ absent. Gen: 2 (46) **Anurophorus.**

EE: Post-antennal organ present.

F: Terminal spur present, post-antennal organs placed in rows. Gen: 3(47) **Tullbergia.**

FF: Terminal spurs absent, post-antennal organs in circles. Gen: 4 (48) **Anurida,**

CC: Mouth-parts appearing cone-like on under side of head.

D: 3 ocelli on either side of head. Gen; 5 (49) **Neanura.**

DD: Ocelli absent.

E: Post-antennal organs present. Gen: 6 (50) **Aphoromma.**

EE: Post-antennal organs absent. Gen: 7 (51) **Tetrodontophora.**

EXPLANATION OF DRAWINGS.

The terminology used is practically the same as in other groups of insects, with the exception of the sub-order, Collembola, which are peculiar in that they possess a ventral sucker, and saltatorial appendage. The following drawings were taken from the genus, Isotoma, which is one of the most generalized of the entire group.

Fig. 1. Saltatorial appendage. Fig. 2. Antenna. Fig. 3. Ventral view of sucker. Fig. 4. Side-view of sucker. Fig. 5. Post-antennal organ. Fig. 6. Left eye spot showing the ocelli. Fig. 7. Foot.

NOTES ON SOME OHIO MAMMALS.

James S. Hine.

A few facts regarding some of the Ohio mammals have been brought out in the past year or so. A number of species have been added to the state list and some observations recorded on well known Ohio forms.

The Little Brown Bat, Myotis lucifugus, has been taken at Sandusky where is appears to be rather common.

Much has been said about the Cooper Lemming Mouse, Synaptomys cooperi, but there does not appear to be a definite published record of its occurrence in Ohio. The past summer the species has been collected in Franklin and Madison Counties. In the former county it was trapped in low grass land and appeared to be common, as nearly a dozen specimens were taken. In the latter county a female and two young were procured from under a log in a low pasture near a stream.

The Prairie Meadow Mouse has been reported as a member of the state fauna but specimens on which this record was founded turn out to be the Pine Mouse, Microtus pinetorum scalopsoides. It is doubtful if Microtus austerus belongs to our fauna, although it has been taken in western Indiana.

When Brayton wrote his report on Ohio mammals, the Rice-field Mouse, Oryzomys palustris, was included on account of a very peculiar record made by Dr. Langdon. A Red-tailed Hawk was shot near New Philadelphia, and in its stomach were found the partially digested remains of what was reported as the Rice-field Mouse. Since that time no living specimen has been reported from Ohio and Rhoades says the species is not found in Pennsylvania. Some years ago two skulls were unearthed at Madisonville and sent to Washington for determination. Dr. Elliot Coues pronounced them to be the skulls of the mouse in question. A year or two ago Prof. W. C. Mills collected a number of skeletons which he unearthed in Ross County, and which prove to be of this same species. Prof. Mills says large numbers of the skeletons were seen and not taken for the reason that he considered them of no special interest, since evidence showed that the animals had crawled into the pits and died there, and as he was studying the food animals of the Aborigines these did not appeal to him. Where the hawk mentioned above got the specimen it had in its stomach is a question. Although one would naturally suppose it to be an Ohio specimen we have no way of proving it. We are certain of one thing, however, and that is the Rice-field Mouse once occurred in numbers over certain parts of Ohio, and the questions that naturally arise are, Is the species a member of our fauna at present, or has it become extinct in the state? If it is extinct what has caused it to become so?

I am pleased to record for the first time the occurrence in the state of the Prairie White-footed Mouse, Peromyscus michiganensis. Specimens were taken in Madison County in 1905, by turning over logs in a low woods pasture.

The Jumping Mouse, Zapus hudsonius americanus, was observed to be abundant in certain parts of Summit County last summer. Mr. Eugene F. Cranz captured a number of specimens at Ira. They were found mostly in fields of standing grain and hay.

The Badger, Taxidia taxus, has been reported as exitnct in the state, but observation the past summer proves it to still be present in northwestern Ohio. In some sections it is common.

Last year at the meeting of the Academy the late Prof. A. A. Wright, gave a paper on the Alleghenian Least Weasel as a member of the Ohio fauna. Since that time a specimen has been received from Summit County, taken by E. F. Cranz who procured it in April, 1905, from a shock of fodder. This specimen was a female in dark pelage. A male trapped December 25, 1905, at Suffield, Portage County, by Orlando Wise, was sent to the O. S. U. Museum by Oscar Himebaugh. The color is white, with the exception of a few reddish patches on the back. So far there are records for six Ohio specimens of this interesting species.

KEY TO THE OHIO VIBURNUMS IN THE WINTER CONDITION.

Robert A. Young.

Viburnum L. Shrubs or small trees with opposite leaf scars, the leaf scars meeting or connected by a line; twigs gray, brown or reddish; stellate pubescent or glabrous, sometimes peltate dotted; terminal bud present or tips withering; axillary buds single, visible scales 1–3 pairs, the outer pair short or completely covering the bud; leaf scars V–shaped to broadly U–shaped or heart–shaped, the bundle scars 3; stipular scars none; pith small, cylindrical or nearly so, solid.

Some of the species are very difficult to separate unless dry leaves are present.

1. Buds completely covered by the outer pair of scales, some with a minute pair at the base. 2.
1. Outer pair of bud scales about half the length of the bud or less; twigs of the season scattered stellate pubescent. 5.
2. Twigs of the season glabrous, pellate dotted and light colored; buds very long, slender and pointed. *V. cassinoides* L. Withe–rod.
2. Twigs of the season glabrous. 3.
2. Twigs of the season densely stellate pubescent. 4.

3. Buds ovate, merely acute, outer pair of scales red, next pair glutinous; twigs of the season light brown or gray, the tips withering. *V. opulus* L. Cranberry-tree and Snowball.
3. Buds long and rather slender; twigs of the season dark reddish brown. *V. lentago* L. Sheepberry. and *V. prunifolium* L. Black Haw.
   V. lentago has prominently acuminate leaves and acuminate winter buds. V. prunifolium has obtuse or merely acute leaves and acute winter buds.
4. Leaf scar narrow, V-shaped or broadly U-shaped; twigs gravish brown; buds oblong. *V. lantana* L. Wayfaring-tree.
4. Leaf scar broad, U-shaped to heart-shaped; twigs reddish. *V. alnifolium* Marsh. Hobblebush
5. Outer pair of bud scales fully half the length of the bud or more. *V. pubescens* (Ait.) Pursh. Downy Arrow-wood, and *V. dentatum* L. Arrow-wood.
   V. pubescens has pubescent leaves with very short petioles; the twigs of the season are often nearly glabrous. V. dentatum has nearly glabrous leaves with petioles ¼–1½ inches long.
5. Outer pair of bud scales barely half the length of the bud or less. *V. molle* Michx. Softleaf Arrow-wood, and *V. acerifolium* L. Mapleleaf Arrow-wood.
   V. molle has pinnately veined coarsely dentate leaves. V. acerifolium has 3-ribbed, 3-lobed leaves.

A SIMPLE FORMULA FOR MIXING ANY GRADE OF ALCOHOL DESIRED.

E. W. Berger.

Let P represent the grade per cent. of the alcohol on hand, P′ the grade per cent. required, v the number of volumes of water to be added to one volume of P to make alcohol P′ and x the number of volumes of P that we desire to change to P′. Then $\frac{Px}{x+vx}=P'$. This gives us (1) $P'v=P-P'$, and (2) $v=\frac{P-P'}{P'}$. Of these, (1) gives us the pharmaceutical rule quoted by Professor Schaffner in his "Labratory Outlines for General Botany": "Take of the grade at hand as many volumes as the number of the per cent. you wish to make, then add to this enough volumes of pure water to make the total number of volumes agree with the number of the per cent. at hand." And (2) may be translatee into words as follows:—*Rule: To find the number of volumes* (v) *of water to be added to one volume of the grade per cent.* (P) *on hand, to make alcohol of the grade per cent.* P′, *divide the difference between the number* (P) *denoting the grade per cent. on hand and the number* (P′) *denoting the grade per cent. required, by the latter number* (P′). Or, which is simpler, $v=\frac{P-P'}{P'}$.

Professor Irving Hardesty in "Neurological Technique" approximates the above formula (2), and if he had worked it out differently and simplified it, he would have arrived at the same results with me. As it is, he gives the reader, not a simple formula, but a table. His work came to my knowledge after I had worked out and presented my formula before the Biological Club and the same has been useful to me only in suggesting a simplification of the equation used for my starting point.

Biological Hall, Ohio State University.

THE PURPLE GALLINULE IN OHIO.

James S. Hine.

Since not over half a dozen specimens of this bird have been recorded for Ohio, any additional records of captured specimens are of interest. A fine male was brought to the museum a few weeks ago by F. B. Shuller who furnished the following data regarding two specimens shot at Hamilton, Ohio, by Chas. Golden:

Mr. Golden says: "As I recall, it was the first part of April, 1897, while strolling along a marshy place known as Old River, that I noticed a bird upon a decayed log which was lying in the water. The river is about fifty feet wide and the water four inches deep at the point where the observation was made and is a fine feeding ground for waders. My attention was attracted by what I first thought was a piece of red paper which the bird was carrying in its mouth. I threw a stick and the bird flew and alighted on a branch of a large elm tree overhanging the water and between myself and the sun where I could see the bright colors of its bill, and the beautiful purple plumage."

"A gun was procured and the bird shot and presented to Mr. W. B. Shuler who had it mounted by Mr. Geo. Sutter. The following March while duck hunting near the same locality, it was my good fortune to shoot another purple gallinule which I believe Mr. Sutter now has in his possession. The day on which the second specimen was taken was very disagreeable with occasional snow flurries which are characteristic of this season of the year."

A DIURNAL ROTATION IN LEAVES OF MARSILEA.

Robert F. Griggs.

It has long been known that the leaves of the various species of Marsilea "go to sleep" at night. The change of position at the beginning of night is very conspicuous and definite, resembling that of Oxalis and the clovers. It is caused by a bending of the petiolules which bend up at night so as to close the leaflets together thus affording protection from exposure. The occurrence of such strikingly similar movements in these three plants which have no inter-relationships nor similarities other than the accidental resemblances of their leaves is a very remarkable coincidence.

So far as the writer has found this day and night motion is the only one that has been reported for Marsilea. But in addition there are under certain conditions at least, very conspicuous changes of position in response to light stimuli, which are of considerable interest.

During the summer of 1904 the writer was engaged in some work for the United States Department of Agriculture which took him to Victoria, Texas. While located at that place he frequently had occasion to visit the government experimental farm located about a mile from the town. Very often instead of following the road he took a short cut across the fields. The land is low, swampy at times and in places is covered with *Marsilea vestita.* On these plants the observations recorded below were made. Unfortunately other business intervened so that it was not possible to make visits to the plants as frequently as would have been desirable to test the universality of the occurrence of the phenomena nor has it been possible since to repeat them. But on account of their interest I venture to publish them for what they are worth. I copy the original notes, with only minor changes, from my note book as they were written at the time.

At six o'clock on the evening of July 14, as I was coming across the fields from the experimental farm to Victoria I saw great numbers of *Marsilea vestita* Hook. and Grev. The leaves were still open and in every case turned to face the setting sun in such a manner as to catch the rays perpendicularly. They were not merely inclined toward the west but were squarely facing in that direction.

At five o'clock the next morning when the day was just dawning they were observed again. The leaves were still tightly folded in their night position. None of them were facing the west as they must have been the night before when they folded up. On the contrary a large proportion of them had turned and were facing the east. But in this respect there was no uniformity in position as there had been in facing west the night before. In the light of the following observation, I interpret this to mean that they were just in process of turning from the west to the east under the influence of the increasing illumination.

At 7:30 on my return from the farm I found that all the leaves were spread out toward the east as they had been to the west the night before. Many thousands were seen and among them all there was not a single exception. The effect was very striking indeed.

The only other opportunity that was offered for observation was a few minutes after two in the afternoon of a cloudy day about an hour after a thunder shower. At that time all of the leaves were spread out parallel to the ground.

I have several times watched other species of Marsilea but have never succeeded in detecting similar movements. It would be most desirable to determine under what special conditions, if any, this phenomenon took place. Perhaps it is a peculiarity of the particular species or variety found at Victoria.

An examination of the leaves to determine in what region the motion took place showed that it was not due to tortion or other movements of the petiole which remained erect and unchanged through the whole process. The motion is rather in the individual leaflets which are turned by the twisting and bending of their petiolules which also cause the folding up of the leaves at nightfall. We have then in these petiolules an exceedingly interesting motile area similar to that found in the Seed Plants.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, March 5, 1906.

The Club was called to order by the President, Mr. Griggs. The minutes of the previous meeting were read and corrected.

Mr. Stauffer then presented his paper on "The Devonian Formations of Ohio." He considered especially the Columbus and Delaware limestones.

Mr. Hyde presented his paper on "The Waverly Formations of Ohio," dealing in particular with the Black Hand and Logan formations.

Prof. Prosser briefly summarized these two papers by calling attention to the most important points.

Dr. Berger gave a method of mounting objects on cover glasses so that they can be examined under the microscope from both sides.

Prof. Osborn discussed the Natural History Survey Bill, and moved that a resolution endorsing the bill be drawn up by the Secretary. The motion carried.

Mr. S. H. Sterner was elected to membership, after which the club adjourned.

Z. P. Metcalf,
Secretary.

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J. C. Crawford.

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MAY,

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