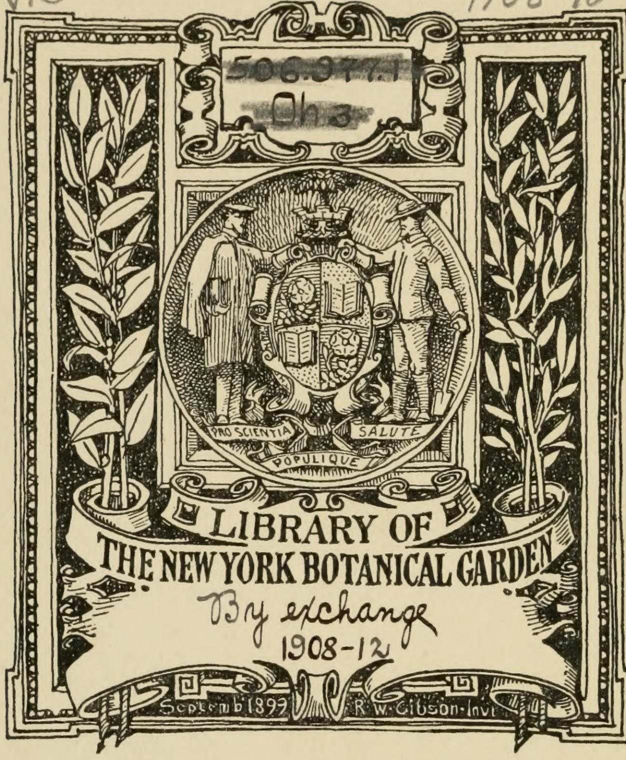
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Proceedings

of the

Ohio State

Academy of Science

VOLUME V, PART 1

Sixteenth Annual Report

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume V, Part I

Sixteenth Annual Report

of the

Ohio State Academy of Science 1907

Organized 1891 Incorporated 1892

Publication Committee

J. H. Schaffner J. C. Hambleton E. L. Rice

Date of Publication, April 25, 1908

Published by the Academy
Columbus, Ohio

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Mercer, W. F., *Biology* .... Ohio University, Athens
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Odenbach, F. L., *Meteorology* .... St. Ignatius College, Cleveland
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Osburn, Raymond C., *Zoology, Ichthiology* .... 510 W. 124th St., New York
Pallister, H. D. .... 3754 Independence Road, Cleveland
Pickel, Geo. J., *Chemistry* .... St. Ignatius College, Cleveland
Piwonka, Thomas .... 226 Superior Ave., Cleveland
Porterfield, J. C. .... 916 New Hayden Building, Columbus
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Sanders, J. G., *Entomology, Botany* .... U. S. Dept. Agr., Washington, D. C.
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Sanger, U. G., *Botany* .... Newark
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Scheffel, Earl R., *Geology* .... Granville
Seaton, Miss F. .... 103 Glen Park Place, Cleveland
Selby, A. D., *Botany* .... Experiment Sta., Wooster

Slocum, C. E. .... Defiance
Smead, Anna, *Biology* .... 624 Nestle St., Toledo
Smith, Ethel M. .... 122 Center St., Ashtabula
Smith, G. D., *Botany, Zoology* .... 450 Spicer St., Akron
Smith, J. Warren, *Meteorology* .... Weather Bureau, Columbus
Smyth, Lumina C. Riddle, *Botany* .... State House, Topeka, Kans.
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Soule, William .... 1804 S. Union Ave., Alliance
Stair, L. D. .... 92 Wadena St., Cleveland
Stauffer, Clinton R., *Geology* .... 5514 Madison Ave., Chicago, Ill.
Sterki, Victor, *Conchology, Botany* .... New Philadelphia
Stickney, M. E., *Botany* .... Granville
Stockberger, W. W., *Botany* ...... Dept. Agriculture, Washington, D. C.
Stoner, Minnie A., *Domestic Science* .... Laramie, Wyoming
Surface, F. M., *Zoology, Botany* .... Orono, Maine
Sweezey, Otto H. .... 12th Ave., Honolulu, Hawaii
Tilman, Miss Opal I., *Botany* .... Tucson, Arizona
Tight, W. G., *Geology* .... Albuquerque, N. M.
Todd, Joseph H., *Geology, Archaeology* .... Christmas Knoll, Wooster
Todd, Otto K. .... Vermillion
True, H. L. .... McConnelsville
Tyler, F. J., *Botany* .... Bureau of Plant Industry, Washington, D. C.
Van Hook, J. M., *Plant Pathology* .... Experiment Station, Wooster
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Wolfe, E. E., *Botany* .... Marietta College, Marietta
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.... Div. Seed and Plant Introduction, Washington, D. C.

Report of the Sixteenth Annual Meeting

of the

Ohio Academy of Science

The sixteenth annual meeting of the Academy was held at Miami University, Oxford, O., on November 28, 29 and 30, the President, Mr. Charles Dury, of Cincinnati, presiding. On Thursday evening an informal reception took place in Hepburn Hall where accommodations for members of the Academy were generously provided by the University authorities. The sessions on Friday and Saturday were held in Brice Hall.

The meeting was called to order by the President at 9:30 Friday morning. A committee on membership consisting of Prof. Hine, Prof. Durrant, and Prof. Lazenby, together with a committee on resolutions consisting of Prof. Rice, Prof. Waite and Prof. Guyer, was appointed by the chair. The report of the Secretary was presented and accepted. A suggestion was made by Prof. Lazenby that the special papers published by the Society be noted in connection with the proceedings. The report of the Treasurer, Prof. J. S. Hine, was presented and after reference to an auditing committee consisting of Mrs. Hansen and Prof. Rice, was accepted. The following is the report:

REPORT OF THE TREASURER FOR THE YEAR 1906.

For the year since our last annual meeting the receipts, including balance from last year, have amounted to $157.30, and the expenditures to $156.74, leaving a cash balance of $0.56.

RECEIPTS.

Balance from last year..........	$1.30
Membership dues	156.00
Total	$157.30

DISBURSEMENTS.

For printing the annual report	$30.00
160 subscriptions to the Ohio Naturalist	80.00
Miscellaneous	36.74
Balance December 1, 1906	.56
Total	$157.30

Respectfully submitted,
JAMES S. HINE.

The Librarian of the Society, Prof. Mills, was unavoidably detained in connection with the state exhibit at the Jamestown Exposition, consequently no report was made at the meeting.

Prof. Lazenby, chairman of the Board of Trustees, presented the following report which was approved and accepted. Mention was made of the continued interest in the welfare of the Society manifested by Mr. Emerson McMillin through his gift of an additional $250.00 to the "Emerson McMillin Research Fund." The report of the trustees is as follows:

REPORT OF THE BOARD OF TRUSTEES.

The financial statement of the Emerson McMillin research fund, for the year 1906-1907, is herewith presented:

RECEIPTS.

1906.	Balance on hand Nov. 20, 1906	$225.73
	Check from Emerson McMillin Nov. 11, 1907	250.00
	Total	$475.73

EXPENDITURES.

1907.		
Oct. 3.	Spahr & Glenn, printing 500 copies "Land and Fresh Water Mollusca of Ohio"	$67.50
Oct. 9.	W. C. Morse, expense for travel in research work in Geology	25.00
Nov. 26.	W. C. Morse, expense for travel in research work in Geology	25.00
	Total	$117.50
	Balance on hand November 28, 1907	$358.23

Of this balance there have been appropriated, during the year, but not yet expended, $50.00 for research and $50.00 for publication, leaving an unappropriated balance for the year 1907-1908, of $258.23.

William R. Lazenby,
Chairman.

Prof. Schaffner, Chairman of the Publication Committee, being absent in Europe, no report was at this time offered.

Prof. Herbert Osborn, Chairman of the committee on the proposed State Natural History Survey, noted the enlargement of the committee in accordance with the recommendations of last year, and the issuing of printed copies of the bill with recommendations for the passage of such a measure from the men prominent in educational and professional lines throughout the state. Members of the Academy signified their hearty support of the bill.

The committee on the revision of the constitution and by-laws consisting of the Secretary, Prof. Rice and Prof. Landacre, acting jointly with the executive committee, reported that considerable progress had been made but that it would be impossible to prepare a final report before the next annual meeting. It was moved, seconded and carried that the committee be continued.

The Committee on Scientific Publications in Ohio Libraries reported that a considerable number of libraries had responded to their request for lists of scientific periodicals and that a final report would be prepared for later publication. It was moved, seconded and carried that the report be adopted and that the final report be referred to the publication committee.

Under the order of new business the following nominating committee was elected: Prof. Mercer, Prof. Osborn and Prof. Rice, to report nominations for officers at the last business meeting.

After the reading of papers, the Society adjourned for luncheon at 11:50 A. M.

The Society met at 1:45 P. M. and listened to an address by the President, Mr. Charles Dury, on "Some Reminiscences of the Cincinnati Zoo." Mr. Dury was for a considerable period prosector to the Society and had brought together a large number of interesting facts. His account of the famous fight between the lion and the donkey well illustrated the unreliability of newspaper reports along lines of natural history. Among other things he stated that at least 75 % of the deaths among the monkeys of the "Zoo" resulted from tuberculosis.

The Society then proceeded with the reading of the papers and adjourned at 5:15 P. M.

At 7:30 P. M. Prof. G. W. Hoke talked to the Society concerning life in Constantinople. This was illustrated by a large series of lantern slides.

The Society reassembled at 8:45 Saturday morning. The report of the nominating committee was received and the following officers were elected for the ensuing year:

President — Professor Frank Carney, Granville, Ohio.
Vice-Presidents — Professor J. H. Schaffner, Columbus, Ohio, and Professor F. C. Waite, Cleveland, Ohio.
Secretary — Professor L. B. Walton, Gambier, Ohio.
Treasurer — Professor J. S. Hine, Columbus, Ohio.
Executive Committtee (*ex-officio*) — Professor Frank Carney, Granville; Professor L. B. Walton, Gambier; Professor J. S. Hine, Columbus; (elective) — Professor Bruce Fink, Oxford; Professor Lynds Jones, Oberlin.
Board of Trustees — Mr. Charles Dury, Cincinnati, Ohio. (In place of retiring trustee).
Publication Committee — Professor E. L. Rice. (In place of retiring member).

L. B. Walton,
Secretary.

The following were elected by the executive committee during the year.

Geo. E. Coghill, Granville, Ohio.
W. S. Beekman, 514 East Pearl Street, Cincinnati, Ohio.
Alfred Dachnowski, O. S. U., Columbus, Ohio.
Sergius Morgulus, O. S. U., Columbus, Ohio.
B. R. Bales, M. D., Circleville, Ohio.
M. S. Fletcher, M. D., 11 East Seventh Street, Cincinnati, Ohio.
Arthur H. McCray, Duvall, Ohio.
W. F. Henninger, New Bremen, Ohio.

Mary D. McKenzie, Oxford, Ohio.
Earl R. Scheffel, Granville, Ohio.
Freda M. Bachman, Oxford, Ohio.
Kirtley F. Mather, Granville, Ohio.
J. G. Wittenmyer, O. S. U., Columbus.

The membership committee appointed by the President at the opening session reported on the following who were duly elected:

N. M. Fenneman, University of Cincinnati, Cincinnati, Ohio.
William Cramer, 273 Southern Ave., Cincinnatti, Ohio.
R. H. Burke, Oxford, Ohio.
A. M. Banta, Marietta, Ohio.
M. E. Kleckner, Tiffin, Ohio.
A. A. Johnson, Athens, Ohio.
Cora March, Wyoming, Ohio.

The committee on resolutions reported as follows:

Be it Resolved, That we, the members of the Ohio State Academy of Science, hereby express our sense of loss in the death, during the past year, of two of our members, Albert Taylor and William Curtis Whitney.

Be it further Resolved, That we signify to Mr. Emerson McMillin our great appreciation of his continued interest in the efforts of the Academy, and for his substantial contributions to the support of the projects of the same, and that we extend to him our sincere thanks for his numerous favors.

Be it further Resolved, That we extend our heartiest thanks to the authorities of Miami University and to the members of the Local Committee for their numerous courtesies in connection with the Sixteenth Annual Meeting of the Academy.

Edward L. Rice,
M. F. Guyer,
F. C. Waite,
Committee.

Since the meeting at Oxford the Secretary has noted the deaths of two other members, The Hon. Joseph H. Outhwaite, and John J. Janney, both residents of Columbus, O., the deaths occurring within a few days of one another. Both have lived long and useful lives and have at various times signified their interest in the affairs of the Academy. Mr. Janney died at the advanced age of 96 years.

A committee consisting of the incoming President, Secretary and Treasurer was appointed to confer with the Indiana Academy of Science concerning the advisability of holding joint meetings periodically, at some locality near the border line of the two states. The opinion was expressed that such meetings would prove of much interest and that it would be an excellent thing for members of the two academies to meet at intervals at least as often as three years.

An invitation was extended by the incoming President of the Society to meet at Granville in November, 1908. While no definite action was taken by the executive committee, the opinion was generally expressed that the invitation would be accepted.

At the close of the business session, the Society proceeded with the reading of papers.

At 11:45 A. M. the Academy was declared formally adjourned.

The complete program of the meeting was as follows:

1 A Study of the Origin and Growth of the Egg in *Syncoryne mirabilis*. 8 min. — Mary D. Mackenzie
2 A Better Method of Preparing Herbarium Specimens. 7 min. — W. A. Kellerman
3 Compensatory Growth in *Podarke obscura*.. 8 min. — Sergius Morgulis
4 Note on the Development of the Skull in Clupea. 10 min. — Edward L. Rice
5 Factors determining Cave Habitation as illustrated by the Cave Isopod and its nearest outdoor ally. 12 min. — A. M. Banta
6 *Symbiotes duryi* n. sp., A New Endomychid from Ohio. 4 min. — L. B. Walton
7 Notes on the Early Development of Enteropnuesta. 8 min. — B. M. Davis
8 The Discomycetes of Oxford and Vicinity. 15 min. — Freda M. Bachman
9 *Wolffia brasilensis* in Ohio. 3 min. — Robert F. Griggs
10 "The Psychology of Speaking," a Scientific Analysis of the Art of Speaking. 10 min. — John S. Royer

12:00. Luncheon.

1:30 p. m. President's Address. Zoological Reminiscences of the Cincinnati "Zoo." — Charles Dury

2:30 p. m. Reading of Papers.

11. The Flora of Cranberry Island, Buckeye Lake. 7 min. — W. A. Kellerman

12 Reaction of Amphibian Embryos to Tactile Stimuli. 10 min. — G. E. Coghill
13 The Epibranchial Placodes of Ameiurus. 9 min. — F. L. Landacre
14 Periodicity of Spirogyra. 10 min. — W. F. Copeland
15 The Dispersal and Planting of Seeds by Nature's Methods. 15 min. — W. R. Lazenby
16 The Male Reproductive Organs of *Cimbex americanus* Leach. — H. H. Severin and H. C. Severin
17 A Peculiar Circulatory Modification in *Necturus maclosus*. 6 min. — S. R. Williams
18 A Migration of *Anosia plexippus* in Ohio. 8 min. — Herbert Osborn
19 The Variability of Zygospores in *Spirogyra quadrata* formed by Scalariform and by Lateral Conjugation, and its bearing on the Theory of Amphimixis. 10 min. — L. B. Walton
20 Some Observations concerning the effects of Freezing on Insect Larvæ. 6 min. — J. S. Hine

Adjourn at 5:00 p. m. for a 15-minute recess.

5:15 p. m.

21 The Status of American Lichenology. — Bruce Fink
22 Stains for Embryonic Skeletons. 10 min. — E. L. Rice
23 A note on the Occurrence of *Typhlopsylla octactenus* in Ohio. 5 min. — Herbert Osborn
24 The Development of the Swimming Movement in Amphibian Embryos. 10 min. — G. E. Coghill
25 Natural History Notes from Hamilton Co., Ohio. 10 min. — Charles Dury
26 Some Rare and Unnamed Mushrooms found in the Cuyahoga Valley. [Lantern Slides.] 5 min. — G. D. Smith
27 Report on a New Pathogenic Pirosome. 5 min. — E. F. McCampbell
28 The Marine Biological Survey of the San Diego [California] Region. 10 min. — B. M. Davis
29 The Development of a Kelp. 15 min. — R. F. Griggs
30 Regeneration and Inheritance. — Sergius Morgulis
31 The Gold Fish—*Carassius auratus* L.—and its Color. 12 min. — L. W. Sauer
32 A New Experiment in Ionization. 10 min. — F. J. Hillig
33 The Lateral Line Organs of Ameiurus. 8 min. — F. L. Landacre
34 Annual Report on the Ohio State Herbarium for 1907. — W. A. Kellerman and Freda Detmers
35 Notes on Philomycus. 5 min. — V. Sterki
36 Observations on the Life History and Adaptation of a New Semi-Aquatic Aphid, *Aphis aquaticus*. 8 min. — C. J. Jackson
37 Variation in Temperature and Light Intensity when growing plants under cloth of different Colors. — W. A. Kellerman and G. W. Hood

38 One Hundred Species of Mushrooms of the Cuyahoga Valley. 15 min. [Lantern Slides.] — G. D. Smith

39 Some Homologies between the Mouth Parts and Walking Appendages in the Hexapoda. 5 min. — L. B. Walton

40 Ancient Finger Lakes in Ohio. 11 min. — G. D. Hubbard

41 A Deposit of Glass Sand at Toboso, O. [Slides] 10 min. — Frank Carney

42 The Origin of Spring Valley Gorge near Granville, O. [Slides] 15 min. — Earl R. Scheffel

43 Extra-morainic Drift in the Baraboo area, Wisconsin. [Slides] 15 min. — Kirtly F. Mather

Stratigraphical studies in Mary Ann Township, Licking Co., O.:

44 Distribution of Formations. [Slides] 10 min. — Frank Carney

45 A Phase of the Sharon. [Slides] 10 min. — William C. Morse

46 Two Notable Landslides. 9 min. — Geo. D. Hubbard

47 Pleistocene Deposits at Clay Lick, O. [Slides] 15 min. — Kirtly F. Mather

48 A Group of Eskers South of Dayton, O. [Slides] 15 min. — Earl R.Scheffel

49 An Overflow Channel of a Glacial Lake in Yates Co., N. Y. [Slides] 10 min. — Frank Carney

50 High Level Terraces in S. E. Ohio. 12 min. — G. D. Hubbard

51 An Ecological Classification of the Vegetation of Cedar Point. — O. E. Jennings

Gambier, O., Dec. 15, 1907.

L. B. Walton, *Secretary.*

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VOLUME V, PART 2

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Proceedings

of the

Ohio State

Academy of Science

VOLUME V, PART 2

PUBLICATION COMMITTEE:

J. C. HAMBLETON, E. L. RICE, BRUCE FINK.

Special Paper No. 14

Discomycetes in the Vicinity of Oxford, Ohio.

Contributions from the Botanical Laboratory of Miami University. I.

FREDA M. BACHMAN.

INTRODUCTION.

The purpose of this work has been to prepare a descriptive catalog of the discomycetes of this region which would be helpful to students in the study of Discomycetes in Ohio, and to contribute to the distribution of the Discomycetes in the state. Comparatively little systematic work has been done on this group, and none has been done in Ohio except that of A. P. Morgan. Many of the plants are very minute and seldom or never seen by those uninterested. The group is, however, of much biological interest and perhaps would receive much more attention from students of botany if there were more literature to be had.

The time of collecting has extended over a period of two years, 1907 and 1908. Collections have been made by several persons to whom credit has been given with the dates of collection. All of the plants described were found within five miles of Oxford, Ohio. It is very probable that quite a number of the Discomycetes of the region have been overlooked, though no pains were spared in the two years to get as many as possible.

In each species the characteristics of the plants in the fresh condition were noted. In many the apothecia appear to change but little, if any, in drying, and when water is applied have the same appearance as when growing. Others when dry lose both color and form permanently.

Most of those in the family Ascobolaceae were grown in the laboratory on old dung. This was brought from several pastures and placed in moist chambers. Only on that which was exposed to the sunlight and in a temperature of about 20° or 23° C. were many apothecia obtained. Some of the plants seem to grow equally well on the damp blotting paper which lined the dishes.

The classification used is largely that in Engler-Prantl's Natürlichen Pflanzenfamilien. In working out the type species of the genera, the rules adopted by the botanical congress which met in Philadelphia, March, 1907, were observed. Whether this is the best method for determining type species may well be questioned, but it seems to the writer that a universal method for such procedure is desirable, and since many American systematists are using it, it has been used here. However, the use of the genus Lachnea Quel. is a departure from following these rules. A genus of flowering plants, Lachnaea L., is older. For the purposes of such a paper as the following, it was thought best to make no change in a genus on the grounds of priority, at least not until the cryptogamic genera have been carefully examined by some one with abundance of time and bibliographical facilities.

All microscopic drawings were made with the aid of a Bausch and Lomb camera lucida. In drawings showing the structure of the sterile tissues of the apothecia, the lines were followed as far as possible with the camera and very little was done free hand. Where all of a section could not be seen in the field with the desired magnification, and it was necessary to move the section, a break was left in the drawing as in Plate II, figures 2, 3, and 4. All drawings were made from free-hand sections of fresh material or from the plant as growing.

The species marked + have not been previously reported from southwestern Ohio.

Herbarium specimens of all except two or three species are preserved in the herbaria of Freda M. Bachman and Bruce Fink. Nearly full sets are also deposited in the Lloyd museum at Cincinnati, Ohio, and in the herbarium of W. G. Stover.

The writer is indebted to Dr. H. Rehm, Rev. Giacoma Bresadola and Dr. Narcisse Patouillard for determining some of the more difficult species; to Prof. F. J. Seaver for suggestions as to culture methods; to Mr. C. G. Lloyd for the use of literature and specimens in the Lloyd library and museum at Cincinnati, Ohio; to Mr. Wm. Holden, librarian, for looking up literature; to Mr. P. L. Ricker for several citations and types, and to Dr. Bruce Fink, under whose direction all of the work was done, for kind advice and most helpful suggestions.

FREDA M. BACHMAN.

Miami University, Oxford, O., Aug. 31, 1908.

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EXPLANATION OF PLATES.

PLATE I.

Lachnea setosa

Fig. 1 — apothecium, natural size
" 2 — structure of apothecia, × 55
" 3 — hair from outside of cup, × 55
" 4 — paraphysis, × 200
" 5 — ascus, × 200
" 6 — spore somewhat immature, × 200
" 7 — mature spores, × 200

Pustularia stevensoniana

Fig. 8 — apothecium, natural size
" 9 — structure of apothecia, × 45
" 10 — paraphysis, × 325
" 11 — ascus, × 325
" 12 — spores, × 325

PLATE II.

Ascobolus atrofuscus

Fig. 1 — apothecium, × 2
" 2, 3, and 4 — Sterile part of apothecium, × 325
" 5 — paraphysis, × 325
" 6 — ascus closed, × 325
" 7 — ascus with operculum removed, × 325
" 8 — mature spores, × 325

PLATE III.

Arachnopeziza aurelia

Fig. 1 — apothecium, × 2
" 2 — paraphyses, × 325
" 3 — ascus, × 325
" 4 — spores, × 325

Sclerotinia tuberosa

Fig. 6 — mature apothecium and sclerotium, natural size
" 7 — younger stages, natural size
" 8 — paraphysis, × 325
" 9 — ascus, × 325
" 10 — spores, × 325

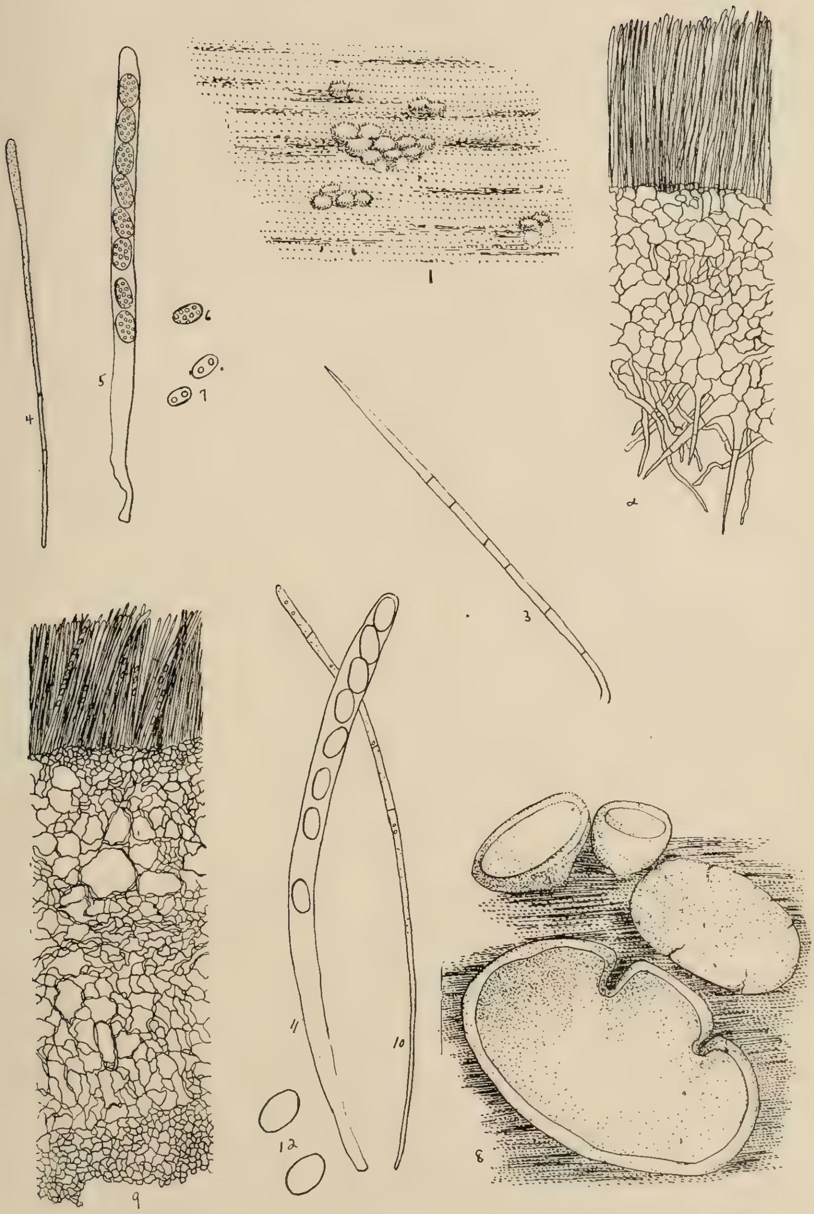

Plate I.

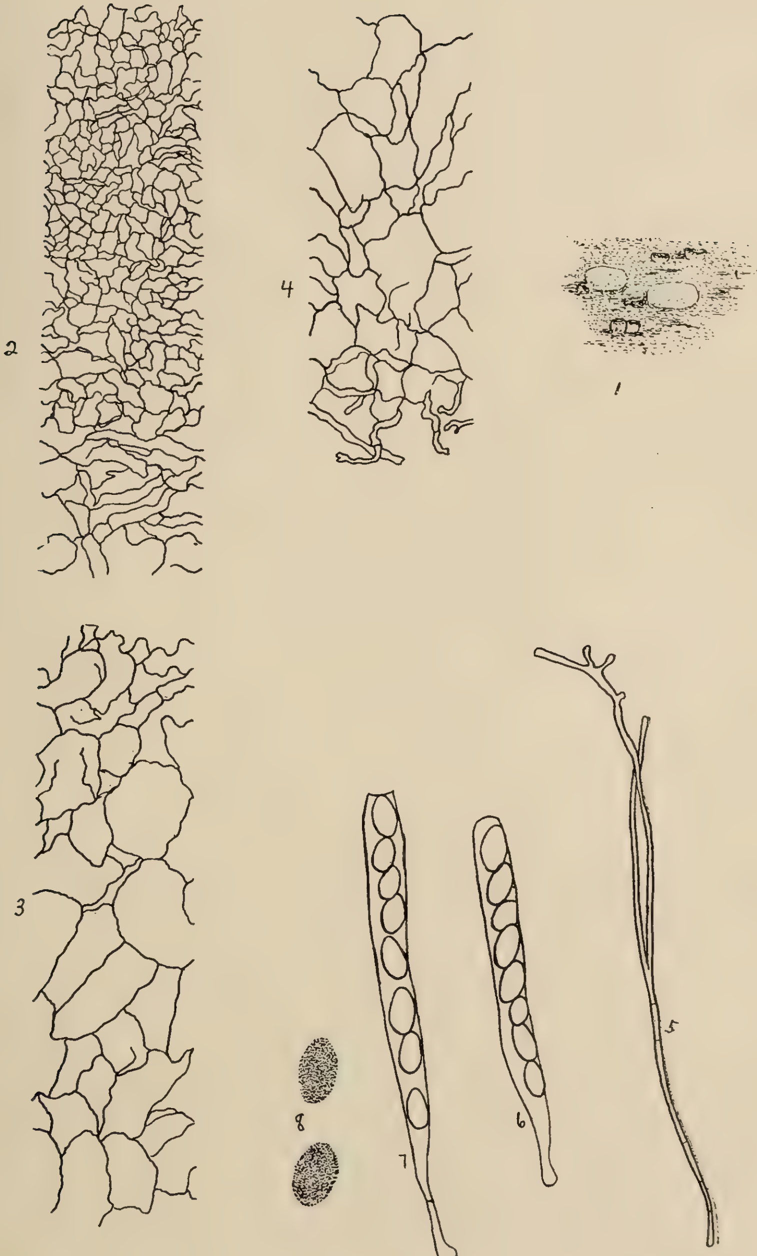

Plate II.

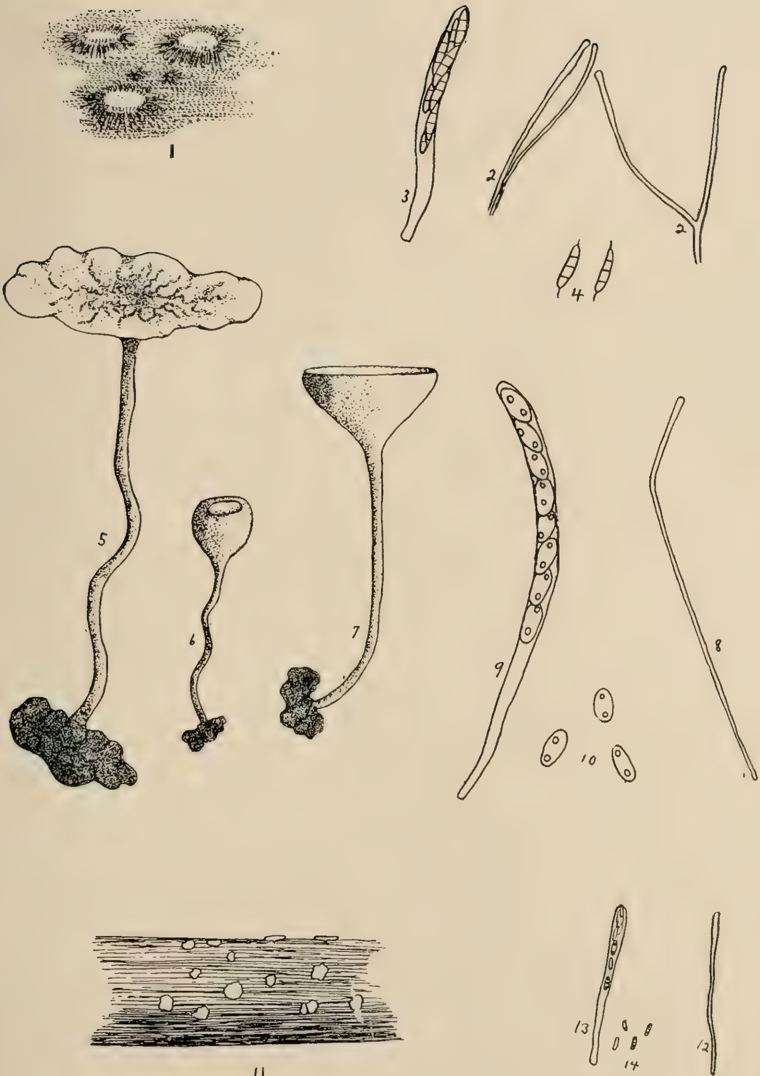

Plate III.

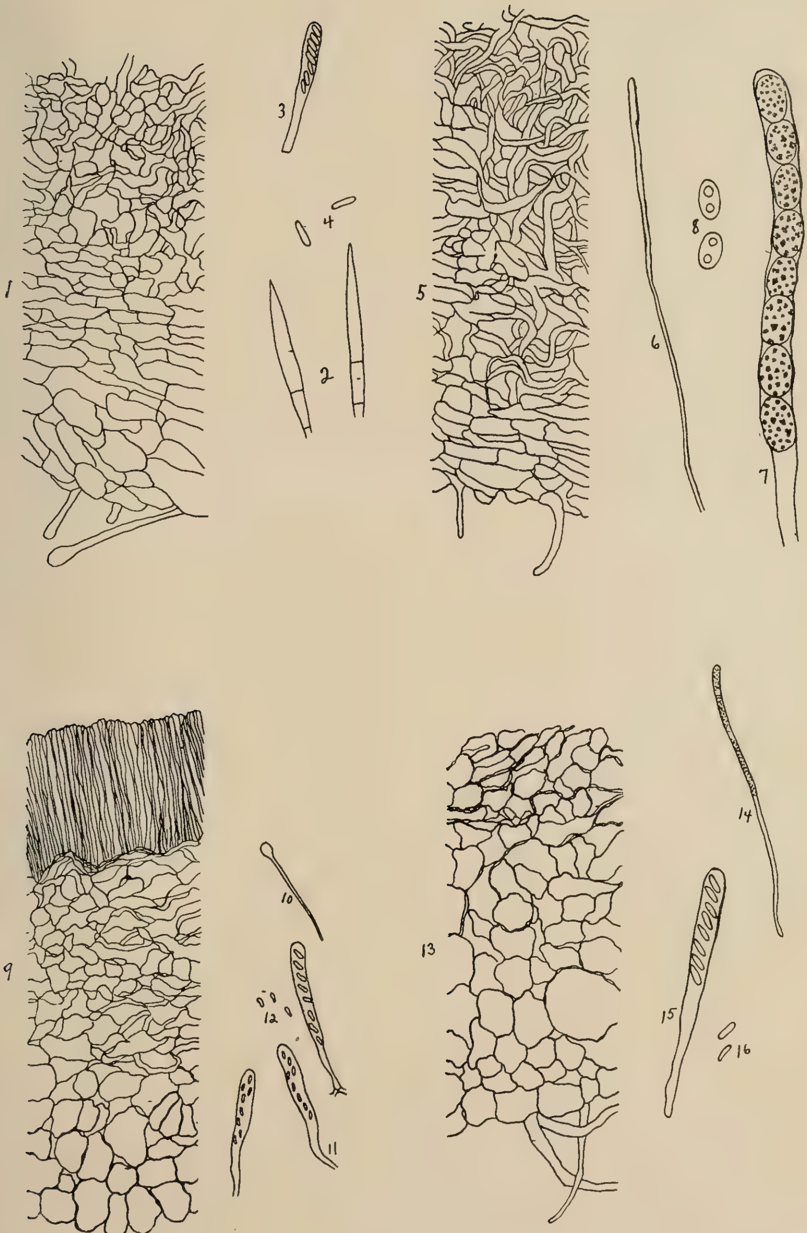

Plate IV.

Helotium herbarum

Fig. 11 — apothecium on an old stem, × 2
" 12 — paraphysis, × 325
" 13 — ascus, × 325
" 14 — spores, × 325

PLATE IV.

Dasyscypha virginea

Fig. 1 — part of the center of the cup and the outer cells and hairs, × 325
" 2 — paraphyses, × 325
" 3 — ascus, × 325
" 4 — spores, × 325

Sarcoscypha occidentalis

Fig. 5 — part of the center of the cup and the outer cells and hairs, × 325
" 6 — paraphysis, × 325
" 7 — ascus, spores immature, × 325
" 8 — mature spores, × 325

Orbilia xanthostigma

Fig. 9 — structure of apothecium, × 460
" 10 — paraphysis, × 460
" 11 — asci, × 460
" 12 — spores, × 460

Mollisia cinerea

Fig. 13 — part of the center of the cup, the outer cells, and attaching hyphae, × 325
" 14 — paraphysis, × 325
" 15 — ascus, × 325
" 16 — spores, × 325

KEY TO ORDERS.

a — Hymenium covered by a membrane until maturity of spores .... Phacidiales
a — Hymenium exposed from the first or very early
  b — Receptacle pileate, mitrate, or clavate................Helvellales
  b — Receptacle cup-shaped or plane........................Pezizales

Order I. Phacidiales.

Vegetative portion within the substratum; saprophytic or parasitic; apothecia immersed or superficial, at first enclosed within a membrane which ruptures irregularly at maturity of the spores.

Family I. Stictidaceae.

Saprophytic. Apothecia soft, fleshy, bright or light colored, immersed in the substratum, rounded or elliptic. Hypothecium thin or nearly absent. Exciple thin, tough, membranaceous, adnate to the substratum.

Genus I. Propolis Fr. Sum. Veg. Scand. 372. 1849.

Type species, Stictis farinosa Pers. Myc. Eur. 339. 1822.

Apothecia pale, yellowish or greenish, exterior brownish. Paraphyses linear, somewhat branched or merely indented at the ends. Asci 8 spored, clavate or cylindrico-clavate, somewhat narrowed at the base. Spores oblong, more or less curved, colorless, guttulate. Growing on decayed wood.

Propolis faginea (Schrad.) Karst. Myc. Fenn. 244. 1871.

Hysterium fagineum Schrad. Journ. Bot. 2: 68. 1799.

Apothecia immersed, spreading, 3-7 mm. long, elliptical, pale, fleshy, membrane covering the hymenium pale grayish. Hymenium gray, hypothecium very poorly developed. Paraphyses filiform, branched at the ends, hyaline when seen singly, in mass the ends appear to be filled with coloring matter and to be adherent. Asci cylindrico-clavate. Spores oblong or fusiform, an oil globule in each end, 20-26 mic. long and 6-8 mic. wide.

Common on old stumps, twigs, board fences, etc. Early spring to late autumn.

Coll. Freda M. Bachman, Oct. 31, 1907. Bruce Fink, May 1, 1908. W. G. Stover, June 27, 1908. Freda M. Bachman, Aug. 5, 1908.

Order II. PEZIZALES.

Vegetative portion within the substratum, or superficial; saprophytic, rarely parasitic; apothecia plane, concave or convex, sessile or stipitate, fleshy, waxy, leathery or gelatinous, free or borne upon a stroma. Hymenium exposed from the first or at least very early; hypothecium well developed, exciple well developed or wanting.

KEY TO FAMILIES.

a — Exciple well developed, leathery
  b — Apothecia minute, dark, free from the first........Patellariaceae
  b — Apothecia large, erumpent........................Cenangiaceae
a — Exciple none or well developed but never leathery
  b — Exciple when present and hypothecium of similar structure
    c — Exciple developed, fleshy........................Pezizaceae
    c — Exciple wanting or poorly developed
      d — Asci emergent ....Ascobolaceae
      d — Asci not emergent.......................Pyronemaceae
  b — Exciple and hypothecium of different structure
    c — Exciple of elongated, light colored usually thin-walled cells .... Helotiaceae
    c — Exciple of roundish, dark, thick-walled cells.....Mollisiaceae

Family I. PEZIZACEAE.

Mycelium mostly within the substratum; usually saprophytic; Apothecia fleshy, superficial or somewhat immersed in the substratum, sessile or stipitate, exterior smooth, scaly, warty or hairy. Hypothecium and exciple of similar structure and either prosenchymatous or pseudo-parenchymatous.

KEY TO GENERA.

a — Externally hairy ....Lachnea
a — Externally smooth, scaly, or warty.........................Peziza

Genus. I. PEZIZA (Dill.) L. Gen. Pl. 493. 1754.

Type species, Peziza acetabulum L.

Mycelium visible only near the base if at all. Apothecia fleshy, sessile or shortly stiptitate, varying much in size, smooth, warty or pruinose, never hairy, variously colored, plane, concave, or convex. Paraphyses simple or branched, colored or hyaline, filamentous or clavate. Asci cylindrical. Spores 8, large, smooth or rough, usually hyaline, elliptic, oblong-elliptic or spherical. Growing on earth or decayed wood.

A very large genus. The subgenera often used as genera.

KEY TO SUBGENERA.

a — Apothecia stipitate .... Geopyxis
a — Apothecia not stipitate
  b — Apothecia small, usually bright colored .... Humaria
  b — Apothecia large
    c — Exterior warty .... Pustularia
    c — Exterior scaly or smooth
      d — Asci becoming very blue with iodine .... Plicaria
      d — Asci slightly blue with iodine .... Discina

Subgenus I. DISCINA.

Apothecia solitary, at first bell-shaped, closed, finally plane, fleshy, edge of the cup wavy and often torn, base often narrowed into a very short thick stipe, exterior smooth. Paraphyses branched at the base, septate, more or less clavate, colored. Asci cylindrical. Spores elliptical, simple, hyaline, often containing a single large oil globule, sometimes 2 oil globules.

KEY TO SPECIES.

a — Interior of the cup covered with large veins .... venosa
a — Interior of the cup having shallow grooves .... reticulata

Peziza reticulata. Grev. Crypt. Fl. 3: 156. 1825.

Apothecia solitary or caespitose, 5-14 cm. broad, edge more or less incised, somewhat repand, interior rugose near the center, light brown becoming quite dark brown when older, exterior whitish, pruinose, fleshy, brittle, substipitate or sessile. Stipe very short and thick. Hymenium brownish hypothecium and exciple of about the same color. Cells of the exciple and the hypothecium are elongated cylindrical cells of septate hyphae. Paraphyses enlarged at the ends, slightly adherent, rather numerous, quite brown at ends because of brownish granules. Asci cylindrical. Spores uniseriate, oval, smooth, 20-23 mic. long and 10-12 mic. wide.

Apothecia are about twice as thick as those of Peziza repanda Wahl. Growing on earth in woods.

Coll. W. G. Stover, April 25, 1908. Bruce Fink, May 2, 1908.

+*Peziza venosa* Pers. Myc. Eur. 1: 220. 1822.

Apothecia solitary, about 10 cm. broad, sessile, funnel-shaped, becoming quite expanded, interior umber brown and having large anastomosing veins, exterior nearly the same color when damp but, when somewhat dry, becoming whitish, very slightly pruinose or having minute fasciculate hairs, edge very tough becoming very dark, entire. Hymenium pale brownish, hypothecium of the same color, central part of the cup with less coloring and composed of a network of hyphae, outer cells somewhat dark. Paraphyses filiform, brownish, slightly clavate. Asci cylindrical, broader than those of P. repanda and P. reticulata. Spores smooth, hyaline, broadly elliptic, 20-24 mic. long and 19-12 mic. wide.

Growing on the ground in the woods.

Coll. Freda M. Bachman, April 28, 1908.

Subgenus II. PLICARIA.

Apothecia often in groups or caespitose, sessile, at first spherical and closed becoming plane and more or less irregular in shape and often torn, fleshy. Paraphyses branched at the base, more or less enlarged upward, hyaline or colored. Asci cylindrical, ends quite blunt. Spores elliptical or oval, smooth or rough, simple, with or without oil globules, hyaline.

KEY TO SPECIES.

a — Apothecia very dark brown or blue black....................badia
a — Apothecia light brown....................................repanda

Peziza badia Pers. Mycol. Eur. 1: 224. 1822.

Apothecia solitary or caespitose, 6-8 cm. broad, interior of the cup light brown with a slight purplish tinge, later becoming quite dark brown, more or less wrinkled at the center, exterior purplish near the base but the upper part covered with the ends of brownish, fasciculate, septate, hyphae making it more or less olivaceous; sessile or substipitate, base pubescent, white. Flesh blue, rather thin. Hymenium and hypothecium brownish, central part almost colorless and composed of large rounded cells; outer cells more compact and ends of hyphae protruding to form the granulations on the surface. Paraphyses septate, hyaline, unbranched, very slightly enlarged upward. Asci cylindrical, blue with iodine. Spores elleptic, granular at first, later biguttulate, smooth, 15-17 mic. long and 6-8 mic. wide.

The sterile parts of the apothecia are described by Massee as composed of hyphae irregularly inflated and less inflated near the outer part of the cup.

Growing on rotting logs and on the ground in woods.

Coll. Bruce Fink, Wm. Shideler, May 19, 1907. L. O. Overholts, H. W. Fink, May 2, 1908. Freda M. Bachman, May 12, 1908.

+*Peziza repanda* Wahl. Ups. 466. 1820.

Apothecia solitary or caespitose, 6-10 cm. broad, edge incised and repand, interior light brown, somewhat wrinkled toward the center, exterior mealy and whitish, but brownish when meal has been rubbed off; fleshy, brittle, substipitate, rooting. Stipe 1-2 cm. long and about 1 cm. thick, wrinkled. Hymenium almost colorless, hypothecium and central part of the cup brownish; cells of central and outer part very large and more or less rounded. Paraphyses filiform, septate, very few. Asci cylindrical. Spores uniseriate, hyaline, smooth, oval, but varying much in size, 12-17 mic. long and 6-10 mic. wide.

Growing on an old log, also on the ground in the woods.

Coll. Marian Richey, Mary Hirn, Freda M. Bachman, April 25, 1908.

Subgenus III. PUSTULARIA.

Apothecia large, solitary or caespitose, immersed or above the substratum, spherical but finally expanded, exterior scaly or warty, base often narrowed and rootlike. Paraphyses branched at the base, septate, often enlarged upward and colored. Asci cylindrical, ends blunt. Spores elliptical or oval, 1 celled, with or without 2 small oil globules, smooth, hyaline.

KEY TO SPECIES.

a — Spores 12-15 mic. long.............................stevensoniana
a — Spores 20-22 mic. long...............................vesiculosa

+*Peziza stevensoniana* Ellis; Rhem Ascom. Lojk. 3, 1882.

Apothecia solitary or caespitose, 3-4 cm. broad, interior pale brownish, exterior brownish or more often whitish and minutely warty or scaly, edge of the cup often remaining somewhat involute; fleshy-waxy, brittle, shortly stipitate. Hymenium hyaline, other parts of the cup somewhat brownish. Paraphyses slender, very slightly enlarged upward, granular. Asci cylindrical. Spores oval, smooth, hyaline, 12-15 mic. long and 10-12 mic. wide.

Found growing on old logs.

Coll. Bruce Fink, May 21, 1908. Freda M. Bachman, June 30, 1908.

Peziza vesiculosa Bull. Hist. Champ. Fr. pl. 457. f. 1. 1787-1795.

Apothecia solitary or caespitose, 1-3 cm. broad, interior light brown, exterior covered with minute light brown scales, cup-shaped or somewhat irregular, edge crenate or incised. Hymenium yellowish, hypothecium and central part paler and composed of large rounded cells, exterior darker. Paraphyses filiform, few, somewhat larger near the ends. Asci cylindrical. Spores oval, smooth, 20-22 mic. long and 8-10 mic. wide.

Growing on dung or in gardens. Very common in the spring.

Coll. Bruce and H. W. Fink, May 27, 1907. Freda M. Bachman, April 15, 1908. Stephen R. Williams, April 30, 1908.

Subgenus IV. HUMARIA.

Apothecia usually in groups, seldom solitary, sessile, at first closed, soon expanded, often becoming convex, sometimes narrowed at the base, fleshy, usually red or yellow in color. Paraphyses branched at the base, septate, often enlarged upward, filled with colored oil globules. Asci cylindical, ends rounded. Spores elliptical, oval, or spindle-shaped, usually smooth, simple, with or without oil globules, hyaline, but when mature often colored.

KEY TO SPECIES.

a — Apothecia brownish ....fuscocarpa
a — Apothecia dull yellow....................................convexula

Peziza fuscocarpa Ell. and Holw. Journ. Mycol. 1:5. 1885.

Apothecia scattered, 3-8 mm. broad, interior of the cup almost black, exterior olivaceous or dark brown with large brown septate hairs near the base. Hymenium reddish-brown; hypothecium dark brown, central part of the cup composed of large olive-brown cells, outer cells very dark. Paraphyses very numerous, slender, brownish with green granules. Asci cylindrical. Spores ovoid, olivaceous, guttulate, 8-10 mic. long and 4 mic. wide.

Growing on well-rotted wood.

Coll. Bruce Fink, Freda M. Bachman, Nov. 11, 1907.

+*Peziza convexula* Pers. Obs. Mycol. 85. 1796.

Apothecia caespitose or scattered, 3-5 mm. broad, somewhat convex, interior and exterior dull yellow, sessile, fleshy. Hymenium ochraceous, hypothecium paler, central part of the cup colorless. Paraphyses septate, clavate, ochraceous, numerous. Asci cylindrical. Spores broadly elliptic, colorless, smooth, 15-20 mic. long and 14-12 mic. wide, when mature usually having one large oil globule in the center.

Growing on ground among moss.

Coll. W. G. Stover, April 30, 1908.

Subgenus V. GEOPYXIS.

Apothecia usually in groups, cup-shaped, fleshy, sessile later stipitate, closed and spherical, later plane, exterior smooth. Paraphyses branched at the base, septate, often enlarged upward and colored. Asci cylindrical, ends usually rounded. Spores elongated or elliptical, smooth, simple, with or without a large central oil globule.

Peziza nebulosa Cooke Mycog. 163. f. 281. 1879.

Apothecia scattered, 0.5-1 cm. broad, dull gray in color, at first cup shaped become almost or entirely plane, stipitate. Stipe 1 cm. or less in length, about 2 mm. in diameter, expanding into the cup. Hymenium slightly brownish, hypothecium and exciple dull gray. Paraphyses filiform, slender. Asci cylindrical. Spores usually fusiform, guttulate, 30-35 mic. long and 7-8 mic. wide.

Growing on old wood in very wet places.

Coll. Freda M. Bachman, G. D. Smith, Bruce Fink, August 6, 1908.

Genus II. LACHNEA Quel. Bull. Soc. Myc. Fr. 25:291. 1878.
Type species, Lachnea fimbriata Quel.

Mycelium within the substratum. Apothecia fleshy or somewhat waxy, sessile, at first closed, becoming plane or concave, exterior or at least the edge pilose or tomentose, hairs dark, variously colored. Paraphyses linear or clavate, frequently filled with colored granules near the apex. Asci cylindrical, usually long, hyaline. Spores 8, elliptic or oblong, smooth or rough, often biguttulate and minutely granular, hyaline.

Growing on the ground, decaying wood or other organic material.

Structure of the cup is similar to that of Peziza but distinct from that genus by the hairy exterior or edge of the cup.

KEY TO SPECIES.

a — Epispore roughened ....hemispherica
a — Epispore smooth
    b — Interior of the cup at first red
        c — Cups 1-2 cm. broad..................................scutellata
        c — Cups 6-8 mm. broad..................................setosa
    b — Interior of the cup brownish
        c — Cups 0.5-1.5 mm. broad..................................erinaceus
        c — Cups 3-5 cm. broad..................................fusicarpa

+*Lachnea fusicarpa* Ger. in Bull. Torr. Bot. Cl. 4:64. 1893.

Apothecia solitary, 3-5 cm. broad, hemispherical, never plane, interior of the cup pale brown, exterior darker brown and covered with short, fasciculate brown, septate hairs; base wrinkled or folded, forming a short thick stipe. Hymenium and hypothecium slightly brownish, outer cells brown. Paraphyses filiform. Asci cylindrical. Spores elliptic, guttulate, 30 mic. long and 10 mic. wide, with a heavy brownish wall.

Growing on the ground under beech trees. Partially immersed.

Coll. Freda M. Bachman, Sept., 1907.

Lachnea hemispherica (Wigg.) Gillet Les Disco. de Fr. 73. 1789.
Peziza hemispherica Wigg. in Hoffm. Veget. Crypt. 2:28. pl. 7. f. 6. 1790.

Apothecia caespitose or solitary, 1-3 cm. broad, fleshy-cartilaginous, brittle, interior pale lead-color becoming white when dry, exterior covered with fasciculate brown hairs, more abundant on the edge. Hairs rather stiff, stout, septate, dark brown, pointed, 70-100 mic. long, in fascicles, sometimes somewhat broader at the base. Hypothecium slightly darker than the hyaline parenchymatous cells which compose the greater part of the cup, outermost cells brown. Paraphyses straight, septate, tips clavate. Asci cylindrical. Spores obliquely uniseriate, oblong, biguttulate 18-22 mic. long and 12-14 mic. wide, epispore minutely roughened.

Found on very much decayed log next to the ground.

Coll. Freda M. Bachman, July 4, 1908.

Opinions seem to vary as to the spores. Massee says they are at first smooth and then minutely aspirate; Phillips says they are smooth; Cooke in Mycographia says they have sometimes a tendency to become rough and gives figures to illustrate.

+*Lachnea setosa* (Nees.) Phil. Brit, Disco. 406. 1887.

Peziza setosa Nees. Sys. 260. f. 275. 1817.

Apothecia caespitose or in groups, 6-8 mm. broad, sessile, plane, mahogany-red, after drying losing color and then pale yellowish gray, exterior of the cup covered with dark brown, septate, pointed hairs. Hymenium reddish, hypothecium of the same color, outer cells of the cup hyaline or tinged with brown. Paraphyses red, clavate at the ends. Asci cylindrical, hyaline. Spores broadly oval, uniseriate, 1-3 oil globules, very often a single large oil globule nearly filling the spore, 16-24 mic. long and 10-12 mic. wide.

Growing on rotten wood in the woods. Very common in summer and fall.

Coll. Freda M. Bachman, Nov. 3, 1907, June 20, 1908. G. D. Smith, W. G. Stover, August 4, 1908.

Lachnea scutellata (Sow.) Gill. Les Disco. de Fr. 75. 1879.

Peziza scutellata Sow. Eng. Fung. 1: pl. 24. 1797.

Apothecia sessile or nearly so, 1-2 cm. broad, interior at first dark red, later becoming brighter red, exterior at first pale, later brownish because covered with dark, brown, pointed, septate straight hairs; edge fringed with longer but similar hairs which at first extend in toward the center but later stand erect or outward. Hymenium reddish-orange in color, hypothecium pale grayish, exciple still lighter in color. Paraphyses septate, unbranched, numerous, enlarged at the apices, filled with orange granules. Asci cylindrical. Spores uniseriate, oblong-elliptic, granular, 18-22 mic. long and 8-12 mic. wide.

Growing on old wood, also on soil. Very common till late fall.

Coll. Freda M. Bachman, April 25, 1907, July 19, 1907. Bruce Fink, W. G. Stover, April 17, 1908. Freda M. Bachman, August 4, 1908.

+*Lachnea erinaceus* (Schw.) Sacc. Syl. Fung. 8: 182. 1889.

Peziza erinaceus Schw. Syn. Fung. Carol. No. 1194. 1822.

Apothecia in clusters, 0.5-1.5 mm. broad, fleshy, interior light brown, exterior covered with bristle-like, brown, septate, pointed hairs. Hymenium and hypothecium pale gray, outer cells of the cup slightly brownish. Paraphyses filiform, slender, granular. Asci cylindrical. Spores hyaline, oblong-elliptic, 2-4 oil globules, uniseriate, 13-16 mic. long and 8-10 mic. wide.

Growing on rotten wood. Probably quite common.

Coll. Bruce and H. W. Fink, June 15, 1907.

Family II. PYRONEMACEAE.

Mycelium mostly superficial and threadlike. Apothecia plane or convex from the first. Hypothecium and exciple when present of similar structure, usually pseudo-parenchymatous. Exciple more often wanting or very poorly developed.

Growing on soil, charcoal, ashes, or decaying vegetation.

Genus I. PYRONEMA Carus Nova. Acta Acad. Caes. Leop. Car. 17: 370 pl. 27. 1835.

Type species, Pyronema marianum Carus.

Mycelium delicate, radiating, white, weblike. Apothecia fleshy, sessile, plane or convex from the first, small, usually bright-colored, glabrous or hairy, distinct or more or less confluent as the hymenium spreads. Exciple very poorly developed. Paraphyses slender or stout, often granular, colored or hyaline, simple, septate or non-septate, filiform or clavate. Asci cylindrical or cylindrico-clavate. Spores 8 ellipsoid or oblong, hyaline, without oil globules, smooth.

Growing most commonly on ashes, charred wood or on the ground where there has been fire, but also found on newly plastered walls and paper. Early spring to late fall.

Pyronema confluens (Pers.) Tul. Select. Fung. Carp. 3: 197. 1865.

Peziza confluens Pers. Obs. Mycol. 81. No. 126. pl. 5. f. 6 and 7. 1796.

Apothecia crowded or confluent, spreading, convex, 1-2 mm. broad, fleshy, orange yellow, sessile. Hymenium pale salmon-pink, hypothecium darker, central part of the cup colorless. Paraphyses filiform, rather stout, sometimes appearing pseudo-septate, hyaline but pinkish in mass. Asci cylindrical, wall thickened at the ends. Spores uniseriate, hyaline, 10-12 mic. long and 6-7 mic. wide, oval, smooth.

Growing on ashes and burnt wood. Probably common. Spring and summer.

Coll. Freda M. Bachman, April 24, 1908.

Family III. ASCOBOLACEAE.

Mycelium mostly in the substratum. Apothecia fleshy, superficial or somewhat immersed, sessile or nearly so, exterior smooth, scaly, or hairy. Exciple when present, and hypothecium of similar structure and usually pseudo-parenchymatous. Exciple often wanting or poorly developed. Asci emergent.

KEY TO GENERA.

a — Spores at maturity dark colored.
  b — Spores in a gelatinous envelope.....................Saccobolus
  b — Spores not in an envelope..........................Ascobolus
a — Spores hyaline.
  b — Apothecia covered externally with sharp, pointed hairs
  .... Lasiobolus
  b — Apothecia not covered with conspicuous hairs........Ascophanus

Genus I. ASCOBOLUS Pers. in Gmel. Sys. 1461. 1791.

Type species, Peziza stercoraria Bull.=Ascobolus furfuraceus Pers.

Mycelium within the substratum. Apothecia fleshy or fleshy-gelatinous, sessile or rarely substipitate, at first concave, becoming either plane or convex, small glabrous or scaly, rarely hairy. Hymenium more or less gelatinous, hyaline or colored. Paraphyses numerous, slender, scarcely enlarged upwards, at first longer than the asci, simple or divided at the base, septate. Asci clavate or cylindrico-clavate, large, attenuated at the base, the apex broad, the operculum round and often drawn up to a point in the center. Spores 8, large, oblong or elliptic, hyaline, then purple and finally brown, smooth with longitudinal branching ridges or verrucose. As the spores mature the hymenium presents a dotted, papillate appearance caused by the hyaline emergent asci filled with dark spores.

Commonly found on dung but also on damp paper or other decaying plant material.

The genus may be distinguished from others of the family by the color and reticulations of the spores, by the non-adherent epispore, and by the length of the paraphyses.

KEY TO SPECIES.

a — Exterior of the apothecia not scaly, immersed............immersus
a — Exterior of the apothecia scaly.
  b — Epispore minutely warty............................atrofuscus
  b — Epispore with longitudinal reticulations..............furfuraceus

+*Ascobolus immersus* Pers. Syn. Fung. 677. 1801.

Apothecia solitary or in groups, minute, immersed in the substratum, interior pale-olivaceous, becoming very dark as spores mature; exterior covered with minute hyaline hairs. Hymenium slightly greenish, hypothecium pale. Paraphyses often branched. Asci broadly clavate. Spores oblong-elliptic, showing the large nucleus when immature, becoming brown with longitudinal and branched reticulations; enclosed in a hyaline envelope, 50-60 mic. long and 22-23 mic. wide.

Grown in the laboratory on old cow dung.

Ascobolus furfuraceus Pers. Obs. Mycol. 33. 1796.

Apothecia scattered or in clusters, 3-6 mm. broad, sessile, pale olive, becoming quite dark as the spores mature, exterior covered with yellowish scaly particles. Hymenium greenish, hypothecium pale. Paraphyses filiform, granular, somewhat enlarged at the ends. Asci clavate, operculate, ends blunt and usually somewhat narrower. Asci and paraphyses hyaline, but both surrounded by a greenish, gelatinous, granular mass. Spores uniseriate or irregular, ellipsoid, with longitudinal reticulations, 23 mic. long and 10 mic. wide.

Grown in the laboratory on old cow dung. Found in a pasture on cow dung.

Coll. Freda M. Bachman, April 4, 1908.

+*Ascobolus astrofuscus* Phil. & Plow. in Grev. 2: 186. pl. 24. f. 1. 1874.

Apothecia solitary or in groups, sessile, becoming plane, edge crenulate, interior and exterior dark reddish-brown, exterior scaly. Hymenium and outer cells of the cup brownish. Paraphyses somewhat longer than the asci, simple or branched. Asci narrowly clavate. Spores oblong-elliptic, 22 mic. long and 13 mic. wide, hyaline, then violet, then brown, minutely warty.

Growing on the ground where fire had been and among charcoal.

Coll. Freda M. Bachman, July 1, 1908.

Genus II. SACCOBOLUS Bond. Ann. Sci. Nat. 10:228. 1869.

Type species, Saccobolus kerverni (Cronan) Boud.

Mycelium within the substratum. Apothecia fleshy, sessile, somewhat concave, then becoming plane and convex, small, somewhat transparent, glabrous. Paraphyses numerous, slender, septate, simple or branched, of the same length as the asci, the apices clavate and often colored. Asci broad, short, attenuated at the base, emergent, with triangular operculum. Spores 8, usually elliptic, hyaline, then purple and finally brown, smooth, if ridged, then transversely never longitudinally, large, enclosed in a common hyaline gelatinous envelope.

Growing on dung.

The genus is easily distinguished from Ascobolus by the smaller size of the apothecia, by the shorter, larger and less prominent asci, by the shorter paraphyses, and by the gelatinous envelope enclosing the spores. The hymenium becomes dotted as in Ascobolus as the spores mature.

+*Saccobolus depauperatus* (B. & Br.) Phil. Brit. Disco. 296. 1887.

Ascobolus depauperatus B. & Br. Ann. and Mag. Nat. Hist. III. 15: 448. No. 1084. pl. 14. f. 6. 1865.

Apothecia scattered or in groups, pale pink, becoming somewhat darker, minute, sessile. Paraphyses slender, bent at the ends, not branched. Asci operculate, broadly clavate, hyaline. Spores hyaline, then purple, then brown, oval or somewhat fusiform, ejected in a mass surrounded by a gelatinous envelope, not filling the ascus when mature, 12 mic. long and 5 mic. wide.

Grown on old cow dung in the laboratory.

Coll. Freda M. Bachman, Nov. 13, 1907.

Genus III. ASCOPHANUS Bond. Mem. Ascob. 51. 1869.

Type species, Ascophanus subfuscus (Cronan) Bond.

Mycelium mostly in the substratum but more or less abundant beneath the apothecia. Apothecia fleshy or fleshy-gelatinous, sessile, concave then plane or convex, small, glabrous or pruinose, somewhat pyriform. Paraphyses simple or branched, septate, slender, often granular, hyaline or colored, equal in length with the asci, apices usually clavate. Asci broadly clavate, rarely oblong-ovate, hyaline or slightly tinted, attenuated at the base, prominent as crystalline papillae on the hymenium, with a conspicuous round, often recurved operculum. Spores 8 or 16, elliptic or oblong-elliptic, when immature surrounded singly by a hyaline gelatinous envelope, smooth or rare minutely punctate, hyaline or very slightly tinted, the nucleus conspicuous.

Commonly found on dung but also on decaying plant material.

The genus may be distinguished from Ascobolus and Saccobolus by the spores which are always hyaline although sometimes by refraction they appear greenish or roseate, and from Lasiobolus by the less hairy exterior of the apothecia. A single species has 16 spores.

+*Ascophanus saccharinus* (Currey) Bond. Ann. Sci. Nat. v. 10: 251. pl. 12. 1869.

Ascobolus saccharinus Berk. & Curr. Journ. Bot. 2:154. f. 10. 1864.

Apothecia scattered or crowded, 2-4 mm. broad, interior salmon pink, becoming convex, exterior paler, at first surrounded by hyaline hyphae which are not apparent later. Hymenium salmon pink, hypothecium very pale pink or hyaline. Paraphyses stout, septate, enlarged near the apex and filled with reddish granules. Asci clavate, very broad. Spores 8, smooth, irregularly arranged, oblong-elliptic, 18 mic. long and 10 mic. wide.

Grown on cow and horse dung in the laboratory.

Genus IV. LASIOBOLUS Sacc. Bot. Cent. 18:220 [8]. 1884.

Type species, Lasiobolus papillatus (Bond.) Sacc.

Mycelium seldom visible. Apothecia fleshy, sessile, becoming plane or convex, minute, externally covered with sharp pointed hairs. Paraphyses simple or branched, septate, slender or somewhat stout, often granular, equaling the asci in length, apices often clavate. Asci clavate or cylindrico-clavate, hyaline, tapering slightly at the base. Spores 8, elliptic or oblong-elliptic, hyaline.

Growing commonly on dung.

The genus may be distinguished from Ascophanus by the sharp pointed hairs which cover the exterior of the apothecia.

Lasiobolus equinus (Müll.) Karst. Acta Soc. Fauna et Fl. Fenn. 2^6: 122. 1885.

Peziza equina Müll. Fl. Dan. 5:8. pl. 779. f. 3. 1778.

Apothecia in groups, 0.5-1.5 mm. broad. sessile, brownish, exterior of cup having a number of bristle-like, septate, colorless hairs. Hymenium, hypothecium and exciple brownish yellow. Paraphyses numerous, septate, granular, rather stout. Asci cylindrico-clavate, operculate, hyaline. Spores oblong-elliptic, smooth, hyaline, usually granular, 22 mic. long and 10 or 11 mic. wide.

Growing on old cow dung in pasture.

Coll. Freda M. Bachman, April 21, 1908.

Family IV. HELOTIACEAE.

Mycelium superficial, somewhat superficial or wholly within the substratum. Apothecia fleshy-waxy, waxy, membranous, cartilaginous or gelatinous, sessile or stipitate, exterior smooth or hairy, concave becoming more or less plane or plane from the first. Hypothecium usually distinct from the tissue beneath. Exciple composed of elongated, palallel, light colored cells.

KEY TO GENERA.

a — Mycelium superficial .... Arachnopeziza
a — Mycelium within substratum.
  b — Apothecia springing from sclerotia.
    c — Apothecia large .... Sclerotinia
    c — Apothecia small ....
  b — Apothecia not from sclerotia.
    c — Externally hairy.
      d — Apothecia large, bright-colored, hairs inconspicuous, appressed .... Sarcoscypha
      d — Apothecia small, pale.
        e — Apothecia sessile or subsessile............ Lachnella
        e — Apothecia stipitate .... Dasyscypha
    c — Externally smooth.
      d — Cartilaginous or gelatinous.
        e — Spores simple .... Ombrophila
        e — Spores several celled...................... Coryne
      d — Waxy.
        e — Stipe slender .... Phialea
        e — Stipe none or thick....................... Helotium

Genus I. HELOTIUM Pers. Syn. Fung. 677. 1801.

Type species, Leotia acicularis Pers.

Mycelium within the substratum. Apothecia waxy, often thick, sessile or with a short thick stipe, externally smooth or sometimes pruinose, often plane from the first, usually bright colored and small. Paraphyses slender, filiform. Asci cylindrical or cylindrico-clavate, hyaline. Spores 8, elliptic, fusiform, ovoid or oblong, blunt or sharp pointed, hyaline, guttulate, pseudo-septate, 2-4 celled.

Growing on old wood or herbaceous stems.

KEY TO SPECIES.

a — Interior of the cup bright yellow.......................... citrinum
a — Interior of the cup pale yellow.
  b — Growing on wood................................ pallescens
  b — Growing on stems................................ herbarum

+*Helotium herbarum* (Pers.) Fr. Sum. Veg. Scand. 356. 1846.

Peziza herbarum Pers. Syn. Fung. 1 : 664. 1801.

Apothecia sessile, pale yellow, 1-3 mm. broad. Hymenium, hypothecium and exciple colorless. Paraphyses filiform. Asci slightly clavate. Spores ellipsoid or fusiform, guttulate, pseudo-septate, 10-15 mic. long and 2.5-4 mic. wide.

Very common on old stems in late autumn.

Coll. Freda M. Bachman, Oct. 31, 1907.

+*Helotium pallescens* (Pers.) Fr. Sum. Veg. Scand. 355. 1846.

Peziza pallescens Pers. Obs. Mycol. 85. 1799.

Apothecia scattered or in groups, 1-2 mm. broad, sessile or shortly stipitate, yellowish white. Hymenium and hypothecium slightly brownish, central and outer cells of the cup pale gray. Paraphyses filiform. Asci cylindrico-clavate. Spores oblong elliptic, guttulate, pseudo-septate, 8-13 mic. long and 2-4 mic. wide.

Found growing on old wood.

Coll. Freda M. Bachman, Nov. 13, 1907.

Helotium citrinum (Hedw.) Fr. Sum. Veg. Scand. 355. 1846.

Octospora citrina Hedw. Desc. Musc. Frond. 1: 28. pl. 7. 1787.

Apothecia caespitose or in groups, 2 mm.-1 cm. broad, often plane from the first, usually with a short stipe, interior very bright yellow, exterior paler, smooth. Stipe 1-3 mm. long. Hymenium pale olivaceous and slightly darker than the hypothecium, exciple hyaline. Paraphyses hyaline. Asci cylindrico-clavate. Spores pseudo-septate, oblong-elliptic or fusiform, 10-15 mic. long and 3-4 mic. wide.

Growing on old stumps or twigs. Very common in summer and fall.

Coll. Freda M. Bachman, Sept. 28, 1907. Bruce Fink, June 23, 1908.

Genus II. PHIALEA. Bond. Les Disco. de Fr. 93. 1879.

Type species, Phialea aspregrenii (Fr.) Gill.=Phialea bolaris Bond.

Mycelium within the substratum. Apothecia waxy-membranaceous, at first urceolate and more or less closed, later concave or convex, glabrous or pruinose, stipitate, with slender stipe, usually bright-colored and small. Paraphyses slender, filiform, slightly wider at the ends. Asci cylindrical or somewhat cylindrico-clavate. Spores 8, ovoid, oblong or somewhat rounded. hyaline.

Growing on decorticate wood and herbaceous stems.

The genus differs from Helotium in the more slender stipe, in the apothecia being urceolate and more or less colored at first.

Phialea scutula (Pers.) Gill. Les Disco. de Fr. 108. 1879.

Peziza scutula Pers. Mycol. Eur. 1: 284. 1882.

Apothecia scattered, 2-3 mm. broad, cup-shaped becoming almost plane, stipitate, interior pale yellow, exterior same color. Stipe 5-8 mm. long, slender. Hymenium and hypothecium pale or colorless. Paraphyses filiform, slightly wider at the ends. Asci cylindrico-clavate. Spores pseudo-septate, guttulate, 3 or 4 oil globules, fusiform or oblong-elliptic, 16-18 mic. long and 3-5 mic. wide.

Growing on old stems in damp places.

Coll. Freda M. Bachman, Oct. 31, 1907. Bruce Fink, July 4, 1908.

Genus III. LACHNELLA Fr. Sum. Veg. Scand. 365. 1849.

Type Species, Lachnella flammea (Alb. and Schw.) Fr.

Mycelium within the sub-stratum. Apothecia fleshy-waxy, firm, sessile, at first closed and globose, then expanded, exterior pilose or villous, small. Hairs of the cup hyaline or colored. Paraphyses filiform or needle-like usually exceeding the asci in length. Asci cylindrico-clavate or clavate. Spores 8, simple, hyaline, oblong, oblong-elliptic or ovoid.

Growing on decaying wood, stems, or leaves.

+*Lachnella papillaris* (Bull.) Phil. Brit. Disco. 257. 1887.

Peziza papillaris Bull. Hist. Champ. Fr. pl. 467, f. 1. 1787-1795.

Apothecia caespitose or scattered, 1-2 mm. broad, cup-shaped becoming nearly plane but closed when dry, sessile, interior pallid, exterior of the same color but covered with brown, septate, blunt hairs, having crystal granules on the ends. Hymenium somewhat brownish, other parts of the cup pale gray. Paraphyses filiform, slightly exceeding the asci in length, more or less pointed at the ends. Asci cylindrico-clavate. Spores oblong-elliptic, hyaline, 2-celled, 6-12 mic. long and 3 mic. wide.

Growing on old wood. Very common.

Coll. Freda M. Bachman, Nov. 22, 1907.

Genus IV. SARCOSCYPHA Sacc. Syl. Fung. 8: 153. 1889.

Type species, Sarcoscypha coccinea (Jacq.) Sacc.

Mycelium within the substratum. Apothecia waxy or fleshy-waxy, stipitate, generally cup-shaped, usually bright-colored, exterior tomentose and paler than the interior, caespitose or in groups, large. Hairs of the cup short or long, white or slightly colored often appressed and inconspicuous. Stipe erect or rooting. Paraphyses slender, branched, more or less clavate, filled with colored granules. Asci cylindrical attenuated at the base. Spores 8, elliptic or oblong, smooth or seldom rough, hyaline, guttulate, large, simple.

Growing on decorticate wood or partially buried sticks.

KEY TO SPECIES.

a — Hairs conspicuous .... floccosa
a — Hairs inconspicuous.
  b — On half-buried sticks in early spring.................. coccinea
  b — On decaying wood all summer......................... occidentalis

Sarcoscypha floccosa (Schw.) Sacc. Syl. Fung. 8: 156. 1889.

Peziza floccosa Schw. Syn. Am. No. 782. 1831.

Apothecia solitary or caespitose, 1-2 cm. broad, fleshy, funnel-shaped, interior bright scarlet, exterior pink, tomentose, edge surrounded by longer erect hairs. Stipe straight or flexuous, 3-4 cm. long, tomentose. Hairs of the exterior colorless. Hymenium and hypothecium reddish, outer parts hyaline. Paraphyses filiform, hyaline, reddish in mass. Asci cylindrical. Spores granular, elliptic, 30 mic. long and 11 mic. wide.

Growing on partly buried sticks in woods.

Coll. Bruce Fink, May 30, 1908. Freda M. Bachman, Grace M. Kalter, June 10, 1908.

Sarcoscypha coccinea (Jacq.) Sacc. Syl. Fung. 8: 154. 1889.

Peziza coccinea Jacq. Fl. Aus. 2: pl. 169. 1774.

Apothecia fleshy, 2-5 cm. broad, stipitate, interior brilliant scarlet, exterior pale or pinkish and covered with hyaline, appressed, septate hairs, not apparent to the unaided eye. Paraphyses numerous, filled with colored granules. Asci operculate. Spores uniseriate, oblong-elliptic, smooth, 23-29 mic. long and 10 mic. wide, oil globules varying in number.

Found on sticks partly buried in the soil or under leaves. Probably rare. In early spring.

Coll. Bruce Fink, April 11, 1908.

Sarcoscypha occidentalis (Schw.) Sacc. 8: 154. 1889.

Peziza occidentalis Schw. Syn. N. Am. Fung. 171 No. 781. 1831.

Apothecia fleshy, leathery when dry, 1-2 cm. broad, stipitate, interior scarlet, exterior paler and covered with appressed, inconspicuous hairs. Stipe 5 mm.-2 cm. long, slender. Hymenium pale brick-red, hypothecium and exciple pinkish. Paraphyses filiform, tapering slightly toward the base, filled with reddish granules. Asci cylindrical. Spores uniseriate, oblong-elliptic, smooth, 18-20 mic. long, and 10 mic. wide, granular, usually containing 2 large oil globules when mature.

Growing on sticks or decayed logs in the woods. Common all summer.

Coll. Bruce Fink, June 15, 1907, July 23, 1907, Grace M. Kalter, Freda M. Bachman, May 25, 1908, Freda M. Bachman, August 5, 1908.

Genus V. CHLOROSPLENIUM Fr. Sum. Veg. Scand. 356. 1849.

Type species, Chlorosplenium schweinitzii Fr.=Peziza chlora Schw.

Mycelium within the substratum, often colored. Apothecia waxy, tough, stipitate, cup-shaped or somewhat irregular, becoming expanded and often subflexuous and repand, green or olivaceous, interior often paler than exterior; glabrous, caespitose or in groups. Stipe short, thick. Paraphyses simple or divided only near the base, often granular and colored, the ends sometimes slightly adherent. Asci cylindrical or cylindrico-clavate. Spores 8, simple, elliptic or fusiform, usually guttulate.

Growing on decaying wood.

KEY TO SPECIES.

a — Substratum colored green .... aeruginosum
a — Substratum uncolored.
  b — Apothecia greenish yellow .... chlora
  b — Apothecia very dark green .... versiforme

Chlorosplenium chlora (Schw.) Mass. Brit. Fung. Fl. 356. 1849.

Peziza chlora Schw. Syn. Fung. Carol. No. 1235. 1822.

Apothecia solitary or in groups, 4-6 mm. broad, interior greenish yellow, exterior slightly darker and somewhat roughened, cup-shaped. Hymenium pale olivaceous, hypothecium greenish, exciple dark. Paraphyses filiform, granular, rather stout. Asci cylindrico-clavate. Spores elliptic or fusiform, finely guttulate, 6-9 mic. long and 2.5-3 mic. wide.

Growing on old wood. Probably quite common.

Coll. Freda M. Bachman, Nov. 3, 1907.

Chlorosplenium versiforme (Pers.) De. Not. Comm. Soc. Critt. Ital. 1:376. 1864.

Peziza versiformis Pers. Icon. et Descr. 25. pl. 7. f. 7. 1798.

Apothecia caespitose, 2-3.5 cm. broad, stipitate, funnel-shaped or somewhat irregular, interior and exterior greenish black. Stipe 1-2 cm. long. Hymenium slightly brownish, the ends of the paraphyses and asci dark green; hypothecium brown, central part of the cup of three dark brown and two lighter brown strata. Paraphyses filiform, branched, filled with green granules near the ends, also somewhat adherent at the ends. Asci cylindrical. Spores 6-10 mic. long and 2-4 mic. wide, elliptic.

Growing on rotting logs.

Coll. Freda M. Bachman, Nov. 21, 1907.

Chlorosplenium aeruginosum (Oeder) Tul. Select. Fung. Carp. 3: 187. 1865.

Elvela aeruginosa Oeder Fl. Dan. 3^9: 7. pl. 534. f. 2. 1770.

Mycelium coloring the substratum green. Apothecia in groups, 6 mm.-1 cm. broad, interior of the cup pale green or creamy, exterior verdigris-green; stipitate, somewhat leathery. Stipe 0.5-1 cm. long, usually slender. Hymenium and hypothecium almost colorless, central part of the same color, exterior portion dark green. Paraphyses filiform, sometimes branched. Asci cylindrico-clavate. Spores fusiform, 9-14 mic. long and 3-4 mic. broad, guttulate.

Growing on rotting wood.

Coll. Freda M. Bachman, Oct. 31, 1907. Bruce Fink, May 2, 1908. Grace M. Kalter, Bruce Fink, Aug. 11, 1908.

Genus VI. Sclerotinia Fuck. Symb. Mycol. 330. 1869.

Type species, Sclerotinia libertiana Fuck.

Apothecia fleshy-waxy, stipitate, cup-shaped or funnel shaped, later more or less expanded arising from sclerotia, large or small, usually glabrous. Stipe long, slender, more or less immersed. Paraphyses filiform. Asci cylindrical. Spores 8, oblong elliptic, ovate or elliptic, hyaline guttulate.

Growing on the ground in the spring.

+*Sclerotinia tuberosa* (Hedw.) Fuck. Symb. Mycol. 331. 1869.

Octospora tuberosa Hedw. Desc. Musc. Frond. 1: 33. pl. 10. 1787.

Apothecia springing from sclerotia, 2-3.5 cm. broad, stipitate, interior of the cup light to dark brown and becoming somewhat wrinkled, exterior of the same color. Stipe 2-4 cm. long, slender, often flexuous. Hymenium brownish, hypothecium very dark brown, outer cells of the cup lighter brown. Paraphyses filiform. Asci cylindrical. Spores uniseriate, usually elliptic, sometimes oblong-elliptic, hyaline, smooth, 12 mic. long and 6 mic. wide.

Growing on earth in the spring in woods. Very common.

Coll. Bruce and H. W. Fink, May 10, 1907. Freda M. Bachman, April 23, 1908.

Genus VII. ARACHNOPEZIZA Fuck. Symb. Mycol. 303. 1869.

Type species, Tapesia aurelia Pers.

Mycelium superficial, arachnoid. Apothecia fleshy-waxy, sessile, exterior villous or scaly, interior concave becoming plane; in groups. Paraphyses filiform. Asci cylindrical or cylindrico-clavate. Spores 8, fusiform, oblong-elliptic, hyaline, simple or 1-3 septate.

Growing on decaying vegetation, most often on wood.

KEY TO SPECIES.

a — Apothecia minute, white .... delicatula
a — Apothecia larger, yellow .... aurelia

Arachnopeziza aurelia (Pers.) Fuck. Symb. Mycol. 303. 1869.

Peziza aurelia Pers. Mycol. Eur. 270. 1822.

Mycelium often abundant, yellowish. Apothecia solitary or in groups, 0.5-1 cm. broad, hemispherical, becoming plane, interior of the cup bright yellow, exterior covered with reddish fasciculate hairs. Hymenium and central part of the cup hyaline, hypothecium somewhat darker. Paraphyses filiform. Asci cylindrico-clavate. Spores 4 celled, hyaline, 15-18 mic. long and 4-5 mic. wide, fusiform or oblong often having a short cilium at each end.

Very little of the mycelium was above the substratum in the material collected in the spring, while that of late fall showed a thick mass of hyphae in which the apothecia were borne.

Growing on old logs or stumps.

Coll. Gertrude Lett, Freda Bachman, Nov. 9, 1907. L. O. Overholts, May 2, 1908.

+*Arachnopeziza delicatula* Fuck. Symb. Mycol. 304. 1869.

Mycelium delicate and visible only near the apothecia. Apothecia scattered, minute, about 0.5 mm. broad, cup-shaped, becoming nearly plane, white, when old and dry, dingy-yellow, exterior with a few hyaline hairs. Hymenium and other parts pale yellowish. Paraphyses filiform. Asci cylindrico-clavate, but narrowed at the ends. Spores oblong-elliptic or slightly fusiform, simple, hyaline, 6 mic. long and 2 mic. wide.

Growing on old somewhat charred wood.

Coll. Freda M. Bachman, Nov. 3, 1907.

Genus VIII. DASYSCYPHA Fuck. Symb. Mycol. 304. 1869.

Type species, Dasyscypha bicolor (Bull.) Fuck.

Mycelium within the substratum. Apothecia fleshy-waxy, stipitate, pilose or villous, at first concave, becoming more or less expanded, small. Stipe slender, hairy. Hairs of the cup hyaline or colored, often covered with granules which may disappear. Paraphyses filiform or needle-like, often exceeding the asci in length. Asci cylindrical or cylindrico-clavate. Spores 8.

Growing on decaying wood and stems.

The genus may be distinguished from Lachnella by the presence of a stipe.

KEY TO SPECIES.

a — Interior of the cup yellowish.
  b — Apothecia stipitate ....turbinulata
  b — Apothecia sessile or subsessile.........................patula
a — Interior white.
  b — Paraphyses with obtuse ends..............................nivea
  b — Paraphyses needle-like.
    c — Growing on wood..................................virginea
    c — Growing on leaves..................................ciliaris

+*Dasyscypha patula* (Pers.) Sacc. Syl. Fung. 8: 443. 1889.

Peziza patula Pers. Obs. Mycol. 1: 42. 1799.

Apothecia in groups, 40-300 mic. broad, sessile or with a very short stipe, white, hemispherical, the disc surrounded by non-septate, long, slender, pointed, hyaline, hairs. Hymenium, hypothecium and exciple colorless. Paraphyses needle-like and longer than the asci. Asci cylindrico-clavate. Spores elliptic or fusiform, hyaline, 7-10 mic. long and 1.5-2 mic. wide.

Growing on maple leaves in late fall. Common.

Coll. Freda M. Bachman, Oct. 23, 1907.

+*Dasyscypha ciliaris* (Schrad.) Sacc. Syl. Fung. 8: 443. 1889.

Peziza ciliaris Schrad. Journ. Bot. 2: 2. 1799.

Apothecia solitary or in groups, minute, about 220 mic. broad, almost sessile, white exterior covered with hyaline, needle-like, septate hairs. Hymenium and hypothecium hyaline. Paraphyses quite stout, needle-like, somewhat longer than the asci. Asci cylindrico-clavate. Spores 12-16 mic. long and 1-2 mic. wide, elliptic or fusiform.

Growing on maple leaves.

Coll. Freda M. Bachman, Nov. 3, 1907.

+*Dasyscypha turbinulata* (Schw.) Sacc. Syl. Fung. 8: 456. 1889.

Peziza turbinulata Schw. Syn. Fung. 173. No. 813. 1834.

Apothecia in groups, 0.5-1 cm. broad, at first greenish-yellow, exterior paler and villous, stipe of the same color and villous. All tissues of the cup greenish-yellow in section. Paraphyses filiform hyaline, sometimes branched. Asci cylindrico-clavate. Spores fusiform or elliptic, hyaline, 12-18 mic. long and 3-5 mic. wide.

Growing on old logs, etc.

Coll. Bruce Fink, May 2, 1908.

Dasyscypha virginea (Batsch) Fuck. Symb. Mycol. 305. 1869.

Peziza virginea Batsch Elen. Fung. 125. 1786.

Apothecia in groups, 2-3 mm. broad, becoming almost plane, interior and exterior white. Stipe 2-4 mm. long, slender. Hairs of the cup septate, somewhat clavate. Hymenium hyaline, hypothecium and exciple slightly less clear than the hymenium. Paraphyses needlelike. Asci cylindrico-clavate. Spores obliquely uniseriate, elliptic or fusiform, 5-7 mic. long and 1.5-2 mic. wide.

Very common on rotting wood or on the under side of bark on decaying logs from early spring to late autumn.

Coll. Freda M. Bachman, Nov. 3, 1907. Bruce Fink, Apr. 11, 1908, May 2, 1908. Freda M. Bachman, July 4, 1908.

+*Dasyscypha nivea* (Fr.) Sacc. Syl-Fung. 8:437. 1889.

Lachnea nivea Fr. Sys. Mycol. 2:90. 1822.

Apothecia in groups, 2-3 mm. broad, white, stipitate, exterior covered with minute hyaline, septate, obtuse hairs. Stipe short, slender. All tissues hyaline in microscopic section. Paraphyses filiform, ends obtuse. Asci cylindrical. Spores simple, hyaline, fusiform or oblong, 8-10 mic. long and 1.5-2 mic. wide.

Growing on rotten wood. This may be distinguished from D. virginea by the more waxy texture of the apothecia and the obtuse ends of the paraphyses.

Coll. Bruce and H. W. Fink, May 2, 1908. Freda M. Bachman, Aug. 8, 1908.

Genus IX. Coryne Tul. Select. Fung. Carp. 3:190. 1865.

Type species, Lichen sarcoides Jacq.

Mycelium within the subtratum. Apothecia gelatinous, caespitose, hard when dry, sessile or substipitate, exterior smooth, at first concave, becoming nearly plane, generally dark colored, purple or violet, rarely greenish, large. Stipe when present, thick and short. Paraphyses slightly thickened at apices. Asci more or less clavate, attenuated at the base. Spores 8, oblong, fusiform, elliptic or oval, hyaline, 2-8 celled.

Growing on decaying wood, rarely on other vegetation.

+*Coryne sarcoides* (Jacq.) Tul. Select. Fung. Carp. 3:190. pl. 17. f. 1-10. 1865.

Lichen sarcoides Jacq. Misc. Aus. Bot. 2:378. pl. 22. 1781.

Apothecia nearly sessile, 1.5-2.5 cm. broad, interior dark, purplish-red, exterior paler or pinkish. Hymenium dull red, hypothecium and central part of the cup paler, outer cells darker. Paraphyses very slender, numerous, slightly adherent. Asci slightly enlarged upwards. Spores 4-7 celled, more or less pointed at the ends, 15-22 mic. long and 4 mic. wide.

Growing in cracks of old logs or stumps. Very common.

Coll. W. G. Stover, Oct. 8, 1907. Freda M. Bachman, Oct. 23, 1907.

Genus X. OMBROPHILA Fr. Sum. Veg. Scand. 357. 1849.

Type species, Ombrophila violacea (Hedw) Fr.

Mycelium within the substratum. Apothecia gelatinous, sessile or substipitate, slightly concave becoming either plane or convex, thick. Stipe when present, short and thick. Paraphyses filiform, or somewhat clavate, simple or branched at the base. Asci narrowly clavate. Spores 8, ellipsoid or oblong, hyaline, guttulate.

Growing on decaying wood.

+*Ombrophila violascens* Rehm Discom. 478. 1891.

Apothecia solitary or in groups or caespitose 0.5-2.5 cm. broad, varying in shape, interior faded red or dark reddish purple, exterior of the same color, sessile or with short stipe, gelatinous grisly. Hymenium hyaline or tinged with red, hypothecium of the same color, central part of the cup red and then hyaline, outer cells reddish. Paraphyses filiform, slightly clavate, non-septate. Asci cylindrico-clavate, distended with spores. Spores obliquely uniseriate or straight in the ascus, simple, hyaline, guttulate, broadly elliptic, smooth, 6-9 mic. long and 5 mic. wide.

Growing on old wood among moss.

Coll. Bruce Fink, Freda M. Bachman, Oct 12, 1907.

Family V. MOLLISIACEAE.

Mycelium superficial, somewhat superficial or wholly within the substratum. Apothecia fleshy-waxy or cartilaginous, rarely membranous, sessile or stipitate, superficial or at first immersed. Hypothecium forming a distinct layer. Outer cells of the cup dark colored, more or less rounded and thick-walled.

KEY TO GENERA.

a — Mycelium superficial .... Tapesia
a — Mycelium within the substratum.
  b — Apothecia gelatinous, paraphyses with globose ends...... Orbilia
  b — Apothecia fleshy-waxy, paraphyses filiform.
    c — Minute, texture very soft........................ Pezizella
    c — Somewhat larger, texture quite firm................ Mollisia

Genus I. MOLLISIA Karst. Mycol. Fenn. 1:187. 1871.

Type species, Mollisia cinerea (Batsch.) Karst.

Mycelium within the substratum. Apothecia waxy, sessile, becoming plane. sometimes lobed, small, glabrous, superficial or suberumpent, exterior dark. Paraphyses filiform, somewhat stout, septate only at the base. Asci clavate or cylindrico-clavate. Spores 4-8, usually simple, rarely two-celled, hyaline, ellipsoid, oblong, or fusiform, often granular or minutely guttulate.

Growing on decaying wood or stems.

Mollisia cinerea (Batsch) Karst. Mycol. Fenn. 189. 1871.

Peziza cinerea Batsch Elen. Fung. 197. f. 137. 1786.

Apothecia in groups or scattered, 2-7 mm. broad, cupshaped with edge thickened and raised, becoming plane, sessile, exterior very dark, interior light to very dark ashy, soft and fleshy, form well-preserved in drying. Hymenium brownish ashy, hypothecium and exciple of darker brownish cells. Paraphyses filiform, numerous, hyaline. Asci cylindrico-clavate. Spores 8, uniseriate, fusiform, 7-11 mic. long and 2-3 mic. wide.

Very common on wood and bark. Summer and autumn.

Coll. Bruce Fink, June 11, 1907. Freda M. Bachman, Oct. 31, 1907, Aug. 7, 1908.

Genus II. TAPESIA Fuck. Symb. Mycol. 300. 1869.

Type species Tapesia anomala (Pers.) Fuck.

Mycelium superficial, more or less tomentose, white, yellow, red, or dark brown. Apothecia waxy, becoming somewhat coriaceous, sessile, rarely substipitate. exterior glabrous; scaly or hairy, concave, then more or less plane, small. Paraphyses filiform. Asci elongate, cylindrico-clavate often somewhat acute at the ends. Spores 8, oblong, ovate, cylindrical or fusiform, hyaline.

Growing on decaying wood, seldom on stems.

Distinguished from Mollisia by the superficial mycelium.

+*Tapesia cinerella* Rehm Disco. 575. 1891.

Mycelium delicate, radiating, thin. Apothecia scattered or in groups, at first somewhat globose, sessile, 1-3 mm. broad, interior pale grayish, edge paler, exterior dark. Hymenium and hypothecium and central part of cup almost colorless, outer cells darker. Paraphyses filiform. Asci cylindrical. Spores oblong, simple, hyaline, 5-8 mic. long and 3-4 mic. wide.

Found on decaying wood. Saccardo gives the spore measurements 10-12 mic. long and 3-5 mic. wide and the color of the disc as ashy or yellowish.

Coll. Bruce Fink, May 3, 1908.

+*Tapesia lividofusca* (Fr.) Rehm Disco. 576. 1892.

Peziza lividofusca Fr. Sys. Mycol. 2: 147. 1822.

Mycelium delicate, not abundant, most apparent when the apothecia are dry. Apothecia lobed, sessile, spreading, 2-3 mm. broad, at first cup shaped, interior pale brownish-ashy, exterior black. Hymenium colorless, hypothecium hyaline, exciple black. Paraphyses few, very slender. Asci cylindrico-clavate narrowed toward the ends. Spores fusiform, 7-10 mic. long and 3-4 mic. wide.

Growing on old or rotting wood. Probably common.

Coll. Freda M. Bachman, Nov. 3, 1907, Aug. 7, 1908.

Genus III. PEZIZELLA Fuck. Symb. Mycol. 299. 1869.

Type species, Pezizella sordida Fuck.

Mycelium within the substratum. Apothecia waxy-membranaceous, sessile, somewhat hemispherical, becoming plane, glabrous, pallid, very small. Paraphyses filiform, hyaline. Asci cylindrical or cylindrico-clavate. Spores 8, oblong, fusiform or ellipsoid, simple, hyaline.

Growing on decaying wood stems or leaves.

KEY TO SPECIES.

a — Apothecia 1 mm. or more broad.
    b — Apothecia white ....hyalina
    b — Apothecia yellowish ....xylita
a — Apothecia less than 1 mm. broad.
    b — Pale yellow and growing on stems.......................dilutella
    b — Olivaceous and growing on leaves...............hyalinosulfurea

+*Pezizella dilutella* (Fr.) Fuck. Symb. Mycol. 300. 1869.

Peziza dilutella Fr. Sys. Mycol. 2: 147. 1822.

Apothecia in groups, minute, 60-120 mic. broad, cup-shaped then plane, very pale yellow. Hymenium and hypothecium almost colorless, exciple darker. Paraphyses filiform and about half the width of the asci. Asci cylindrico-clavate. Spores rod-like or very slightly curved, hyaline, simple, smooth, 7-10 mic. long and 1.5 mic. wide.

Found growing on old stems in very damp woods.

Coll. Freda M. Bachman, Oct. 30, 1907.

Pezizella hyalina (Pers.) Rehm Rabenh. Krypt. Fl. 1^{3}:653. 1896.

Apothecia in groups, 1-2 mm. broad, white, almost sessile, exterior villous, hairs, hyaline and minute. All parts of the cup hyaline in microscopic section. Paraphyses filiform, slender, few. Asci cylindrico-clavate. Spores simple, hyaline, 8-10 mic. long and 2-3 mic. wide, oblong-elliptic or slightly fusiform.

Growing on rotting wood.

Coll. Bruce Fink, May 25, 1908.

+*Pezizella hyalinosulfurea* Rehm. n. sp.

Apothecia in superiore folii pagina dispersa, sessilia, primitus globoso-clausa, dein patellaria, disco plano tenuissime marginato, extus glabra, versus basim augustata, hyalino-sulfurea, 200-250 μ. diam., excipulo pseudoparenchymatice contexto, ad marginem cellulis $8/1.5\mu$ elongatis obtuse, fimbriato, sicca citrinula, concava. Asci clavati, apice rotundati, 25-30/5-6 μ, $J+$, 8 spori. Sporae oblongae, rectae, utrinque rotundatae, 1 cellulares, hyalinae 5-7/2-2.5 μ, distichae. Paraphyses filiformes, hyalinae 2 μ cr.

Ad folium Fagi putridum. Oxford, O., U. S. A.

2/1907, leg. Freda M. Bachman.

+*Pezizella xylita* (Karst.) Rehm Disco. 656. 1892.

Peziza xylita Karst. Mon. Pez. 190. 1869.

Apothecia caespitose or scattered, 2-3 mm. broad, interior pallid or yellowish, exterior darker, sessile. Hymenium and hypothecium pallid, outer cells of the cup brownish. Paraphyses filiform, filled with granules. Asci cylindrico-clavate. Spores fusiform, 7-10 mic. long and 3-4 mic. wide, guttulate.

Karsten says the spores are ovoid-oblong or somewhat needle-like and 4-7 mic. long and 1.5-2 mic. wide.

Growing on old wood.

Coll. Freda M. Bachman, Nov. 3, 1907. Bruce Fink, May 30, 1908.

Genus IV. ORBILIA Fr. Sum. Veg. Scand. 357. 1849.

Type species, Orbilia xanthostigma Fr. Sys. Mycol. 146. 1822.

Mycelium usually entirely within the substratum. Apothecia subgelatinous, becoming more or less plane, sessile or sometimes very shortly stipitate, glabrous, small, reddish or yellowish, somewhat translucent. Paraphyses simple or branched at the base, the ends clavate, globose, flattened or covered with a mucilaginous epithecium. Asci cylindrico-clavate. Spores 8, small, ovoid, filiform, fusiform or spherical, simple.

Growing on wood or other decaying plant material.

KEY TO SPECIES.

a — Mycelium partially above the substratum..................auricolor
a — Mycelium wholly within the substratum.
  b — Spores spherical ....coccinella
  b — Spores linear or oblong.
    c — Spores 4-5 mic. long..........................xanthostigma
    c — Spores 10-14 mic. long..............................vinosa

Orbilia vinosa (Alb. & Schw.) Karst. Myc. Fenn. 101. 1871.

Peziza vinosa Alb. & Schw. Consp. Fung. 308. 1805.

Apothecia scattered or in groups, shortly stipitate, 1-2.5 mm. broad, funnel-shaped then plane, externally smooth, interior and exterior bright red; subgelatinous. Stipe about 1 mm. long, stout. Hymenium pinkish-yellow, hypothecium and exciple pale gray. Paraphyses enlarged at the ends, often globose. Spores needle-like, 10-14 mic. long and 1 mic. wide, hyaline.

Common on old wood and the inside of bark.

Coll. Freda M. Bachman, Oct. 30, 1907. L. O. Overholts, May 2, 1908. Bruce Fink, Aug. 7, 1908.

+*Orbilia coccinella* Fr. Sum. Veg. Scand. 357. 1849.

Apothecia scattered or in groups, subsessile, 1-2 mm. broad, funnel-shaped, then plane, interior and exterior dingy yellowish-red changing to brick-red when dry; subgelatinous. Hymenium, hypothecium and exciple pale yellow. Paraphyses slender, hyaline, with globose ends. Spores spherical, smooth, uniseriate, 2-3 mic. in diameter.

Common on old logs, etc.

Coll. Freda M. Bachman, Nov. 3, 1907, July 4, 1908, Aug. 6, 1908.

Orbilia xanthostigma Fr. Sys. Mycol. 146. 1822.

Apothecia scattered or caespitose, 1-3 mm. broad, becoming plane, exterior and interior reddish when growing, reddish yellow when dry, subsessile. Hymenium, hypothecium and exciple hyaline. Paraphyses slender, ends globose. Spores elliptic, hyaline, 3-4 mic. long and 1.5 mic. wide.

Growing on old logs, etc.

Coll. Bruce Fink, June 6, 1908. Freda M. Bachman, July 4, 1908.

+*Orbilia auricolor* (B. & Br.) Sacc. Syl. Fung. 8: 625. 1889.

Peziza auricolor B. & Br. Ann. & Mag. Nat. Hist. III. 15. No. 90. 1865.

Apothecia attached to the substratum by numerous white septate hyphae which later become brown. Apothecia scattered or crowded, sessile, becoming plane, interior and exterior yellowish or reddish-yellow, 1.5-3 mm. broad. Hymenium and hypothecium hyaline, outer cells of the exciple somewhat dark. Paraphyses slender, the ends flattened as a nail. Asci clavate. Spores fusiform or oblong, 4-5 mic. long and 1-1.5 mic. wide.

Growing on decaying wood.

Coll. G. D. Smith, Freda M. Bachman, Aug. 5, 1908.

Family VI. PATELLARIACEAE.

Mycelium wholly within the substratum. Apothecia leathery or horny, superficial or at first immersed, dark-colored, usually small. Exciple and hypothecium well-developed. Paraphyses more or less adherent near the ends.

KEY TO GENERA.

a — Spores simple or two-celled.
  b — Spores simple ....Patinella
  b — Spores two-celled ....Karschia
a — Spores several celled.
  b — Spores 24-33 mic. long.............................Durella
  b — Spores 46-56 mic. long.............................Patellaria

Genus I. KARSCHIA Körb. Parerg. Lich. 459. 1865.

Type species, Karschia talcophila (Ach.) Körb.

Apothecia coriaceous, sessile, superficial or slightly erumpent, disc round, plane, becoming more or less convex, very dark or black, small. Paraphyses thickened near the ends and united into a gelatinous epithecium. Asci clavate. Spores 8, ovate-oblong, or oblong-elliptic, two-celled, somewhat constricted at the septum, at first hyaline, then brown or brownish.

The apothecia appear like those of the lichen genus Lecidea. Körber says the paraphyses are branched.

Growing on decaying wood and stems.

Karschia lignyota (Fr.) Sacc. Syl. Fung. 8: 779. 1889.

Patellea lignyota Fr. Sys. Mycol. 2: 150. 1822.

Apothecia usually in groups, minute, black, sessile, edge uneven or crenulate. Hymenium olivaceous, hypothecium almost hyaline, exciple black. Paraphyses slightly enlarged at the ends, rather stout. Asci broadly clavate. Spores crowded in the ascus, brownish, oblong-elliptic, 9-11 mic. long and 4 mic. wide, often breaking apart at the septum.

Very common on old wood.

Coll. Freda M. Bachman, Nov. 22, 1907.

Genus II. DURELLA Tul. Select. Fung. Carp. 3:177. 1865.

Type species, Peziza compressa Pers.

Apothecia tough-coriaceous, twisted when dry, subsuperficial, sessile, somewhat concave, black or olivaceous. Paraphyses hyaline and somewhat branched near the ends. Asci clavate, shortly attenuated at the base. Spores 8, oblong or elliptic, colorless or very rarely dark, 4-6 celled, somewhat constricted at the septa.

Growing on decaying wood and stems.

Durella clavispora (B & Br.) Sacc. Syl. Fung. 8:794. 1889.

Patellaria clavispora B. & Br. Ann. & Mag. Nat. Hist. II. 13:465. no. 774.

Apothecia in groups 1-1.5 mm. broad, black, sessile, plane or somewhat convex. Hymenium hyaline except near the ends of the paraphyses, hypothecium, exciple and the ends of the paraphyses dark green. Paraphyses sometimes branched at the ends. Asci clavate. Spores hyaline, clavate, curved, 8-9 celled, usually a single large oil globule in each cell, 24-33 mic. long and 7-9 mic. wide.

On old wood and stems. Probably common.

Coll. Freda M. Bachman, Oct. 23, 1907. Bruce Fink, March 31, 1908, Aug. 11, 1908.

Genus III. PATELLARIA Fr. Sys. Orb. Veg. 113. 1825.

Type species, Patellaria atrata Fr.

Apothecia coriaceous, blackish, sessile, small, circular or elongated, plane then slightly convex, superficial. Paraphyses granular, colored near the ends, somewhat adherent forming a dark epithecium. Asci clavate. Spores 8, fusiform, often clavate and curved, 4 or more celled.

Patellaria atrata (Hedw.) Fr. Sys. Orb. Veg. 114. 1825.

Lichen atratus Hedw. Desc. Spec. Mus. Frond. 2:61. pl. 21. f. a. 1789.

Apothecia usually in groups 1-1.5 mm. broad, black, sessile, somewhat elongated. Hymenium hyaline except at the ends of the paraphyses, the hypothecium, exciple and ends of the paraphyses dark green. Paraphyses sometimes branched near the ends, granular. Asci clavate, attenuated at the base and somewhat smaller at the ends. Spores clavate and curved, containing 6-10 large oil globules, 7-10 septate, 46-56 mic. long and 10-11 mic. wide.

Probably very common on decaying wood and stems.

Coll. Freda M. Bachman,, Oct. 31, 1907.

Genus IV. PATINELLA Sacc. Grev. 4:22. 1875.

Type species, Patinella hyalophaea Sacc.

Apothecia plane or somewhat concave, sessile, blackish or dark colored, somewhat horny. Ends of the paraphyses slightly enlarged or equal. Asci cylindrical. Spores 8, ellipsoid or oblong, rarely globose, simple, hyaline.

+*Patinella olivacea* Sacc. Syl. Fung. 8:770. 1889.

Peziza olivacea Batsch Elench. 127. f. 51. 1786.

Apothecia solitary or in groups, 3-7 mm. broad, interior and exterior dark olivaceous, edge paler but greenish, sessile, attached to the substratum by many brownish, septate, simple rhizoids, exterior somewhat roughened. Hymenium light olivaceous, hypothecium more brown, exciple of vesiculose brownish cells, larger and somewhat polygonal near the outside. Paraphyses sometimes branched, hyaline, ends surrounded with a green gelatinous substance. Asci cylindrical. Spores arranged end to end, containing two oil globules, hyaline, later becoming brownish, simple, oblong, 8-10 mic. long and 4 mic. wide.

Very common on rotting logs.

Coll. Freda M. Bachman, June 27, 1908, Aug. 11, 1908. Bruce Fink, Aug. 12, 1908.

Family VII. CENANGIACEAE.

Mycelium within the substratum. Apothecia leathery, waxy or gelatinous, at first more or less immersed then superficial, often enclosed within a membrane at first.

KEY TO GENERA.

a — Apothecia leathery, dark .... Urnula
a — Apothecia gelatinous .... Sarcosoma

Genus I. URNULA Fr. Sum. Veg. Scand. 364. 1849.

Type species, Urnula craterium (Schw.) Fr.

Apothecia leathery, tough, stipitate, urnshaped, exterior dark, furfuraceous or pubescent, interior dark, at first closed later opening by a round or irregular aperture. Stipe stout and about equal in length with the cup. Asci cylindrical. Spores 8, oblong, hyaline.

Distinct from Sarcoscypha in color and villous stipe.

Urnula craterium (Schw.) Fr. Nov. Symb. 106. 1851.

Peziza craterium Schw. Syn. Fung. Carol. no. 1175. pl. 1. f. 7-11. 1822.

Apothecia solitary or caespitose, 3-5 cm. broad and 5-8 cm. high, interior brown to dark purplish brown, exterior dark brown, somewhat scaly and covered with dark brown appressed hairs, edge involute and jagged caused by the irregular rupture of the cup. Hymenium brown, outer part of the exciple very dark brown. Paraphyses hyaline, septate, branched, numerous. Asci very long, curved near the ends, cylindrical. Spores uniseriate, guttulate, granular, 26-29 mic. long and 10 mic. wide.

Growing on the ground or on buried sticks. Spring.

Coll. Bruce and H. W. Fink, Mch. 16, 1908. Freda M. Bachman, Apr. 11, 1908.

Genus II. SARCOSOMA Casp. in Rabenh. Krypt. Fl. 1^3:497. 1891.

Type species, Sarcosona globosum (Schmid.) Rehm.

Apothecia gelatinous, large, spherical, becoming more or less plane, exterior brown, interior paler. Paraphyses linear, much branched, scarcely thickened at the apices. Asci long, operculate. Spores elliptic 8, with or without oil globules, nearly hyaline.

Growing on decaying leaves, sticks, etc.

Sarcosoma rufa (Schw.) Rehm in Raben. Krypt. Fl. 1^3:497. 1891.

Bulgaria rufa Schw. Syn. N. Am. Fung. 178. 1834.

Apothecia solitary or caespitose, 3-6 cm. broad, stipitate, exterior dark, almost black, interior very light brown, concave, becoming plane. Stipe 1-2 cm. long. Hymenium pale or slightly tinged with brown, hypothecium brownish, central portion hyaline outer cells dark brown. Paraphyses slender, filiform. Asci cylindrical. Spores hyaline, ellipsoid, 15-20 mic. long and 8-10 mic. wide.

Growing on partly buried sticks in the woods.

Coll. Bruce Fink, W. G. Stover, Freda M. Bachman, July 19, 1907. Bruce Fink, W. G. Stover, June 22, 1908. Freda M. Bachman, Aug. 6, 1908.

Order III. HELVELLALES.

Mycelium within the substratum. Receptacle sessile or stipitate, upper portion pileate, mitrate or clavate. Hymenium on the upper surface and exposed from the first. Fleshy or waxy, rarely gelatinous.

Family I. HELVELLACEAE.

Receptacle fleshy, stipitate, pileate or mitrate. Asci opening by opercula.

KEY TO GENERA.

a — Pileus more or less deeply pitted........................Morchella
a — Pileus more or less lobed................................Helvella

Genus I. MORCHELLA (Dill.) Pers. Sym. Meth. Fung. 618. 1801.

Type species, Morchella esculenta (L.) Pers.

Mycelium within the substratum. Ascophore composed of pileus and stipe, 7-24 cm. high. Pileus wholly adnate to the stipe or partially free, clavate, globose or conical, irregularly and more or less deeply pitted by the prominent anastomosing ribs, gray or brownish. Stipe hollow, bulbous near the base or cylindrical throughout, narrowed at the base, granular or smooth, even or ribbed, white or light colored, interior more or less papillate or granular. Paraphyses colorless often stout. Asci cylindrical, long. Spores hyaline 8, smooth, elliptic or oblong- elliptic.

Growing on the ground in spring. Edible.

KEY TO SPECIES.

a — Pileus partially free from the stipe. .... semilibera
a — Pileus attached to stipe.
  b — Stipe granular .... crassipes
  b — Stipe not granular.
    c — Pileus rounded .... esculenta
    c — Pileus conical .... esculentaconica

Morchella esculenta (L.) Pers. Syn. Fung. 618. 1801.

Phallus esculenta L. Sp. Pl. 4: 1178. 1753.

Solitary or in groups, 8-12 cm. high. Stipe frequently bulbous, white, smooth, or granulose, often somewhat wrinkled about equal to the pileus in length, 1.5-2.5 cm. thick. Pileus very irregular in shape, ribs branching in any direction and thick with quite broad edges and these usually white, pits deep, varying in size and shape, brown or brownish-gray. Hymenium and hypothecium almost colorless. Paraphyses filiform, septate, stout. Asci long cylindrical. Spores elliptic, 15-23 mic. long and 8-12 mic wide, hyaline.

Very common on the ground in spring, most often under trees.

Coll. Freda M. Bachman, April 20, 1908. W. G. Stover, April 29, 1908. H. W. Fink, L. O. Overholts, May 2, 1908.

+*Morchella esculenta conica* Fr. Sys. Mycol. 2: 7. 1822.

Pilus conical, pits more or less rectangular and usually quite narrow, ribs extending longitudinally with transverse branches. Spores oval, hyaline, 15-17 mic. long and 9-12 mic. wide.

Very similar to Morchella esculenta (L.) Pers. and found with it.

Coll. Freda M. Bachman, April 18, 1907.

Fries in Sys. Mycol. 2: 7. 1822 gives this as a subspecies of M. esculenta. Boudier in Histoire et Classification de Discomycètes d'Europe gives conica as a distinct species and describes it as having a partially free pileus. It is evident that our plant is the one described by Fries and not the species now often described by Europeans as M. conica.

+*Morchella crassipes* Pers. Syn. Fung. 621. 1801.

Solitary or in groups, 16-24 cm. high. Stipe much larger near the base but constricted just at the base, white or yellowish, very granular, much furrowed, usually somewhat longer than the pileus. Pileus oblong or somewhat conical, the ribs extending in various directions, and quite thick but with thin edges, pits deep, varying in size and shape, yellowish-brown. Hymenium and hypothecium almost colorless. Paraphyses septate, sometimes slightly enlarged upward, stout. Asci cylindrical. Spores oval, hyaline, 22 mic. long and 14 mic. wide.

Growing on the ground in the woods.

Coll. L. O. Overholts, May 2, 1908.

+*Morchella semilibera* De Cand. Fl. Fr. 2: 212. 1805.

Solitary or in groups, 10-15 cm. high. Stipe 10-12 cm. long, narrowed at the base, mealy, fragile, very pale yellow. Pileus bell shaped, 2-3 cm. long, except at the apex free from the stipe, pits shallow and radiating from the apex of the pileus, ribs narrow with few branches. Paraphyses septate, filiform. Asci cylindrical. Spores hyaline, oval, 24 mic. long and 15 mic. wide.

On the ground in rather shady places in spring.

Coll. Bruce Fink, W. G. Stover, May 2, 1907. Freda M. Bachman, April 25, 1908.

Genus II. HELVELLA L. Gen. Pl. 493. 1754.

Type species, Helvella mitra L.

Mycelium within the substratum. Ascophore consisting of stipe and pileus, 3-16 cm. high. Pileus irregular, often lobed, margin often adhering in several places to the stipe, fruiting surface above, glabrous, pruinose or villous beneath, waxy-membranaceous, variously colored. Stipe hollow or stuffed, stout or slender, even, lacunose or ribbed, attached to the pileus at its center. Paraphyses linear, often clavate, hyaline or colored. Asci long, cylindrical. Spores 8, smooth, elliptic or oblong elliptic, hyaline.

Growing in the ground or decaying wood. Most of the species are said to be edible.

Helvella elastica Bull. Champ. 289. pl. 242. 1791-98.

Solitary, about 10 cm. high. Stipe slender, whitish, attenuated upward, even or somewhat ribbed near the base, pruinose or smooth, at first stuffed, later hollow. Pileus saddle-shaped, grayish above, white or whitish beneath, 2-3 cm. broad. Paraphyses septate, ends clavate. Asci cylindrical. Spores containing one large oil globule, broadly elliptic, 18-20 mic. long and 10-12 mic. wide.

Found growing on the ground under trees.

Coll. Freda M. Bachman, May 25, 1908.

Genus III. GYROMITRA Fr. Sum. Veg. Scand. 346. 1849.

Type species, Gyromitra esculenta (Pers.) Fr.

Mycelium within the substratum. Ascophore composed of pileus and stipe. Pileus fleshy, varying in shape, attached to the stipe, more or less inflated, upper surface ribbed, ribs variously branched, hymenium on the outer surface. Paraphyses linear. Asci cylindrical. Spores 8, elliptical, smooth.

Growing on the ground or decayed wood.

Gyromitra brunnea Underwood Proc. Ind. Acad. Sci. for 1893. 33. 1894.

Solitary or in groups, 6-9 cm. high. Stipe stuffed, later hollow, pubescent near the base, smooth above, white or creamy in color, usually larger at the base, 1.5-2 cm. thick. Pileus quite irregular, attached at various points to the stipe, surface convoluted, reddish brown in color, under side almost white and finely pubescent. Hymenium and hypothecium brownish. Paraphyses stout, septate, clavate, sometimes branched, dark brown at the ends. Asci cylindrical. Spores elliptical, containing 1-3 oil globules, hyaline, 20-24 mic. long and 12-14 mic. broad.

Found growing in the ground in the woods.

Coll. Freda M. Bachman, May 2, 1908.

INDEX TO ORDERS, FAMILIES, GENERA AND SPECIES.

Proceedings

of the

Ohio State Academy of Science

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Special Paper No. 15

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume V, Part III. Special Paper No. 15

Trees of Ohio
and
Surrounding Territory

Including the Area Westward to the Limits of the Prairie and South to the Thirty-Seventh Parallel.

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PREFACE.

This manual is intended to aid the amateur botanist and nature student in identifying the trees of Ohio and surrounding territory. There are many books which treat entertainingly of the trees of our region, and these may be of great profit to such as know the plants described. Without such knowledge the reading of popular or scientific descriptions can not be of very much value. The real student desires more especially a first hand acquaintance, and it is hoped that the present volume will be of service to those who wish a direct contact with nature.

The keys have been made very complete so that no difficulty should be encountered in identification except in the case of closely related species. No elaborate technical descriptions have been given but a few brief notes are added in connection with each species, calling attention to economic, ecological, or other data of general interest. Characters given in the keys are usually not repeated in the descriptions.

A single English name is given for each species. These names have been taken mainly from Sudworth's "Check List of the Forest Trees of the United States," which on the whole seems to be a very satisfactory basis for an appropriate list. Synonyms will be found in the index. The nomenclature used is essentially that of Britton's Manual.

Most of our common, cultivated, exotic trees have been included, since these form an integral part of the landscape, in many places more conspicuous than the native species. No attention has been paid to the recent effusive treatment of Crataegus. All the trees known to occur in Ohio have been especially mentioned as such.

The study of trees may be made a pleasant and profitable pastime at any season of the year for all who have an interest in nature. When the tree has once been identified its peculiarities should be learned by direct observation until its individuality becomes perfectly familiar. In winter one can usually find dry leaves or fruit on the trees, which will make it possible to tell most of the species at a time when many think botanical study out of season.

J. H. S.

INTRODUCTION.

A tree many be defined as — a woody plant of any size which produces naturally one main, erect stem with a definite crown of branches. A shrub is a woody plant which produces small irregular or slanting stems usually in tufts. In attempting to separate "trees" from the larger "shrubs," one must necessarily be somewhat arbitrary as nature draws no definite division line.

A tree has three main parts, the root system, the stem or trunk, and the crown of branches. The root system is for support in the soil and for taking up water and various mineral substances. This is accomplished by delicate organs called root hairs developed near the root tips. Although largely dependent on their environment the roots still have considerable selective power in taking up the salts dissolved in the soil water. The root system may have a main or tap-root extending deep into the ground with smaller lateral roots; or the tap-root may be only slightly developed or entirely absent, in which case a number of larger branch roots may extend downward from the base of the trunk. The roots which extend laterally near the surface sometimes run to a great distance. Such roots are called tracing roots.

The trunk or bole is a supporting and conducting organ. The water with dissolved mineral substances taken up by the roots passes up through the young wood or xylem while the food material from the young twigs and leaves passes up or down through the phloem cells of the inner bark. There are no real vessels for carrying food and water like the blood vessels of animals, but the sap passes through by osmosis from one cell to another or from one set of cells to another as it frequently happens when some of the cross walls are broken down in a vertical series of cells. The large cells in the wood, however, are called wood vessels. Just how the water is able to pass up to the tops of high trees is not fully understood. In early spring, as in the sugar maple, the water accumulates in the sap wood since there are no leaves from which it can be thrown off above.

The crown is a system of branches on which the leaves are developed and exposed to the light. In the leaves most of the food is manufactured which the tree uses for its growth and nourishment. This production of organic food is carried on through the agency of sunlight and chlorophyll, as the green coloring matter is called. Another important function of the leaves is the transpiration of the surplus water brought up from below. The water transpired by a large tree in a single day is often very great in amount. The leaves are also important breathing organs, although not exclusively so; for all the living cells in the entire plant carry on the process of respiration.

The system of branching in the crown may be of various types. If the main trunk of a tree extends upward through the crown to the tip it is said to be excurrent, as in the larch and Austrian pine. When the terminal bud has no pre-eminence over others and the main trunk is soon lost, the tree is round-topped or spreading and is said to be deliquescent, as in the apple. Excurrent trees are often spire-shaped like the Norway spruce; while deliquescent stems commonly give rise to dome-shaped crowns, as in the white elm. If the terminal bud withers or is self-pruned, as in the linden, the branching is sympodial. If the leaves are opposite and the two lateral end buds develop, the terminal bud being self-pruned, the result is a sympodial dichotomy, as in the bladdernut. Trees in which the terminal buds are persistent and functional are said to have a monopodial system of branching.

The trunk or any branch of a coniferous or dicotylous tree consists of four main parts, the pith, the wood, the cambium or growing layer, and the bark. The wood consists of a series of annual rings, since if normal growth takes place only a single ring is produced each year. Each ring usually consists of two layers called early wood and late wood. During special seasons or if growth is checked at times during the growing period more than one ring may be produced, although this is never perfect and can usually be detected by careful examination. In most trees the inner part of the wood and the pith are dead and this is called the heart wood or duramen, while the outer wood is lighter in color with living cells next the cambium layer, and is called the sap-wood or alburnum. Sometimes there is a striking difference in the color of the two parts. Strands of cells pass from the pith or annual rings through the wood to the bark. These are called medullary rays. The peculiar qualities of wood are due to the character of its cells which have their walls lignified or thickened by a deposit of a chemical substance called lignin.

The bark usually consists of two main layers called inner bark and outer bark. The inner bark is often in very thin layers and is hence called liber. The outer bark is very diverse in character. Usually it consists mainly of layers of cork cells which are very impervious to water. Since the outer bark usually does not increase in diameter as rapidly as the wood it is finally torn into strips and peels off on the outside. Trees have many interesting ways of developing and getting rid of their outer bark.

More commonly the outer bark is developed as follows: In a young main stem or twig there is a tissue between the outer layer of cells or epidermis and the circle of vascular bundles which is called the cortex. While the stem is developing and hardening, the outermost layer of cortical cells just below the epidermis is modified and begins to grow. This layer is the cork cambium or phellogen. The layer of tissue thus formed by the repeated divisions of the cells of the phellogen is called the periderm or cork. On the inner side of the phellogen another layer of tissue is produced which is called the phelloderm or secondary cortex. The phellogen may continue to produce periderm until the outer bark becomes very thick; and finally new cork cambiums may develop farther in in the cortex or even in the phloem of the inner bark. In some plants the cork cambium originates from the epidermis and in some from the deeper layers of the cortex.

Some trees have no special means of shedding their leaves while others shed them only after a year or more. Most of our indigenous species are "deciduous," that is they cast their leaves at the end of each growing season by the formation of a cleavage plane or separation layer through the base of the petiole. They also prepare for winter by developing elaborate winter buds. The function of the winter buds is mainly to check evaporation from the delicate stem tips during the periods of freezing and thawing.

Many of the smaller branches and twigs of a tree especially when growing in a dense forest are continually dying off. But the tree rids itself of these dead branches by forming a collar of tissue from the cambium layer around the base of the dead branch, which finally covers over the wound when the dead member falls off. This process is known as natural pruning. By the formation of a similar callus other wounds are covered up. There is still a more remarkable process present in many trees by which surplus living branches are cut off in one way or another. Terminal and lateral buds are also commonly cut off. This process is known as self-pruning. The most common method is by the formation of a cleavage plane in a basal joint or in the annual nodes of growth. In some genera brittle zones are produced. The self-pruning process is very highly developed in the cottonwood, white oak, white elm, and silver maple.

Trees grow in height only at the tips of the main stem or branches. Some trees are naturally shortlived; others attain an enormous size and age, but from the very nature of their upright development their life must sooner or later come to an end. In some cases the individual organism may continue by a new development from sprouts growing out of the stump or the roots.

All of our trees bear flowers and seeds. After arriving at a certain age depending on the species, the tips of some twigs or the axillary buds will develop flowers. In the more highly developed and typical flowers four sets of organs are present; the calyx composed of sepals, the corolla composed of petals, the androecium composed of stamens, and the gynoecium composed of carpels. The two essential sets of organs in the flower are the stamens and the carpels. These may both be in the same flower, when the flower is said to be bisporangiate or in separate flowers, when the flower is monosporangiate. If the two kinds of flowers are on one individual the plant is monoecious, if on two distinct individuals the plant is dioecious. The stamens produce microsporangia and the carpels megasporangia or ovules. In the angiosperms the carpel usually has three parts called stigma, style, and ovulary, the ovules being completely inclosed in the ovulary. Commonly all the carpels of the gynoecium are grown together and in such cases a compound ovulary is produced with one or more cavities.

Following a peculiar process known as reduction, which takes place in the cells inside of the microsporangium, a considerable number of microspores are developed, four for each original cell. In nearly the same way, four megaspores one of which survives, are usually produced in each ovule. The flowers are thus modified spore-bearing branches or shoots producing two kinds of nonsexual spores. The flowers are nonsexual organs and the tree itself is always a nonsexual plant called the sporophyte. The microspores germinate and develop into the pollen grains and the megaspores into the so-called embryo sacs, or minute, parasitic, male and female gametophytes respectively. After pollination has taken place, which is simply the transfer of the pollen to the ovules or the stigmas, a tube grows from the pollen grain into the embryo sac. The two sperm cells produced in the pollen grain or in the pollen tube pass down the tube and one unites with the egg cell of the female gametophyte. This union of sperm and egg is called fertilization. The resulting cell which is the oospore germinates and gives rise to an embryo inside of the ovule, the whole finally constituting the body called the seed. This embryo in the seed is the sporophyte and after sprouting develops into the tree. The seed is produced inside of or in connection with the modified carpels and other contiguous parts, the whole being called the fruit. The fruits of our trees are of many types usually with some adaptation for seed distribution, so that the seed with its little embryonic tree inside may be carried away from the parent plants to some other and perhaps more favorable environment. Here, if conditions are proper, it sprouts and begins its life as an independent individual. The whole process of flower, seed, and fruit production is exceedingly complex and requires close study and observation if one would know the more obscure activities going on during the life cycle of a tree.

KEY TO THE GENERA OF TREES IN THE SUMMER CONDITION.

Based mainly on leaf and twig characters. The number following the generic name refers to the list number.

1. Foliage leaves with expanded blades, netted-veined. 8.
1. Foliage leaves needle-shaped, narrowly linear, subulate, or scale-like; conifers. 2.
1. Foliage leaves fan-shaped with dichotomous venation, a number on thick, wart-like, persistent dwarf branches. **Ginkgo.** (1).
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.** (7).
2. Without dwarf branches. 4.
3. Dwarf branches small, self-pruned, with 2-5 foliage leaves. **Pinus.** (2).
3. Dwarf branches thick, wart-like, persistent, with numerous deciduous leaves. **Larix.** (3).
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).
6. Leaves flat, those on the upper side of the twig much shorter than the lateral ones; trees. **Tsuga.** (5).
6. Leaves more or less 4-sided, spreading in all directions. **Picea.** (4).
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.** (8).

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.** (9).

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.** (10).

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8. Leaves alternate. 9.
8. Leaves opposite or whorled. 74.
9. Leaves simple. 10.
9. Leaves compound. 62.
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. 53.
11. Leaves truncate or broadly emarginate; with complete stipular rings at the nodes. **Lirodendron.** (33).
11. Leaves entire. 12.
11. Leaves serrate, dentate, crenate, pinnatifid, or variously lobed. 25.
12. With stipular rings at each leaf node; leaves large. **Magnolia.** (32).
12. Not with stipular rings. 13.
13. With thorns and milky sap. 14.
13. Without thorns; sap not milky. 15.
14. With thorns beside the axillary buds; leaves not tapering at the base, acute or even heart-shaped. **Toxylon.** (27).
14. With terminal thorns and some axillary thorns; leaves tapering to the base; narrow or slender-cuneate. **Bumelia.** (65).

15. Leaves evergreen, coriaceous, some on wood of the previous season. 16.
15. No leaves on wood of the previous season. 17.
16. Leaves green on both sides, thick, coriaceous, oblong to oblanceolate, 5-10 in. long; winter buds very scaly. **Rhododendron.** (62).
16. Leaves green on both sides, or glaucous beneath, coriaceous, 2-5 in. long; oval or oval-lanceolate, winter buds naked. **Kalmia.** (63).
17. Pith with prominent diaphragms but solid; vascular bundles in base of petiole 3-7. 18.
17. Pith not both diaphragmed and solid, but sometimes with lenticular cavities. 19.
18. Leaves 2-ranked; bark with fetid odor; vascular bundles in base of petiole 5-7. **Asimina.** (31).
18. Leaves not 2-ranked; vascular bundles in base of petiole 3. **Nyssa.** (76).
19. Leaves resin-dotted, waxy-dotted or punctate, oblong-lanceolate, spatulate, or oblanceolate, short-pointed, narrowed at the base. **Myrica.** (13).
19. Leaves not dotted nor punctate. 20.
20. Pith prominently 5-angled; leaves with deciduous stipules and with bristle tips. **Quercus.** (22).
20. Pith cylindrical or nearly so; leaves not bristle-tipped. 21.
21. Leaves with the upper 2 lateral veins more or less parallel with the midrib. **Cornus.** (75).
21. Leaves pinnately veined to the tip. 22.
22. Bundle scar central; pith sometimes diaphragmed with lenticular cavities. 23.
22. Bundle scars 2 or more; pith without lenticular cavities. 24.
23. Leaves truncate or short-pointed at the base, usually widest below the middle or somewhat oblong, glabrous when mature; fruit a large pulpy berry, very astringent when green. **Diospyros.** (66).

23. Leaves pointed at the base, widest above the middle, lower surface pubescent; fruit a nut-like drupe. **Symplocos.** (67).
24. With prominent deciduous stipules; bark not resinous. **Cydonia.** (39).
24. Without stipules; bark resinous, aromatic. **Cotinus.** (53).

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25. Lateral veins from the midrib straight and parallel or nearly so; some or all lateral veins usually ending in the serrations, teeth or lobes. 26.
25. Lateral veins not straight and parallel. 37.
26. Leaves not 2-ranked. 27.
26. Leaves quite regularly 2-ranked, that is with the third leaf over the first. 30.
27. Pith 3-angled, buds stalked. **Alnus.** (19).
27. Pith 5-angled, buds not stalked. 28.
27. Pith cylindrical or nearly so. 29.
28. 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.** (22).
28. Leaves with sharply acuminate teeth; buds not clustered at the tip; nuts with a prickly or spiny involucre. **Castanea.** (21).
29. Usually with prominent and typical lateral thorns; carpels of the pome bony. **Crataegus.** (41).
29. 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.** (38).
29. Without thorns; leaves serrate or serrate-dentate; pome berry-like, carpels not bony. **Amelanchier.** (40).
30. Leaves decidedly inequilateral at the base. 31.
30. Leaves not inequilateral or only very slightly so. 32.
31. Axillary buds prominently stalked; leaves repand-dentate. **Hamamelis.** (29).

31. Buds sessile; leaves doubly serrate; bark not scaling off in plates. **Ulmus.** (23).
31. Buds sessile; leaves serrate; bark scaling off in plates like in the Sycamore. **Planera.** (24).
32. Lateral veins ending in the large dentations or serrations which are always simple (a vein for each). 33.
32. 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. 34.
33. Leaves ovate or ovate-oblong, short acuminate; teeth not with slender points; bark smooth, light-gray. **Fagus.** (20).
33. Leaves oblong-lanceolate, acuminate, with slender often inwardly curved points on the serrations; bark rough. **Castanea.** (21).
34. Lateral veins not ending in the serrations or teeth. **Amelanchier.** (40).
34. Lateral veins ending in some of the serrations, teeth or lobes. 35.
35. Bark smooth, the trunk and larger branches with fluted or projecting ridges; leaves acute or acuminate, sharply doubly serrate; nuts small, in a large-bracted catkin. **Carpinus.** (16).
35. Trunk and larger branches not with fluted or projecting ridges. 36.
36. Bark of trunk and larger branches separating into papery or leathery sheets; trees or shrubs with glabrous, pubescent, or glandular-warty twigs. **Betula.** (18).
36. Bark of trunk scaly, fine furrowed; twigs pubescent; carpellate catkin in fruit appearing like that of the hop. **Ostrya.** (17).
36. Bark scaling off in plates like in the Sycamore; fruit coriaceous, nut-like. **Planera.** (24).

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37. Leaves 2-ranked. 38.
37. Leaves not 2-ranked. 39.

38. 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.** (18).

38. Bark not in papery or leathery sheets; leaves not doubly serrate, the lateral veins not ending directly in the serrations or teeth. **Amelanchier.** (40).

39. Leaves not with spines. 40.

39. Leaves evergreen, with spine-tipped lobes. **Ilex.** (54).

40. Pith not solid, diaphragmed, with lenticular cavities. 41.

40. Pith solid but with prominent diaphragms; vascular bundles 3 in the base of the petiole. **Nyssa.** (76).

40. Pith solid, without diaphragms. 42.

41. Leaves oval or obovate, serrate or denticulate, abruptly acuminate, wedge-shaped at the base, more or less stellate pubescent beneath; bark of twigs peeling off in slender shreds; fruit 4-winged. **Mohrodendron.** (68).

41. Leaves oblong or slightly obovate, acute or acuminate at both ends, crenate-serrate or repand, short petioled; twigs of the season and lower surface of leaves pubescent, not stellate; fruit a nut-like drupe. **Symplocos.** (67).

42. Leaves with peltate scales, or resin-dotted, oblanceolate or wedge-lanceolate. **Myrica.** (13).

42. Leaves not peltate scaly, nor resin-dotted. 43.

43. Outer bud scales of winter buds more than 1. 44.

43. 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.** (12).

44. Pith decidedly 5-angled. 45.

44. Pith cylindrical or nearly so. 46.

45. Bundle scars 3; leaves with gland-tipped teeth, usually broad-based, usually with 2 prominent glands at the base of the blade. **Populus.** (11).

45. Bundle scars several, scattered; leaves without glands; buds clustered at the tip of the twig. **Quercus.** (22).

46. With stipules or stipular scars. 47.
46. Without stipules or stipular scars; leaves sour, with prominent scattered hairs on the midrib beneath; trees; fruit a capsule. **Oxydendrum.** (64).
47. With typical lateral thorns; fruit a drupe-like pome with bony ripe carpels. **Crataegus.** (41).
47. Not with typical lateral thorns, but some may have thorn-like stunted branches. 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. 49.
48. Leaves not with distinct glands on the top of the petiole nor at the base of the blade, but they may be glandular-hairy. 50.
49. 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; fruit a velvety drupe. **Amygdalus.** (43).
49. Glands various; twigs not red and green, some with cleavage planes in basal joints; terminal bud present or absent, fruit a smooth drupe. **Prunus.** (42).
50. Axillary buds usually superposed; leaves lanceolate or oblong-lanceolate, tapering towards the short petiole; fruit a berry-like drupe. **Ilex.** (54).
50. Axillary buds not superposed. 51.
51. 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.** (60).
51. Leaves not with gland-tipped serrations, or if so then not as above; terminal bud present; fruit a pome. 52.
52. Leaves sharply and regularly serrate, glabrous when mature, petioles long; pome with grit cells. **Pyrus.** (37).
52. Leaves irregularly dentate or serrate, or more or less lobed; pome without grit cells. **Malus.** (38).

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53. Base of petiole covering the axillary bud; twigs with stipular rings. **Platanus.** (31).
53. Axillary buds usually evident; twigs without stipular rings. 54.
54. Leaves 2-ranked. 55.
54. Leaves not 2-ranked. 60.
55. Leaves entire, round-heart-shaped. **Cercis.** (44).
55. Leaves serrate, dentate, or lobed. 56.
56. Pith usually in transverse plates; leaves ovate-lanceolate, inequilateral, taper-pointed. **Celtis.** (25).
56. Pith solid, not diaphragmed. 57.
57. With milky sap. 58.
57. Without milky sap. 59.
58. Twigs gray or brown, glabrous or nearly so; leaves pubescent or glabrous beneath. **Morus.** (26).
58. Twigs grayish-green, downy; leaves tomentose beneath. **Broussonetia.** (28).
59. Leaves not inequilateral; vascular bundles in base of petiole 3. **Betula.** (18).
59. Leaves inequilateral at the base; vascular bundles in base of petiole several, scattered. **Tilia.** (61).
60. Leaves more or less star-shaped, with 3-7 long pointed serrate lobes, strongly aromatic when crushed; pith 5-angled. **Liquidambar.** (30).
60. Leaves entire or three-lobed, bark spicy-aromatic; internodes very unequal. **Sassafras.** (35).
60. Leaves crenate, serrate, dentate, or lobed, not star-shaped and not spicy-aromatic. 61.
61. Pith 5-angled; trees usually with resinous buds; leaves usually broad based. **Populus.** (11).
61. Pith cylindrical or nearly so; usually with prominent typical thorns. **Crataegus.** (41).

—62—

62. Pith diaphragmed, with cavities; large trees with pinnate leaves. **Juglans.** (14).

62. Pith not diaphragmed. 63.
63. Leaves trifoliate or odd-pinnate. 64.
63. Leaves evenly pinnate or bipinnate; axillary buds superposed. 73.
63. Leaves odd-bipinnate, serrate; twigs and leaves usually prickly. **Aralia.** (74).
64. Lobes or teeth at the base of the leaflets with prominent green glands beneath; leaves pinnate, very large with disagreeable odor. **Ailanthus.** (51).
64. Lobes or teeth if present without green glands. 65.
65. With stipular spines a pair for each leaf; leaflets mostly entire. 66.
65. Without stipular spines, but some may have thorns or prickles. 67.
66. Leaflets oval or ovate, not pointed, usually mucronate, not punctate. **Robinia.** (48).
66. Leaflets ovate, pointed, glandular-punctate. **Xanthoxylum.** (49).
67. Base of petiole covering the axillary buds; not prickly. 68.
67. Base of petiole not covering the axillary buds. 70.
68. Leaves 3-foliate, leaflets crenulate, glandular punctate; bark with disagreeable odor; axillary buds superposed. **Ptelea.** (50).
68. Leaves pinnate, not punctate. 69.
69. Leaflets serrate; pith very large; bark resinous or milky. **Rhus.** (52).
69. Leaflets entire; pith small, bark not resinous or milky. **Cladrastis.** (47).
70. Leaflets entire or if occasionally few-toothed then the rachis prominently winged. 71.
70. Leaflets serrate or dentate, the rachis not winged. 72.
71. Leaflets decidedly inequilateral, obliquely lanceolate or falcate, acuminate. **Sapindus.** (59).
71. Leaflets not inequilateral or only slightly so, not slender falcate, sometimes poisonous to the touch. **Rhus.** (52).

72. Pith 5-angled; stipules none, base of petiole with numerous vascular bundles, scattered or in 3 areas. **Hicoria.** (15).
72. Pith cylindrical or nearly so; leaves with stipules; vascular bundles in base of petiole 3-5. **Sorbus.** (36).
73. Pith small; base of petiole covering the axillary buds; usually with prominent thorns. **Gleditsia.** (45).
73. Pith very large, base of petiole not covering the axillary buds; without thorns. **Gymnocladus.** (46).

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74. Leaves simple. 78.
74. Leaves compound. 75.
75. Leaves digitate with 5 or more leaflets. **Aesculus.** (58).
75. Leaves trifoliate or pinnate. 76.
76. Base of petiole covering the axillary buds; leaflets dentate, lobed, or nearly entire. **Acer.** (57).
76. Base of petiole not covering the axillary buds. 77.
77. Leaves trifoliate; bark with strong odor; terminal bud self-pruned. **Staphylea.** (56).
77. Leaflets 5-13; terminal bud present. **Fraxinus.** (69).
78. Leaves pinnately veined. 82.
78. Leaves palmately veined or at least with 2 prominent side ribs from the base. 79.
79. Leaves entire or if somewhat 3-lobed with entire margin. 80.
79. Leaves serrate, crenate, dentate or variously lobed. 81.
80. Pith diaphragmed, or with large cavities; petioles usually hollow; axillary buds superposed. **Paulownia.** (72).
80. Pith and petioles solid; axillary buds not superposed; under side of leaves with glands in the axils of the larger veins. **Catalpa.** (73).
81. Leaves more or less lobed; fruit a 2-winged samara. **Acer.** (57).
81. Leaves not lobed; fruit a drupe. **Rhamnus.** (60).
82. Leaves serrate, dentate, crenate, or variously lobed. 83.
82. Leaves entire. 85.

83. Bark of ripe twigs green, bundles scar or vascular bundle in base of petiole 1; pith rhombic. **Euonymus.** (55).
83. Bark of ripe twigs gray, brown, or red; pith cylindrical or nearly so. 84.
84. Axillary buds sometimes superposed; leaves finely denticulate; twigs light brown, sometimes thorny; drupe narrowly oblong. **Adelia.** (70).
84. Axillary buds not superposed; twigs not 4-angled, brown; flowers epigynous; fruit a fleshy drupe; vascular bundles in the base of the petiole 3. **Viburnum.** (77).
84. Axillary buds not superposed; leaves serrate with stipules, small; bundle scar central; twigs brown, sometimes with thorns; shrub-like trees with drupe-like berries. **Rhamnus.** (60).
85. Leaves coriaceous, evergreen, hence on wood of the previous season. **Kalmia.** (63).
85. Leaves deciduous each year. 86.
86. Leaves with the two outer lateral veins more or less parallel with the midrib; fruit a drupe. **Cornus.** (75).
86. Leaves pinnately veined to the tip, 3-6 in. long, fruit an oblong drupe. **Chionanthus.** (71).

KEY TO THE GENERA OF TREES IN THE WINTER CONDITION.

Based mainly on twig and stem characters. The number following the genric name refers to the list number.

1. Foliage leaves persistent and usually evergreen. 2.
1. Foliage leaves deciduous each year. 11.
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.** (2).
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.** (6).
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.** (5).
6. Leaves more or less 4-sided, spreading in all directions. **Picea.** (4).
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.** (8).
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.** (9).
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.** (10).

8. Leaves with spine-tipped lobes or teeth. **Ilex.** (54).
8. Leaves without spines. 9.
9. Leaves pubescent at least below, lanceolate, mucronate, not evergreen; buds clustered at the tip of the twig; trees with 5-angled pith. **Quercus.** (22).
9. Leaves glabrous. 10.
10. Leaves green on both sides, thick, coriaceous, oblong to oblanceolate, 5-10 in. long; winter buds very scaly. **Rhododendron.** (62).
10. Leaves green on both sides or glaucous beneath, coriaceous, 2-5 in. long, oval to oval-lanceolate; winter buds naked; erect shrubs. **Kalmia.** (63).

—11—

11. Twigs with thick wart-like dwarf branches; conifers. 12.
11. Twigs without true dwarf branches. 13.
12. Young twigs covered with scales. **Larix.** (3).
12. Twigs without scales. **Ginkgo.** (1).
13. Twigs with numerous small scattered self-pruning scars, without apparent leaf scars but with minute dry scale leaves, with feather-like dwarf branches, some usually remaining in winter; foliage leaves spreading into two ranks; roots often with knees; a conifer. **Taxodium.** (7).
13. Twigs with evident leaf scars and lateral winter buds. 14.
14. Leaf scars alternate. 15.
14. Leaf scars opposite or whorled. 72.
15. Twigs with distinct and complete stipular ridges or rings at the leaf nodes. 16.
15. Twigs without complete stipular rings. 18.
16. Leaf scar surrounding the axillary bud, terminal bud self-pruned; wood with prominent medullary rays. **Platanus.** (31).

16. Leaf scar not surrounding the axillary bud, terminal bud not self-pruned; buds enclosed in the large connate stipules. 17.
17. Buds glabrous; twigs brown; pith diaphragmed; leaf scars oval or circular; bark spicy-aromatic. **Liriodendron.** (33).
17. 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.** (32).
18. With thorns, prickles, or spines; or with spur-like branches ending in thorns. 19.
18. Without thorns, prickles or spines, but some may have thorn-like stunted branches. 26.
19. With stipular spines, a pair for each leaf scar. 20.
19. Twigs with typical lateral thorns, without terminal thorns. 21.
19. With thorns at the ends of branches or with spur-like branches ending in thorns, and in addition axillary thorns may be present. 22.
19. Stems or twigs with prickles; leaf scar extending nearly around the stem, with about 20 bundle scars; pith large. **Aralia.** (74).
20. Leaf scar covering the two or more superposed axillary buds. **Robinia.** (48).
20. Leaf scar below the axillary buds; buds reddish, pubescent. **Xanthoxylum.** (49).
21. 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.** (27).
21. 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.** (41).
21. Thorns commonly branched, situated above the axil of the leaf; leaf scar covering the two or more superposed axillary buds; twigs polished, often zigzag. **Gleditsia.** (45).

22. Not with three distinct bundle scars. 23.
22. With three bundle scars. 24.
23. Buds and twigs glabrous or nearly so; with few thorns. **Rhamnus.** (60).
23. Buds and sometimes twigs pubescent or downy; thorns prominent. **Bumelia.** (65).
24. Terminal bud self-pruned; twigs some shade of black, brown, or reddish. **Prunus.** (42).
24. Terminal bud present. 25.
25. 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.** (37).
25. Buds downy or pubescent, twigs usually pubescent, if glabrous then dark reddish-brown; trees with rounded crowns and spreading branches. **Malus.** (38).

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26. Leaf scars quite regularly 2-ranked, that is with the third scar over the first. 27.
26. Leaf scars not 2-ranked. 38.
27. Bundle scar 1; visible bud scales 2; twigs brown; pith sometimes with cavities. **Diospyros.** (66).
27. Bundle scars 3. 32.
27. Bundle scars more than 3, usually scattered. 28.
28. Pith diaphragmed, solid; bundle scars 5-7; bark with fetid odor; terminal bud elongated, naked, silky; stipular scars none. **Asimina.** (31).
28. Pith not diaphragmed; bark not with fetid odor. 29.
29. Buds very long-pointed, with 10-20 visible scales; medullary rays very prominent; stipular scars narrow, extending some distance around the twig. **Fagus.** (20).
29. Visible bud scales less than 10; terminal bud self-pruned. 30.
30. Visible bud scales 1-3. 31.
30. Visible bud scales more than 3; pith white, rather large. **Morus.** (26).

31. 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.** (61).

31. Twigs glabrous or pubescent, reddish or yellowish-brown; pith 5-angled. **Castanea.** (21).

31. Twigs downy, grayish-green; pith white, cylindrical, large; bark very fibrous. **Broussonetia.** (28).

32. Pith interruptedly diaphragmed, with cavities, small, greenish-white. **Celtis.** (25).

32. Pith solid. 33.

33. Terminal bud naked, elongated, tomentose; buds prominently stalked, light gray; twigs zigzag. **Hamamelis.** (29).

33. Terminal bud absent, the twig showing a terminal self-pruning scar at the morphological tip; or if present then with scales; buds not stalked. 34.

34. Terminal bud present, long pointed; leaf scar narrow contracted between the bundle scars. **Amelanchier.** (40).

34. Terminal bud absent, or if present then the leaf scar oval or semicircular. 35.

35. Twigs dark reddish-brown, speckled, often zigzag; buds reddish-violet, often superposed or clustered; leaf scars not oblique but below the lateral bud. **Cercis.** (44).

35. Twigs dark brown, not speckled; buds not superposed; leaf scars oblique. 36.

36. Bark smooth, trunk and large branches with peculiar fluted or projecting ridges; bud scales brown, finely pubescent; staminate catkins in the bud in winter. **Carpinus.** (16).

36. Trunk not with fluted or projecting ridges. 37.

37. Bark of trunk scaling off like in the Sycamore; twigs very slender; no catkins. **Planera.** (24).

37. 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.** (23).

37. Bark scaly, fine-furrowed, the furrows usually somewhat spiral; bud scales green with brown tips, nearly glabrous; staminate catkins exposed in winter. **Ostrya.** (17).

37. Bark of trunk and larger branches separating into papery or leathery sheets; catkins in winter. **Betula.** (18).

—38—

38. With 2 or more superposed axillary buds; all except 1 may be very small. 39.

38. Axillary buds single or 2 or more side by side; not superposed. 46.

39. Pith diaphragmed, with air cavities. 40.

39. Pith diaphragmed but solid; bundle scars 3; stipular scars none. **Nyssa.** (76).

39. Pith not diaphragmed, solid. 41.

40. Pith large, brown; twigs thick, with large leaf scars and 3 prominent bundle scars. **Juglans.** (14).

40. Pith rather small, white or greenish; leaf scars semicircular; outer bud scales about 2. **Mohrodendron.** (68).

41. Buds partly sunken, hardly projecting beyond the surface; terminal bud self-pruned or tips of branches withering. 42.

41. Buds not sunken in the epidermis. 43.

42. Leaf scar not surrounding the axillary buds; pith large, chocolate-colored; twigs robust, polished, mottled white and purplish-brown. **Gymnocladus.** (46).

42. Leaf scar surrounding the Axillary buds, quadrangular U-shaped; bark with pungent odor; pith white. **Ptelea.** (50).

42. Leaf scar covering the axillary buds; pith small; twigs brown, polished, often zigzag. **Gleditsia.** (45).

43. Pith cylindrical or nearly so. 44.

43. Pith more or less 5-angled, yellowish or brownish; terminal bud large; bundle scars scattered; trees with tough twigs. **Hicoria.** (15).
44. Leaf scar surrounding the hairy axillary buds; bundle scars 5-9; terminal bud self-pruned. **Cladrastis.** (47).
44. Leaf scar not surrounding the axillary buds. 45.
45. Bundle scars 3; buds spherical, bark light gray; leaf scars heart-shaped; stipular scars none. **Sapindus.** (59).
45. Bundle scar usually 1; buds rounded or somewhat pointed; stipular scars or minute stipules present. **Ilex.** (54).

—46—

46. Terminal and lateral buds stalked; pith 3-angled; both staminate and carpellate catkins present all winter. **Alnus.** (19).
46. Buds sessile or nearly so; pith not 3-angled. 47.
47. Leaf scars surrounding the axillary buds which are usually sunken; terminal bud self-pruned; bark resinous; pith large. **Rhus.** (52).
47. Leaf scars not surrounding the axillary buds. 48.
48. Bundle scar 1, or if several then closely crowded and confluent, appearing as 1. 49.
48. Bundle scars more than 1. 54.
49. Stipular scars and stipules present. 50.
49. Stipular scars and stipules none. 51.
50. Terminal bud absent; bud scales dark brown or black. **Rhamnus.** (60).
50. Terminal bud present; stipules minute, usually persistent. **Ilex.** (54).
51. Terminal bud present. 52.
51. Terminal bud absent. 53.
52. Pith diaphragmed, with cavities; bark reddish; outer bud scales several, short. **Symplocos.** (67).
52. Pith not diaphragmed; bark green, very spicy aromatic; internodes very unequal. **Sassafras.** (35).

53. 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.** (64).

53. With 2 visible scales in the triangular flattened bud; pith sometimes with lenticular cavities; twigs pubescent, zigzag at the tip. **Diospyros.** (66).

—54—

54. Outer bud scales more than 1. 55.

54. Outer bud scale 1; twigs usually with brittle zones and hence very easily detached; stipular scars present; bundle scars 3. **Salix.** (12).

55. Pith diaphragmed but solid; bundle scars 3; no stipular scars. **Nyssa.** (76).

55. Pith not diaphragmed. 56.

56. Pith more or less 5-angled. 57.

56. Pith cylindrical or nearly so. 61.

57. Buds clustered at the tip of the twig; bundle scars numerous, scattered. **Quercus.** (22).

57. Buds not clustered at the tip. 58.

58. Bundle scars numerous usually scattered. 59.

58. Bundle scars 3. 60.

59. Buds small with about 3 outer scales; twigs reddish or yellowish-brown, glabrous or pubescent; terminal bud present or absent; stipular scars prominent. **Castanea.** (21).

59. Terminal bud large with 4 or more visible scales, hairy or peltate pubescent; lateral buds usually superposed; twigs tough. **Hicoria.** (15).

60. Without stipular or self-pruning scars; crushed buds fragrant, aromatic, not resinous, glabrous. **Liquidambar.** (30).

60. 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.** (11).

61. 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; large trees. **Ailanthus.** (51).

61. Pith small, or if large and brown then the bark resinous. 62.

62. Bark with a resinous or sticky milky sap; pith usually large, if rather small then the bark aromatic. 63.

62. Bark not resinous. 64.

63. 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.** (53).

63. Buds not clustered at the tip; bark sometimes aromatic, often very poisonous to the touch; leaf scar partly surrounding the bud or the bud covered; small trees or shrubs. **Rhus.** (52).

64. Terminal bud absent. 65.

64. Terminal bud present. 68.

65. Stipules or stipular scars absent or indistinct. 66.

65. Stipules or stipular scars present. 67.

66. Buds clustered at the tip of the twig; young twigs glandular dotted. **Myrica.** (13).

66. Buds not clustered at the tip; twigs not glandular. **Prunus.** (42).

67. Buds and twigs very downy, twigs dark brown or black. **Cydonia.** (39).

67. Buds downy or pubescent; twigs glabrous or pubescent, gray or brown. **Rhamnus.** (60).

68. Twigs green or yellowish-green, glabrous; internodes very unequal; lateral buds minute; small trees. **Cornus.** (75).

68. 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.** (43).

68. Twigs not green or red and green unless the plants are low shrubs, but gray, brown, black, or reddish. 69.

69. Bundle scars 5 or more in the broad U-shaped leaf scar; tips of the buds quite downy; small trees. **Sorbus.** (36).

69. Bundle scars 3. 70.

70. Buds rounded at the apex, often clustered at the tip of the twig; twigs glandular dotted. **Myrica.** (13).

70. Buds rounded at the apex; scales thick; twigs often zigzag; plant usually with some thorns, not glandular dotted. **Cratægus.** (41).

70. Buds pointed; plants sometimes with thorn-like stunted branches, not glandular dotted. 71.

71. 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.** (42).

71. 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.** (37).

71. Buds downy or strongly pubescent; twigs strongly pubescent or if glabrous then dark reddish-brown; trees with rounded or spreading crowns. **Malus.** (38).

71. Buds and twigs very pubescent; terminal bud with long spreading scales; shrubs or small trees with globose berry-like drupes containing 2-4 stones. **Rhamnus.** (60).

—72—

72. Bundle scars 1, or several closely united in a curved line, appearing as 1. 74.

72. Bundle scars more than 1 but not in an ellipse or ring. 78.

72. Bundle scars numerous, in an ellipse or ring; buds small and flat or superposed. 73.

73. Pith with cavities or more or less diaphragmed; axillary buds superposed. **Paulowina.** (72).

73. Pith solid; axillary buds small and flat, not superposed, leaf scars often in trees. **Catalpa.** (73).

74. Twigs very green, more or less 4-angled; pith diamond-shaped or rhomboidal. **Euonymus.** (55).

74. Twigs not green when ripe but gray, brown or red, sometimes 4-angled; pith cylindrical or nearly so. 75.

75. Terminal bud absent, the twig usually ending in a thorn. **Rhamnus.** (60).

75. Terminal bud present. 76.

76. Axillary buds often superposed; twigs often with thorns; leaf scars small. **Adelia.** (70).

76. Axillary buds not superposed; no thorns on the twigs; leaf scars rather large. 77.

77. 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.** (71).

77. 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.** (69).

78. With 4 distinct stipular scars; terminal bud self-pruned; twigs green with strong odor. **Staphylea.** (56).

78. Without definite stipular scars; twigs not green or if so then the terminal bud present. 79.

79. 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.** (58).

79. Bundle scars 3 or sometimes 5. 80.

80. Terminal bud with 2 long acuminate pubescent outer scales; line connecting the uppermost leaf scars notched. **Cornus.** (75).

80. Terminal bud with one main pair of visible scales and a smaller pair at the base. **Viburnum.** (77).
80. Terminal bud with several pairs of visible scales; bundle scars 3-5; twigs sometimes green. **Acer.** (57).

GENERAL KEY TO THE FAMILIES AND GENERA.

Based on the flower and other characters. The number following the generic name refers to the list number.

SPERMATOPHYTA.

1. Ovules naked on an open carpel; pollen falling directly on the ovule; trees or shrubs; ours usually evergreen with narrow leaves, or with fan-shaped leaves and dichotomous venation; monoecious, rarely dioecious. 2.
1. Ovules in a closed carpel or set of carpels; provided with a stigma for the reception of the pollen; flowers more commonly showy. 4.

2. GYMNOSPERMAE.

2. Carpellate flowers developing as woody cones, the carpels arranged in spirals or opposite, each usually with 1-2 ovules; or by coalescence forming a black or blue berry-like fruit. 3.
2. Carpellate flowers developing large plum-like fleshy seeds; dioecious trees with fan-shaped leaves dichotomously veined. GINKGOACEAE.

a. **Ginkgo.** (1).

3. Leaf-buds scaly; carpels usually numerous; leaves spirally arranged, the foliage leaves often situated on dwarf branches. PINACEAE.
   a. Ovuliferous scales woody; leaves needle-shaped, 2-5 on a dwarf branch. **Pinus.** (2).
   a. Ovuliferous scales thin; leaves linear or filiform, scattered or on thick wart-like dwarf branches. b.
   b. Leaves deciduous on wart-like dwarf branches. **Larix.** (3).
   b. Leaves scattered, persistent. c.
   c. Cones pendulous. d.

c. Cones erect. **Abies.** (6).

d. Leaves more or less 4-angled or tetragonal, sessile. **Picea.** (4).

d. Leaves flat, short-petioled. **Tsuga.** (5).

3. Leaf buds naked; carpels few, spiral; leaves on feather-like dwarf branches which are deciduous. TAXODIACEAE.

a. **Taxodium.** (7).

3. Leaf-buds naked; carpels few, opposite, sometimes forming a black or blue berry-like fruit; leaves opposite or whorled, rarely scattered, persistent. JUNIPERACEAE.

a. Cones oblong, ovuliferous scales not peltate. **Thuja.** (8).

a. Cones globose, ovuliferous scales peltate. **Chamaecyparis.** (9).

a. Cones becoming fleshy, berry-like. **Juniperus.** (10).

4. ANGIOSPERMAE.

4. Leaves mostly parallel-veined, sometimes netted-veined; parts of the flower very often in threes (trimerous); cotyledon 1; vascular bundles scattered through the pith, usually not in a circle; no annual rings of growth. No trees in our region. MONOCOTYLAE.

4. Leaves usually netted-veined; parts of the flower more commonly in fives (pentamerous) or fours (tetramerous); cotyledons usually 2; vascular bundles usually in a circle around a central pith, forming annual rings of growth in perennial stems, with bark on the outside. 5.

5. DICOTYLAE.

5. Perianth none or of similar segments or divided into calyx and corolla; corolla when present choripetalous (petals distinct). 6.

5. Perianth composed of calyx and corolla, calyx may be minute or suppressed; corolla sympetalous (petals more or less united). 36.

6. Perianth none; sometimes a minute border, cup, or gland may represent the calyx. 7.
6. Only the calyx present, sepals distinct or united, green or colored. 9.
6. Calyx and corolla both present, calyx may be minute. 16.
7. Leaves alternate, simple. 8.
7. Leaves opposite, compound; flowers in crowded panicles or racemes. OLEACEAE.

a. **Fraxinus.** (69).

8. Both staminate and carpellate flowers in aments; ovulary uni-locular many-seeded; seeds with a tuft of cottony hairs. SALICACEAE.
   a. Stamens numerous, bracts fimbriate or incised; buds with several scales; pith 5-angled. **Populus.** (11).
   a. Stamens 2-10, bracts entire; buds with one outer scale. **Salix.** (12).
8. Both staminate and carpellate flowers in aments, ovulary uni-locular with 1 erect ovule; carpellate flowers single in each bract of the ament. MYRICACEAE.

a. **Myrica.** (13).

8. Both staminate and carpellate flowers in aments, ovulary bi-locular; carpellate flowers 2 or more in each bract of the ament, or capitate. BETULACEAE.

See 11 below.

8. Flowers monoecious in dense heads; base of petiole covering the axillary bud. PLATANACEAE.

a. **Platanus.** (31).

8. Flowers imperfectly bisporangiate or monoecious, crowded into catkin-like heads; ovules 1-several in each cavity; stamens 4-many. HAMAMELIDACEAE.

a. **Liquidambar.** (30).

9. Flowers, at least the staminate ones in aments or ament-like spikes. 10.

9. Flowers not in aments but variously clustered, sometimes solitary. 12.

10. Leaves simple. 11.

10. Leaves odd-pinnate; fruit a nut inclosed in a husk. JUGLANDACEAE.

    a. Pith of twigs in transverse plates; husk indehiscent; nut rugose. **Juglans.** (14).

    a. Pith solid; husk at length splitting into segments, nut smooth or angled. **Hicoria.** (15).

11. Both staminate and carpellate flowers in aments; sap not milky. BETULACEAE.

    a. Staminate flowers solitary in the axil of each bract, without a calyx; carpellate flowers with a calyx. b.

    a. Staminate flowers 3-6 in the axil of each bract, with a calyx; carpellate flowers without a calyx. c.

    b. Fruiting bractlet flat, 3-cleft and incised; nut small. **Carpinus.** (16).

    b. Fruiting bractlet bladder-like, closed, membranous; nut small. **Ostrya.** (17).

    c. Stamens 2; fruiting bracts 3-lobed or entire, deciduous. **Betula.** (18).

    c. Stamens 4; fruiting bracts woody, persistent; pith 3-angled. **Alnus.** (19).

11. Carpellate flowers subtended by an involucre which becomes a bur or cup in fruit; staminate flowers in aments, or capitate. FAGACEAE.

    a. Staminate flowers capitate; nut triangular. **Fagus.** (20).

    a. Staminate flowers in slender aments; nut rounded. b.

    b. Carpellate flowers 2-5 in each involucre, which becomes prickly in fruit. **Castanea.** (21).

    b. Carpellate flower 1 in each involucre, which consists of numerous scales. **Quercus.** (22).

11. Trees with alternate leaves and milky sap; ovules pendulous. MORACEAE.

See 15 below.

12. Leaves opposite or whorled. 13.
12. Leaves alternate. 14.
13. Trees or shrubs with pinnate leaves and fruit a samara with 1 wing; or leaves simple and fruit a drupe. OLEACEAE.
    - a. Leaves compound; fruit a samara; flowers mostly dioecious. **Fraxinus.** (69).
    - a. Leaves simple; fruit a drupe; flowers dioecious, from catkin-like scaly buds. **Adelia.** (70).
13. Fruit a 2-winged, 2-seeded samara; leaves palmately veined or if pinnately compound then the petioles covering the axillary buds. ACERACEAE.

    a. **Acer.** (57).

14. Base of petiole covering the axillary bud; the flowers in dense spherical heads, the carpellate on a long slender peduncle; twigs with stipular rings. PLATANACEAE.

    a. **Platanus.** (31).

14. Base of petiole not covering the axillary bud, and inflorescence and twigs not as above. 15.
15. Trees or shrubs with compound punctate leaves. RUTACEAE.

    a. **Xanthoxylum.** (49).

15. Trees usually with serrate pinnately-veined sometimes palmately-veined leaves with fugaceous stipules; ovulary unilocular, 1-2-ovuled; fruit a samara, drupe or nut. ULMACEAE.
    - a. Flowers in clusters on twigs of the previous season; fruit a samara or nut-like. b.
    - a. Flowers on twigs of the season, fruit a drupe. **Celtis.** (25).
    - b. Flowers expanding before the leaves; fruit a samara. **Ulmus.** (23).
    - b. Flowers expanding with the leaves; fruit nut-like. **Planera.** (24).
15. Trees with milky sap; stipules fugaceous; fruit aggregate. MORACEAE.

a. Staminate flowers racemose or spicate, the carpellate capitate. b.

a. Staminate and carpellate flowers in ament-like spikes. **Morus.** (26).

b. Carpellate perianth deeply 4-cleft; twigs with thorns. **Toxylon.** (27).

b. Carpellate perianth 3-4 toothed; twigs not thorny. **Broussonetia.** (28).

15. Trees with alternate, palmately lobed, fragrant leaves; the flowers in dense heads, the carpellate ones long-peduncled. HAMAMELIDACEAE.

a. **Liquidambar.** (30).

15. Shrubs or trees with 9 or 12 stamens in 3 or 4 cycles; anthers opening by valves; aromatic; fruit a 1-seeded drupe or berry. LAURACEAE.

a. **Sassafras.** (35).

15. Shrubs or trees with simple leaves, with 4-5 perigynous stamens alternate with the sepals; ovulary 2-5-locular, ovules solitary in each cavity, stigmas 2-5; fruit a drupe. RHAMNACEAE.

a. **Rhamnus.** (60).

15. Trees with simple alternate leaves and diaphragmed but solid pith; stamens 5-15, flowers epigynous; ovulary unilocular with 1 pendulous ovule. Some CORNACEAE.

a. **Nyssa.** (76).

—16—

16. Flowers hypogynous or perigynous; ovulary free from the calyx or adherent to the perigynous disc. 17.

16. Flowers epigynous; calyx above the ovulary. 33.

17. Stamens numerous, at least more than 10 and more than twice the petals. 18.

17. Stamens not more than twice as many as the petals, when of just the number as the petals then alternate with them. 21.

17. Stamens of the same number as the petals and opposite them; ovulary 2-5-locular, calyx 4-5-cleft, valvate in the bud; petals involute; fruit a drupe or capsule; shrubs, small trees, or vines with simple leaves. RHAMNACEAE.

a. **Rhamnus.** (60).

18. Carpels 1 or more, united, but styles and stigmas may be several. 19.

18. Carpels more than 1, distinct; filaments shorter than the anthers; perianth trimerous; leaves 2-ranked. ANONACEAE.

a. **Asimina.** (34).

18. Carpels numerous spirally arranged and cohering over each other, forming an aggregate cone-like fruit; trees; sepals and petals in threes; twigs with stipular rings. MAGNOLIACEAE.

a. Anthers introrse; leaves not truncate. **Magnolia** (32).

a. Anthers extrorse; leaves truncate. **Liriodendron.** (33).

19. Ovulary compound, plurilocular. 20.

19. Ovulary 1-locular, 2-ovuled; fruit a drupe with 1 seed. ROSACEAE. (DRUPATAE).

a. Drupe glabrous, stone smooth or nearly so. **Prunus.** (42).

a. Drupe velvety, stone deeply pitted. **Amygdalus** (43).

20. Calyx deciduous; flower cluster subtended by a large membranous bract; trees with alternate, 2-ranked leaves and mucilaginous sap. TILIACEAE.

a. **Tilia.** (16).

20. Leaves alternate with deciduous stipules; ovulary composed of 2-5 wholly or partly united carpels; fruit a more or less fleshy pome. ROSACEAE. (POMATAE).

a. Ripe carpels papery or leathery. b.

a. Ripe carpels bony. **Cratægus.** (41).

b. Leaves pinnate. **Sorbus.** (36).

b. Leaves simple. c.

c. Cavities of the ovulary as many as the styles. d.

c. Cavities of the ovulary becoming twice as many as the styles. **Amelanchier.** (40).

d. Cavities of the ovulary with 1-3 seeds. e.

d. Cavities of the ovulary with many seeds. **Cydonia.** (39).

e. Flesh of the pome with grit-cells. **Pyrus.** (37).

e. Flesh of the pome without grit-cells. **Malus.** (38).

21. Ovulary only 1, carpels 1 to many, united. 24.

21. Carpels 2 or more, distinct, or somewhat united at the base. 22.

22. Leaves compound. 23.

22. Shrubs or trees with alternate simple leaves. HAMAMELIDACEAE.

a. Ovules 1 in each cavity, fruit a woody capsule. **Hamamelis.** (29).

a. Ovules several in each cavity, fruit globular, spiny. **Liquidambar.** (30).

23. Leaves punctate with pellucid dots, alternate. RUTACEAE.

a. Carpels 2-5, distinct. **Xanthoxylum.** (49).

a. Ovulary 1, 2-locular. **Ptelea.** (50).

23. Leaves large, pinnate, alternate, not punctate but with disc-like glands under the teeth or lobes. SIMARUBACEAE.

a. **Ailanthus.** (51).

24. Carpel 1, ovulary with 1 parietal placenta; leaves alternate, usually with stipules, usually compound. FABACEAE.

A. Fruit a legume; upper petal inclosed by the lateral ones in the bud; leaves simple or compound mostly with stipules. CASSIATAE.

a. Leaves simple, flowers bisporangiate. **Cercis.** (44).

a. Leaves compound, flowers dioecious or imperfectly dioecious. b.

b. Stamens 3-5; pod flat. **Gleditsia.** (45).

b. Stamens 10; pod thick, woody. **Gymnocladus.** (46).

B. Fruit a legume or loment, upper petal inclosing the lateral ones in the bud; leaves compound (sometimes with 1 leaflet) with stipules. PAPILIONATAE.

a. Without stipular spines; leaflets large, 3-6 in. long; base of petiole covering the axillary buds like a cap. **Cladrastis.** (47).

a. With stipular spines; leaflets small, 1-2 in. long; base of petiole not covering the axillary buds like a cap, but solid. **Robinia.** (48).

24. Carpels more than 1 as shown by the compound ovulary, cavities, placentae, styles, or stigmas. 25.

25. Ovulary 2-locular to plurilocular. 26.

25. Ovulary 1-locular, ovules solitary, stigmas 3; shrubs or trees with resinous or milky sap and alternate leaves without stipules. ANACARDIACEAE.

a. Leaves compound, styles terminal. **Rhus.** (52).

a. Leaves simple, styles lateral. **Cotinus.** (53).

26. Flowers regular or nearly so. 27.

26. Flowers irregular; shrubs or trees with opposite digitate leaves; ovulary 3-locular. HIPPOCASTANACEAE.

a. **Aesculus.** (58).

27. Stamens neither just as many nor twice as many as the petals. 28.

27. Stamens just as many or twice as many as the petals. 29.

28. Stamens distinct and fewer than the 4 petals; trees or shrubs with opposite pinnate or simple leaves. OLEACEAE.

a. Flowers dioecious, from catkin-like scaly buds. **Adelia.** (70).

a. Flowers bisporangiate, petals linear. **Chionanthus.** (71).

28. Stamens more numerous than the petals; leaves palmately veined, opposite; fruit 2-winged. Some ACERACEAE.

a. **Acer.** (57).

29. Ovules 1 or 2 in each cavity. 30.

29. Ovules several or many in each cavity; stipules between the opposite and pinnately compound leaves, caducous; shrubs or small trees. STAPHYLEACEAE.

a. **Staphylea.** (56).

30. Leaves palmately veined, or compound. 31.
30. Leaves pinnately veined, simple, not punctate. 32.
31. Leaves pinnately compound, alternate; climbing herbaceous vines with fruit an inflated 3-lobed capsule; or trees with a globose or lobed berry. SAPINDACEAE.

a. **Sapindus.** (59).

31. Leaves palmately veined or pinnately compound; fruit 2-winged; trees or shrubs with opposite leaves and no stipules. ACERACEAE.

a. **Acer.** (57).

31. Leaves 3-foliate, pellucid-punctate, without stipules. Some RUTACEAE.

a. **Ptelea.** (50).

32. Calyx minute, fruit a berry-like drupe; trees or shrubs with simple mostly alternate leaves. ILICACEAE.

a. **Ilex.** (54).

32. Calyx not minute; pod colored, dehiscent; seeds inclosed in a pulpy aril; shrubs or woody climbers with alternate or opposite leaves and with minute fugaceous stipules. CELASTRACEAE.

a. **Euonymus.** (55).

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33. Leaves simple. 34.
33. Leaves compound. 35.
34. Perfect stamens 4, styles 2; leaves alternate, palmately veined and lobed, or if pinnately veined then 2-ranked. HAMAMELIDACEAE.

See 22 above.

34. Stamens 5, 10, or many; styles 2-5; leaves alternate with stipules. ROSACEAE (POMATAE).

See 20 above.

34. Stamens 4 or 5, style and stigma 1; leaves opposite or alternate; fruit a 1-2-seeded drupe. CORNACEAE.
   a. Ovulary 2-locular, flowers bisporangiate.
   Cornus. (75).
   a. Ovulary 1-locular, flowers dioecious or imperfectly dioecious. **Nyssa.** (76).

34. Stamens 4 or 5 on a flat disc which covers the 3-5-locular ovulary; fruit a somewhat fleshy capsule; shrubs, trees or woody climbers with opposite leaves and minute fugaceous stipules. CELASTRACEAE.

See 32 above.

35. Stamens many; leaves odd-pinnate, fruit a berry-like pome. Some — ROSACEAE (POMATAE).

a. **Sorbus.** (36).

35. Stamens 5, styles usually 2-5; fruit a fleshy berry or drupe; leaves bipinnate. ARALIACEAE.

a. **Aralia.** (74).

—36—

36. Flowers hypogynous (ovulary superior). 37.

36. Flowers epigynous (ovulary inferior); stamens as many as the lobes of the corolla; leaves opposite, usually without stipules, not blackening in drying. CAPRIFOLIACEAE.

a. **Viburnum.** (77).

37. Stamens free from the corolla (or only slightly united at the base) as many as the petals (flowers tetracyclic) and alternate with them, or twice as many (pentacyclic) or more. 38.

37. Stamens united with the corolla, as many as the petals and opposite them or twice as many or more. 39.

37. Stamens united with the corolla or only united at the base, as many as the petals or fewer and alternate with them. 40.

38. Ovulary 2-5-locular; shrubs often with evergreen leaves; fruit a capsule, berry or drupe. ERICACEAE.

a. Fruit a septicidal capsule; leaves remaining green throughout the year. b.

a. Fruit a loculicidal capsule; leaves deciduous in autumn. **Oxydendrum.** (64).

b. Corolla somewhat irregular, seeds flat and winged. **Rhododendron.** (62).

b. Corolla regular, seeds angled or rounded. **Kalmia.** (63).

38. Choripetalous plants in which the petals are sometimes partly or completely united.

a. Ovulary 1-locular (1 carpel) with 1 parietal placenta. FABACEAE.

See 24 above.

b. Ovulary 4-8-locular, with a solitary seed in each cavity; fruit a berry-like drupe. ILICACEAE.

See 33 above.

39. Stamens as many as the lobes of the small white corolla; leaves entire, simple and alternate, with thorns. SAPOTACEAE.

a. **Bumelia.** (65).

39. Stamens twice as many as the lobes of the greenish-yellow corolla or more; styles 2-8; plants mostly monoecious or dioecious; leaves alternate, simple, and entire. EBENACEAE.

a. **Diospyros.** (66).

39. Stamens twice as many as the lobes of the yellow corolla or more; style 1; stamens in several series; flowers mostly bisporangiate; leaves alternate and simple. SYMPLOCACEAE.

a. **Symplocos.** (67).

39. Stamens twice as many as the lobes of the white corolla or more; style 1; stamens in 1 series, flowers mostly bisporangiate, leaves alternate and simple. STYRACACEAE.

a. **Mohrodendron.** (68).

40. Flowers regular; seeds 1-4; fruit a samara, drupe, or berry. OLEACEAE.
   - a. Fruit a samara; leaves pinnate. **Fraxinus.** (69).
   - a. Fruit a drupe or berry; leaves simple. b.
   - b. Flowers dioecious. **Adelia.** (70).
   - b. Flowers bisporangiate, lobes of the corolla linear. **Chionanthus.** (71).

40. Flowers irregular, zygomorphic; seeds numerous, capsule ovoid, acute; stamens 4, didynamous; pith with cavities. Some — SCROPULARIACEAE.

a. **Paulownia.** (72).

40. Flowers irregular, zygomorphic; seeds numerous, capsule long, terete; fertile stamens usually 2; pith solid. BIGNONIACEAE.

a. **Catalpa.** (73).

CLASSIFICATION AND DESCRIPTION OF THE SPECIES.

SERIES III. SPERMATOPHYTA. SEED-PLANTS.

Subkingdom, GYMNOSPERMAE. Gymnosperms.

Class, GINKGOEAE.

Order, GINKGOALES.

Ginkgoaceae. Ginkgo Family.

1. **Ginkgo** Kaempf. Ginkgo.

Trees with deciduous, fan-shaped, dichotomously veined leaves on wart-like dwarf branches.

* *Ginkgo biloba.* L. Maiden-hair-tree. A large, beautiful and hardy tree with dioecious flowers. Seed large, drupe-like. Autumn leaves orange. Introduced from China and Japan; should be commonly cultivated for ornament.

Class, CONIFERAE. Conifers.

Order, PINALES.

Pinaceae. Pine Family.

2. **Pinus** L. Pine.

Resinous evergreen trees with small dwarf branches bearing 2-5 narrow foliage leaves; dwarf branches and ordinary twigs covered with scale leaves. Dwarf branches self-pruned after a number of years. Carpellate cones woody, with numerous carpels. Our most important lumber trees.

1\. Dwarf branches with 5 foliage leaves; ovuliferous scales little thickened at the tip. *P. strobus.*

1\. Dwarf branches with 2-3 foliage leaves; ovuliferous scales much thickened at the tip. 2.

2\. Dwarf branches with 3 foliage leaves, rarely 2 or 4. 3.

2\. Dwarf branches mostly with 2 foliage leaves some of them may be with 3. 4.

3\. Leaves 6-10 in. long; carpellate cone oblong-conic. *P. taeda.*

3\. Leaves 3-5 in. long; carpellate cones ovoid. *P. rigida.*

4\. Twigs glaucous; resin-ducts parenchymatous; carpellate cones 1½-3 in. long; ovuliferous scales tipped with a prickle or small spine. 5.

4\. Twigs not glaucous. 6.

5. Leaves slender, 2½-5 in. long; buds not very resinous; prickles of the ovuliferous scales short and small. *P. echinata.*
5. Leaves stout, 1½-2½ in. long; buds very resinous; prickles of the ovuliferous scales long and stout. *P. virginiana.*
6. Leaves 1-4 in. long, grayish-green or light green; ovuliferous scales without or with a small prickle, or with a thick point or spine. 7.
6. Leaves 4-6 in. long, dark-green; ovuliferous scale without a spine or prickle, or sometimes with a very small prickle. 9.
7. Ovuliferous scale without a spine or prickle when mature but with a minute central point; leaves ½-1½ in. long, curved; resin ducts parenchymatous. *P. divaricata.*
7. Ovuliferous scale with a thick point or spine. 8.
8. Leaves 2½-4 in. long, light green; twigs orange or orange brown; resin ducts parenchymatous; carpellate cones ovoid. 3-5 in. long. *P. pungens.*
8. Leaves 1½-2½ in. long, grayish-green; twigs dull greenish-yellow or greenish-brown; resin-ducts peripheral; carpellate cones ovate-conic, 2-3 in. long. *P. silvestris.*
9. Carpellate cones terminal or subterminal, oval-conic; ovuliferous scales pointless when mature. *P. resinosa.*
9. Carpellate cones lateral, ovoid-conic; ovuliferous scale with a small prickle. *P. laricio.*

1. **Pinus stròbus** L. White Pine. A large tree with nearly smooth bark, except when old; branches horizontal in whorls. Often forming dense forests. Wood soft and straight-grained; used in enormous quantities for building purposes. One of the most valuable timber trees in the world. Has been more extensively used in America for lumber than any other tree. Newf. to Man., south along the Allegh. to Ga. and to Ohio, Ill. and Ia.

2. **Pinus resinòsa** Ait. Red Pine. A tall tree with reddish bark. Wood rather hard but not very durable. Turpentine is obtained to a limited extent from this species. A tree of rapid growth. Newf. to Man., Mass., Penn., and Minn.

3. **Pinus divaricàta** (Ait.) Gord. Jack Pine. A slender tree with spreading branches, the bark becoming flaky. Wood light and rather soft. In sandy soil. N. B. and N. W. Terr., south to Me., N. Y., Ill., and Minn.

4. **Pinus virginiàna** Mill. Scrub Pine. A slender, usually small tree with spreading or drooping branches; the old

bark flaky and dark-colored. Wood very resinous, soft and durable but of poor quality. In sandy soil. L. I. to S. C., Ala., Tenn., Ohio, and Ind.

5. **Pinus echinàta** Mill. Yellow Pine. A large tree with spreading branches; leaves sometimes in 3's. Wood rather hard and very valuable; much used as lumber. Also furnishes some turpentine. Produces shoots from stumps. In sandy soil. N. Y. to Fla., Ill., Kan., and Tex.

6. **Pinus pùngens** Mx. f. Table-mountain Pine. A tree with spreading branches, the old bark rough and in flakes, leaves sometimes in 3's. Wood light and soft; much used for charcoal. N. J. to Ga. and Tenn.

7. **Pinus taèda** L. Loblolly Pine. A tree of very rapid growth with spreading branches and thick, rugged bark, flaky in age. Wood rather hard; much used for lumber in the south. Often growing in old fields. N. J. to Fla., Ark., and Tex.

8. **Pinus rigida** Mill. Pitch Pine. A tree with spreading branches, the old bark rough and furrowed, flaky in strips. Sprouts readily from the stump if cut down or burned. Wood rather hard and brittle and full of resin; used for fuel, charcoal, and coarse lumber. A source of turpentine to a limited extent. In dry, sandy or rocky soil. N. B. to Ont., Tenn., Ohio, W. Va., and Ga.

*. *Pinus silves'tris* L. Scotch Pine. A large and valuable tree with drooping branches; much cultivated. From it are obtained the red and yellow deal much used as lumber in Europe.

*. *Pinus lari'cio* Poir. Austrian Pine. A tall, open, pyramidal tree of rapid growth with the thick branches in regular whorls. Often cultivated.

3. **Làrix** Adans. Larch.

Tall pyramidal trees with horizontal or ascending branches and with clusters of narrowly linear deciduous leaves on thick wart-like dwarf branches. Carpellate cones woody, with numerous carpels.

1. Carpellate cones small, ½-¾ in. long, oval or almost globular; ovuliferous scales glabrous. *L. laricina.*

1. Carpellate cones rather large, ¾-1½ in. long; ovuliferous scales finely tomentose on the back. *L. decidua.*

1. **Larix laricina** (DuRoi) Koch. Tamarack. A slender tree with close or at length scaly bark. Wood hard, durable, and very strong; used in ship-building, for railroad ties, posts, and telegraph poles. In swamps and about the margins of lakes. Newf. to N. W. Terr., south to Minn., Ind., Ohio, and N. J.

*. *Larix decídua* Mill. European Larch. A beautiful tree with horizontal branches and drooping branchlets, conical in shape when young; much cultivated in some parts of the United States. The source of Venice turpentine.

4. **Picea** Link. Spruce.

Evergreen trees, conic in outline, with short linear 4-sided leaves spreading in all directions; the leaf scars on persistent sterigmata. Carpellate cones pendulous.

1. Carpellate cones 2½-6 in. long. *P. excelsa.*
1. Carpellate cones ¾-2 in. long. 2.
2. Twigs and sterigmata of the leaves glabrous, glaucous; carpellate cones oblong-cylindric. *P. canadensis.*
2. Twigs pubescent, brown; carpellate cones ovoid or oval. 3.
3. Leaves not glaucous. *P. mariana.*
3. Leaves glaucous. *P. brevifolia.*

1. **Picea canadénsis** (Mill.) B. S. P. White Spruce. A slender tree sometimes with a strong skunk-like odor. Leaves light green, slender, ½-¾ in. long, very acute. An important timber tree with light and straight-grained wood. Newf. to Alaska, south to Me., Mich., Black Hills, and Br. Col.

2. **Picea mariàna** (Mill) B. S. P. Black Spruce. A tree with spreading branches and smooth or only slightly roughened bark. Leaves not over ⅔ in. long, stout, green, closely covering the twigs. Wood light and straight-grained; used for paper pulp, for general lumber and for masts and spars of ships. Newf. to N. W. Terr., south to N. J., N. C., Mich., and Minn.

3. **Picea brevifòlia** Peck. Swamp Spruce. A small, slender tree, or on mountains a shrub. Leaves nearly straight,

obtuse, or merely mucronate, ¼-½ in. long. In swamps and bogs. Vt. to Ont., N. Y., and Mich.

*. *Picea excélsa* (Lam.) Link. Norway Spruce. A large tree, conical in shape when young, with numerous stout spreading and drooping branches. Abundant in cultivation. Source of Burgundy pitch.

5. **Tsùga** Carr. Hemlock.

Evergreen trees with slender horizontal or drooping branches. Leaves flat, narrowly linear, spreading more or less into 2 ranks. Leaf scars on short sterigmata. Carpellate cones pendulous.

1. **Tsuga canadénsis** (L.) Carr. Hemlock. A tall tree with slender, horizontal or drooping branches, the old bark flaky in scales. Wood very coarse, light and soft; used for wood pulp. Bark used for tanning. Source of Canada pitch. Self-prunes twigs. N. S. to Minn. south to Ohio, and Del., along the Alleghanies to Ala., and to Mich. and Wis.

6. **Abies** Juss. Fir.

Evergreen trees with flat linear leaves. No sterigmata on the twigs but with ordinary circular or oval leaf scars. Carpellate cones erect.

1. Carpellate bract serrulate, shorter than the ovuliferous scale; leaves obtuse. *A. balsamea.*
1. Carpellate bract aristate, longer than the ovuliferous scale; leaves mostly emarginate. *A. fraseri.*

1. **Abies balsàmea** (L.) Mill. Balsam Fir. A slender short-lived tree. Wood very light and soft. Canada balsam is obtained from its resin. Newf. to N. W. Terr., south to Penn., along the Alleghanies to Va., and to Mich. and Minn.

2. **Abies fràseri** (Pursh) Lindl. Fraser Fir. A slender tree growing on the high Alleghanies. W. Va., N. Car., and Tenn.

Taxodiaceae. Bald-cypress Family.

7. **Taxòdium** Rich. Bald-cypress.

Tall trees with horizontal or drooping branches, ours with feather-like, annually self-pruned, dwarf branches. Carpellate cones, globose.

1. **Taxodium distichum** (L.) Rich. Bald-cypress. A large tree, the old bark flaky in thin strips. The roots develop upright conic "knees." Wood light, soft and durable. In swamps and along rivers. Del. to Fla., west to Tex., north to Mo. and Ind.

Juniperaceae. Juniper Family.

8. **Thùja** L. Arborvitae.

Evergreen trees or shrubs with flattened fan-like twigs. Carpellate cones ovoid or oblong with dry coriaceous scales, not peltate.

1. **Thuja occidentàlis** L. Arborvitae. Usually a small conical tree with fan-like branches. Self-prunes twigs. Wood light and durable; used for posts, railroad ties, etc. Usually in wet soil and along the banks of streams. N. B. to Man., south to Ohio and N. J., along the Alleghanies to N. C., and to Ill. and Minn.

9. **Chamaecyparis** Spach. White-cedar.

Evergreen trees, similar to the Thujas. Carpellate cones globose, with thick, peltate scales.

1. **Chamaecyparis thyoides** (L.) B. S. P. White-cedar. A tree with soft, light, and durable wood; used for boat-building, woodenware, shingles, etc. In swamps. N. H. to N. J., Fla., and Miss.

10. **Juniperus** L. Juniper.

Evergreen trees or shrubs with small globose, berry-like bluish or blackish cones.

1. Leaves all subulate, prickly pointed, verticillate, slender, mostly straight; cones axillary. *J. communis.*

1. Leaves of 2 kinds, scale-like and subulate, opposite or verticilate; cones terminal. *J. virginiana.*

1. **Juniperus communis** L. Common Juniper. A low tree with spreading or drooping branches and shreddy bark. Goats are poisoned from eating the leaves. On dry hills. N. S. to Br. Col. south to N. J., Ohio, Mich., Neb., and in the Rocky Mts. to N. Mex. Also in Europe and Asia.

2. **Juniperus virginiàna** L. Red Juniper. A tree, with spreading often irregular branches when old, but conic in shape when young. Self-prunes twigs. Wood very valuable, light, straight-grained, durable, and fragrant; used for posts, cabinet-work, interior finish, veneers and cooperage, and almost exclusively in the manufacture of lead pencils. Often infested with the "cedar-apple." Poisonous to goats. In dry soil; common on bluffs. N. B. to Br. Col., Fla., Tex., and Ariz. Also in W. I., Ohio.

Subkingdom, ANGIOSPERMAE. Angiosperms.

Class, DICOTYLAE. Dicotyls.

Subclass, APETALAE.

Order, SALICALES.

Salicaceae. Willow Family.

11. **Pópulus** L. Poplar.

Trees with scaly resinous buds. Flowers in aments; fruit a capsule; seeds with long cottony hairs. Leaves mostly with 2 or more glands at or near the base of the blade and with gland-tipped teeth. Twigs prominently self-pruned by means of cleavage planes in basal joints. Pith 5-angled.

1. Leaves and twigs persistently and densely white tomentose below, usually lobed; self-pruning scars very prominent on the small twigs. *P. alba.*
1. Leaves and twigs glabrous or nearly so when old, not lobed. 2.
2. Petioles terete or channeled, not much flattened laterally; leaves crenate. 3.
2. Petioles strongly flattened laterally. 4.
3. Leaves densely tomentose when young; capsule slender-pedicelled. *P. heterophylla.*
3. Leaves not tomentose but usually somewhat pubescent; capsule short-pedicelled. *P. balsamifera.*
4. Leaves broadly deltoid, abruptly acuminate; terminal winter buds usually angular. 5.

4. Leaves broadly ovate or suborbicular; terminal winter buds rounded or only slightly angular. 7.
5. Trees of tall, narrow growth with strongly erect branches, giving a spire-like appearance, young twigs glabrous; leaves usually wider than long, more or less acute at the base. *P. dilatata.*
5. Trees with spreading branches. 6.
6. Young leaves pubescent; capsules nearly sessile. *P. nigra.*
6. Young leaves not pubescent, shining; capsules slender-pedicelled. *P. deltoides.*
7. Leaves coarsely sinuate-dentate, densely white-tomentose when young, glabrous when mature. *P. grandidentata.*
7. Leaves crenulate-dentate, glabrous except the ciliate margins. *P. tremuloides.*

1. **Populus álba** L. White Poplar. A large tree with smooth, light, greenish-gray bark often with black diamond-shaped scars; sprouting freely from the roots and hence not desirable for yards. Young foliage densely white-tomentose, the leaves becoming glabrate and dark green above, broadly ovate or nearly orbicular in outline, 3-5 lobed, or irregularly dentate, 2-4 in. long. Native of Europe and Asia. Ohio.

2. **Populus heterophylla** L. Swamp Poplar. An irregularly branching tree with rough bark. Leaves long-petioled, boardly ovate, crenulate-denticulate, 5-6 in. long. In swamps. Conn. to Ga., west to La. and northward to Ark., Ind. and Ohio.

3. **Populus balsamifera** L. Balsam Poplar. A large tree with nearly smooth gray bark. Leaves broadly ovate, dark green and shining above, pale beneath, rounded or acute at the base, crenulate, 3-5 in. long. Wood very light and soft. In moist or dry soil, commonly along streams and lakes. The subspecies **P. balsamifera cándicans** (Ait.) Gr. Balm-of-Gilead, has the leaves broadly ovate, truncate or cordate at the base, and the petioles and nerves usually puberulent. Mostly escaped from cultivation. Newf. to Alaska, south to N. Y., Ohio, Neb., and Nev.

4. **Populus nigra** L. Black Poplar. A large tree with terete twigs. Mature leaves firm, broadly deltoid, abruptly acuminate at the apex, broadly cuneate or obtuse at the base, crenate, 2-4 in. long. Naturalized from Europe. N. Y. and southward along the Delaware R.

*. *Populus dilatàta* Ait. Lombardy Poplar. A spire-like tree of rapid growth. Commonly planted for ornament.

5. **Populus deltoides** Marsh. Cottonwood. A large tree of very rapid growth, with rough, deeply furrowed, brown bark when old. Bark of young trees grayish-green and rather smooth. The giant of the poplars. Petiole much flattened laterally causing the leaves to rustle in the wind. Leaves glabrous, broadly deltoid-ovate, abruptly acuminate at the apex, crenulate, truncate at the base, 4-7 in. long. Wood light and soft and very durable if kept in the dry; used for building lumber, light boxes, paper pulp, sugar and flour barrels, cracker boxes, crates and wooden ware; also a good fuel wood. A most useful and ornamental tree of very rapid growth if planted in ravines and low places. In cities only staminate trees should be planted. In moist soil, especially on the banks and flood plains of creeks and rivers. Quebec to Man., south to Fla. and Kan. Ohio.

6. **Populus grandidentàta** Mx. Largetooth Aspen. A tree with smooth, greenish-gray bark. Leaves tomentose when young, glabrous when mature, short-acuminate, obtuse or truncate at the base, 2-4 in. long. Wood soft and white; used for paper pulp. In rich moist soil. N. S. to Ont. and Minn., south to N. J. and Ohio, and in the Alleghanies to Tenn.

7. **Populus tremuloides** Mx. American Aspen. A slender tree with light green, smooth bark. Leaves usually short-acuminate at the apex, finely crenulate, truncate, rounded or subcordate at the base, 1-3 in. broad. Petioles very slender, causing the leaves to quiver and rustle in the slightest breeze. Wood white and soft; used for making coarse paper. In moist or dry soil. Newf. to Alaska, south to N. J., Ohio, Ky., and Neb.; in the Rocky Mts. to Mexico and to Lower Cal.

12. **Sàlix** L. Willow.

Trees or shrubs with buds having a single outer scale. Flowers in aments; fruit a capsule; seeds with long cottony hairs. Leaves sometimes with glands on the petiole or at the base of the blade and with gland tipped teeth. Twigs self-pruned by means of basal brittle zones. The charcoal from the larger species used for making gunpowder.

1. Twigs decidedly pendulous or "weeping", green or yellowish-green; leaves linear-lanceolate, acuminate, serrulate, smooth, rather pale beneath, petioles glandular above; capsule glabrous, pedicel very short, stigma sessile. *S. babylonica.*
1. Twigs not pendulous nor weeping, but some may be drooping. 2.
2. Leaves tapering to the short petioled or nearly sessile base, linear-lanceolate, remotely denticulate, coarsely silky when young, usually glabrate in age; shrubs or small trees with a narrow, slender crown; capsule glabrous or silky; stamens 2. *S. fluviatilis.*
2. Petioles present and rather prominent and slender except in some individuals. 3.
3. Leaves silky, tomentose, or hairy below when mature; stamens 2. 4.
3. Leaves glabrous below, or nearly so, when mature, sometimes finely pubescent when young. 5.
4. Leaves long linear-lanceolate, sparingly repand-crenulate, or entire, white or silvery silky beneath, without glands on the petiole, acuminate; twigs terete, green; capsule nearly sessile, silky or tomentose, style long. *S. viminalis.*
4. Leaves lanceolate, narrowed at the base, serrulate, silky pubescent and glaucous beneath, usually with glands on the petiole at the base of the blade; capsule glabrous, pedicel very short, stigma sessile. *S. alba.*
4. Leaves ovate-lanceolate, slender-pointed, firm, pubescent or white-tomentose beneath, sharply serrate or entire; bracts yellow, linear-oblong or lanceolate; capsule silky or tomentose, pedicel filiform. *S. bebbiana.*
5. Petioles usually without glands, or if with glands then the leaves of the ovate type and short pointed; stamens 2. 7.
5. Petioles usually with glands on the top or at the base of the blade; stamens 3-12, in one species 2; capsule glabrous. 8.
6. Length of leaf-blade less than 3 times its breadth; mature leaves thin and dull, elliptic, ovate-oval, or obovate, acute or obtuse at the apex; stamens 2. *S. balsamifera.*
6. Length of leaf-blade 3 times its breadth or more. 7.
7. Leaves oblanceolate or spatulate, acute, serrulate, somewhat glaucous beneath; twigs purplish, flexible; filaments of stamens united; capsule silky or tomentose, sessile; stigma sessile. *S. purpurea.*
7. Leaves lanceolate or oblanceolate, acuminate, finely serrate with minute gland-tipped teeth, pale and glaucous beneath; twigs of the season pubescent or puberulent; capsule glabrous. *S. missouriensis.*

7. Leaves obovate, oblong or oblanceolate, rather thin, acute at both ends, irregularly or indistinctly toothed, glaucous and nearly white beneath; bracts fuscous, obovate or cuneate, long-hairy; capsule silky or tomentose, stalked. *S. discolor.*
8. Petioles short; leaves narrowly lanceolate, usually falcate, narrowed at the base, glabrous or slightly pubescent, green on both sides or slightly paler beneath. *S. nigra.*
8. Petioles rather prominent and slender except in some individuals; leaves lanceolate or broader. 9.
9. Leaves dark-green above, glaucous or whitish beneath not coriaceous. 10.
9. Leaves yellow-green and glossy on both sides, thick, normally ovate, very long acuminate with a slender tip; catkins thick and dense, stamens mostly 3, flower bracts dentate; capsule large, short-pedicelled; twigs brown, polished. *S. lucida.*
10. Leaves ovate-lanceolate, broadest below the middle, acuminate, petioles often red; stamens 5-12; capsule narrow-conic, pedicel slender, 3-5 times as long as the gland; bark rough, brown. *S. amygdaloides.*
10. Leaves lanceolate, long-acute; stamens 2, capsules very narrow-conic, pedicel short, about twice as long as the gland; bark gray. *S. fragilis.*
10. Leaves lanceolate or oblong-lanceolate, rounded, subcordate, or narrowed at the base, 3-8 in. long; very white and somewhat pubescent beneath; capsule conic, pedicel slender, 3-5 times as long as the gland; bark dark reddish-brown with small scales. *S. longipes.*

1. **Salix nigra** Marsh. Black Willow. A medium-sized tree with rough, flaky, dark brown bark. Leaves narrowed at the base, serrulate, 2-5 in. long, $\frac{1}{6}$-$\frac{1}{2}$ in. wide, or wider; capsule ovoid, acute, about as long as its pedicel. Along streams and lakes. The subspecies S. nigra falcate (pursh.) Torr. has narrower more falcate leaves. Hybridizes with S. alba. N. B. to Ont., Fla., Cal., and Kan. Ohio.

2. **Salix lóngipes** And. Ward Willow. A tree with spreading or drooping branches and dark reddish-brown bark. Leaves lanceolate or oblong-lanceolate, rounded, subcordate, or narrowed at the base, 2-7 in. long, $\frac{1}{2}$-$1\frac{1}{2}$ in. wide, somewhat pubescent beneath; capsule conic. Wood dark brown. Along streams and lakes. Md. to Mo., south to Fla., and Texas.

3. **Salix amygdaloides** And. Peachleaf Willow. A tree with rough, brown, scaly bark. Leaves pubescent when young, glabrous when old, dark green above, pale and slightly glaucous beneath, narrowed at the base, 3-5 in. long, $\frac{1}{2}$-$\frac{3}{4}$ in. wide; capsule narrowly ovoid, acute, glabrous, finally about as long as the filiform pedicel. Along streams, lakes and ponds. Quebec to Br. Col., N. Y., Ohio, Mo., and N. Mex.

4. **Salix lùcida** Muhl. Shining Willow. A tall shrub or small tree with smooth or slightly scaly bark, the twigs yellowish brown and shining. Leaves lanceolate, ovate-lanceolate, or ovate, mostly long-acuminate, narrowed or rounded at the base, sharply serrulate, green and glossy on both sides or with a few scattered hairs when young, 3-5 in. long, $\frac{3}{4}$-$2\frac{1}{2}$ in. wide; capsule narrowly ovoid, acute, glabrous, much longer than its pedicel. A very beautiful willow in swamps and along streams and lakes. Newf. to N. W. Terr., N. J., Ohio, Ky., and Neb.

5. **Salix frágilis** L. Crack Willow. A tall slender tree with roughish, gray bark and green branches. Leaves lanceolate, long-acuminate, narrowed at the base, sharply serrulate, glabrous on both sides, rather dark green above, paler beneth, 3-6 in. long, $\frac{1}{2}$-1 in. wide; capsule long-conic. Twigs used for basket work. Native of Europe. Hybridizes with S. alba. Mass. to N. J. and Ohio.

6. **Salix álba** L. White Willow. A large tree with rough gray bark. Leaves lanceolate, narrowed at the base, serrulate, silky-pubescent on both sides when young, less so and pale and glaucous beneath when mature, 2-5 in. long, $\frac{1}{4}$-$\frac{1}{2}$ in. wide; capsule ovoid, acute. In moist soil. Native of Europe. The subspecies S. alba vitellina (L.) Koch., has the mature leaves glabrous and the twigs yellowish-green. N. B. and Ont. to Ohio and Penn.

7. **Salix babylónica** L. Weeping Willow. A large graceful tree with weeping branches, often planted in yards and cemeteries. Leaves linear-lanceolate, serrulate, narrowed at the base, glabrous when mature, green above, paler beneath, 3-6 in. long, $\frac{1}{4}$-$\frac{1}{2}$ in. wide; capsule ovoid-conic. Native of Asia.

8. **Salix balsamifera** (Hook.) Barr. Balsam Willow. Usually a shrub but sometimes arborescent with a slender erect stem. Leaves elliptic, ovate-oval, or obovate, thin, glabrous, acute at the apex, rounded or subcordate at the base, glaucous beneath, 2-3 in. long, $\frac{3}{4}$-$1\frac{1}{2}$ in. wide, slightly crenulate-serrulate; capsule very narrow, acute. In swamps. Lab. to Man. south to Me., Mich., and Minn.

9. **Salix missouriénsis** Bebb. Missouri Willow. A tree with small, appressed scales on the thin bark. Leaves lanceolate, or oblanceolate, acuminate, finely serrate with minute gland-tipped teeth, rounded or narrowed at the base, glabrous or nearly so when mature, pale and glaucous beneath, $2\frac{1}{2}$-5 in. long, $\frac{1}{2}$-1 in. wide; capsule ovoid. Wood dark brown. On river banks and in moist places. The closely related S. cordata is a shrub with pale bracts and the leaves not whitish beneath. Mo., Kan., Neb., and Iowa.

10. **Salix fluviátilis** Nutt. Sandbar Willow. A shrub or small slender tree usually forming thickets. Flowers can be found for a long time. Leaves linear-lanceolate, acuminate, remotely denticulate with somewhat spreading teeth, short-petioled; $2\frac{1}{2}$-4 in. long; capsule ovoid-conic, finely silky when young, glabrate in age. Along streams and ponds and in ravines, sometimes on high ground. Quebec to N. W. Terr., south to Va. and Texas, Ohio.

11. **Salix discolor** Muhl. Pussy Willow. A shrub or low tree in swamps or moist hill-sides. Leaves obovate, oblong or oblanceolate, usually glabrous, glaucous and nearly white beneath, irregularly serrulate or nearly entire, slender-petioled, $1\frac{1}{2}$-4 in. long; capsule narrowly conic, tapering to a slender beak. N. S. to Man., Del., Ohio and Mo.

12. **Salix bebbiàna** Sarg. Bebb Willow. A shrub or small tree. Leaves elliptic, oblong, or oblong-lanceolate, sparingly serrate or entire, dull green and puberulent above, pale and tomentose beneath, nearly glabrous when very old; capsule very narrowly long-conic, twice as long as the filiform pedicel. In dry soil along streams. Anticosti to Hudson Bay and Br. Col., south to N. J., Ohio, Neb., and Utah.

13. **Salix viminàlis** L. Osier Willow. A small slender tree or shrub with green twigs. Leaves long linear-lanceolate, sparingly repand-crenulate or entire, revolute-margined, short-petioled, glabrous above, silvery-silky beneath, 3-6 in. long; capsule narrowly ovoid-conic, acute. Cultivated for wicker-ware. Native of Europe and Asia.

14. **Salix purpùrea** L. Purple Willow. A slender shrub or small tree with smooth and very bitter bark, the branches often trailing. Leaves oblanceolate or spatulate, acute, serrulate, narrowed at the base, short-petioled, glabrous above, paler and somewhat glaucous beneath, $1\frac{1}{2}$-$2\frac{1}{2}$ in. long; capsule ovoid-conic, obtuse, tomentose. Cultivated for wicker-ware. Native of Europe.

Order, Myricales.

Myricaceae. Bayberry Family.

13. **Myrica** L. Bayberry.

Shrubs or trees with alternate simple leaves without stipules. Drupe globose or ovoid, its exocarp waxy. Flowers in catkins.

1. **Myrica cerifera** L. Wax-myrtle. A slender dioecious tree with gray, nearly smooth bark. In sandy swamps or wet woods. Pa. and Md. to Fla., and Tex. north to Ark.

Order, Juglandales.

Juglandaceae. Walnut Family.

14. **Jùglans** L. Walnut.

Trees with spreading branches, superposed buds, diaphragmed pith with cavities, and odd-pinnate leaves; monoecious. Fruit a nut in a fleshy husk. Staminate flowers in aments. Seed of nut edible.

1. Leaflets almost entire; nut rather smooth and thin-shelled; twigs glabrous. *J. regia.*
1. Leaflets serrate; nut rough, thick-shelled. 2.
2. Petioles smoothish or puberulent; axil of leaf without a hairy cushion below the buds; dark brown or black, rough; fruit globose, not viscid. *J. nigra.*
2. Petioles pubescent, sticky or gummy when young; axil of the leaf with a hairy cushion below the buds; bark gray, the ridges smooth on the surface; fruit oblong, viscid. *J. cinerea.*

1. **Juglans nigra** L. Black Walnut. A large tree with rough brownish black bark and a long tap root. Wood heavy, hard, strong, of coarse texture; heart-wood dark brown, of great value; used for cabinet-work, interior finish, gun-stocks, turnery, and as veneer. Common on flood plains of streams. Mass. to Ont. and Minn., south to Kan., Tex. and Fla., Ohio.

2. **Juglans cinèrea** L. Butternut. A large tree with gray bark the outer surface of the ridges smooth. Heart-wood lighter colored and softer than in J. nigra; used for ornamental cabinet-work, interior finish, and cooperage. In rich or rocky woods. N. B. to N. Dak., Neb., Del., Ga., Ark., and Ohio.

*. *Juglans. règia* L. English Walnut. A round-headed tree with the leaflets almost entire and nearly glabrous. Husk of the nut friable. Cultivated for the sweet nuts; from Asia.

15. **Hicòria** Raf. Hickory.

Trees with odd-pinnate leaves and serrate leaflets; monoecious. Axillary buds usually superposed; pith solid, 5-angled. Staminate flowers in aments. Fruit a nut in a husk.

1. Terminal bud-scales valvate, 4-6; leaflets 7-15, lanceolate or oblong-lanceolate, more or less falcate. 2.
1. Terminal bud-scales imbricate, more than 6; leaflets 3-9, not falcate, the uppermost larger and generally obovate. 4.
2. Nut elongated, almost terete, seed sweet; leaflets 11-15, inequilateral, acuminate. *H. pecan.*
2. Nut somewhat compressed or angled, usually as broad as long; seed intensely bitter; lateral leaflets falcate. 3.
3. Leaflets 7-9; nut smooth; husk thin, splitting to below the middle. *H. minima.*
3. Leaflets 9-13; nut angled, husk thin, splitting to the base. *H. aquatica.*
4. Terminal bud large, $\frac{1}{2}$-1 in. long; husk splitting freely to the base, nut angled, seed sweet; middle lobe of the staminate calyx narrow, often at least twice as long as the lateral ones. 5.
4. Terminal bud small, $\frac{1}{4}$-$\frac{1}{2}$ in. long; husk thin, not splitting freely to the base, nut slightly or not angled; lobes of the staminate calyx mostly nearly equal. 8.
5. Bark shaggy, separating in long plates; husk very thick, splitting to the base; outer bud-scales persisting through the winter. 6.

5. Bark close, rough; leaflets 7-9, stellate pubescent; outer bud scales falling away in autumn; husk not separating quite to the base; twigs and petioles tomentose. *H. alba.*
6. Leaflets 3-5, rarely 7, nut rounded at the base, ½-1 in. long. 7.
6. Leaflets 7-9; nut usually pointed at both ends, 1-1¼ in. long. *H. laciniosa.*
7. Leaflets oblong-lanceolate to obovate; twigs puberulent. *H. ovata.*
7. Leaflets narrowly lanceolate; twigs glaucous. *H. carolinae-septentrionalis.*
8. Fruit nearly globular; nut thin-shelled; bark of old trees separating in strips. 9.
8. Fruit obovoid; nut thick-shelled; bark close. 10.
9. Fruit little flattened; middle lobe of staminate calyx short; leaflets 5-7. *H. microcarpa.*
9. Fruit much flattened; middle lobe of staminate calyx long; leaflets 5, occasionally 3. *H. borealis.*
10. Leaves glabrous or nearly so; leaflets 5-7, rarely 3 or 9. *H. glabra.*
10. Leaves with silvery peltate glands; leaflets 5-9. *H. villosa.*

1. **Hicoria pecán** (Marsh.) Britt. Pecan (Hickory). A large tree of rapid growth with rough bark and a long tap root. Leaflets 11-15, oblong-lanceolate, short-stalked, inequilateral, acuminate; fruit oblong-cylindric; husk thin, 4-valved; nut smooth, oblong, thin-shelled, pointed, seed delicious and important commercially; wood like H. ovata. Along streams and in moist soil. Ind. to Iowa, south to Ky. and Tex.

2. **Hicoria minima** (Marsh.) Britt. Bitternut (Hickory). A slender tree with close rough bark. Leaflets 7-9, sessile, long-acuminate, the lateral ones falcate; fruit subglobose, narrowly 6-ridged; husk thin tardily and irregularly 4-valved; nut short-pointed, thin-shelled. Wood heavy, strong, and tough. In moist woods and swamps. Quebec to Minn., Fla., and Tex. Ohio.

3. **Hicoria aquática** (Mx. f.) Britt. Water Hickory. A tree with close bark, living in swamps. Leaflets 9-13, lanceolate, or the terminal one oblong, long acuminate at the apex, narrowed at the base, the lateral ones falcate; fruit oblong, ridged, pointed; husk thin, tardily splitting; nut oblong, thin-shelled, angular. Wood of poorer quality than that of other hickories. Va. to Fla., Ill., Ark., and Tex.

4. **Hicoria ovàta** (Mill.) Britt. Shagbark (Hickory).

A large tree with shaggy bark in narrow plates. Leaflets 5, sometimes 7, oblong, oblong-lanceolate, or the upper obovate, acuminate at the apex, narrowed to the sessile base; fruit subglobose; husk thick, soon splitting; nut white, somewhat compressed, pointed, slightly angled, thin-shelled. Seed finely flavored, most "hickory nuts" of the markets being from this species. Wood very heavy, hard, tough, and elastic; used for agricultural implements, carriages, wagon stock, axe-handles, cooperage, sucker rods, wheel spokes, etc. Also a fine fuel wood. Not durable in the ground. In rich soil. Quebec to Minn., Fla., Kan., Tex., and Ohio.

5. **Hicoria carolinae-septentrionàlis** Ashe. Southern Shagbark (Hickory). A tree with gray bark hanging in loose strips. Leaflets 3-5, glabrous, ciliate; fruit subglobose; husk soon falling into four pieces; nut white or brownish, much compressed, angled, cordate or subcordate at the top, thin-shelled. In sandy or rocky soil. Del. to Ga. and Tenn.

6. **Hicoria laciniòsa** (Mx. f.) Sarg. Shellbark (Hickory). A large tree with the bark separating in long narrow plates and with a long tap root. Leaflets 7-9, rarely 5, acute or acuminate, sometimes 8 in. long; fruit oblong; husk thick, soon splitting to the base; nut oblong, somewhat compressed, thick-shelled, pointed at both ends, yellowish-white; seed sweet and edible. In rich soil. N. Y. and Ohio to Iowa, Kan., Okla. and Tenn.

7. **Hicoria álba** (L.) Britt. Mockernut (Hickory). A large tree with close rough bark. Leaflets 7-9, oblong-lanceolate or the upper oblanceolate or obovate, long-acuminate; fruit globose or oblong-globose; husk thick; nut grayish-white, angled, pointed at the summit, little compressed, thick-shelled; kernel small but sweet and edible. Wood much like in H. ovata. In rich soil. Mass. to Ont., Neb., Fla., Tex. and Ohio.

8. **Hicoria microcàrpa** (Nutt.) Britt. Small Pignut (Hickory). A tree having the older bark separating in narrow plates. Leaflets 5-7, oblong, or ovate-lanceolate, acuminate at the apex; fruit globose or globose-oblong; husk thin, tardily and incompletely splitting to the base; nut subglobose, slightly com-

pressed, thin-shelled, pointed; seed sweet. In rich soil. Mass. to Ohio and Mich., Va. and Mo.

9. **Hicoria boreàlis** Ashe. Northern Hickory. A small tree with rough furrowed bark when young, becoming shaggy in narrow strips when old. Leaflets 5, occasionally 3, lanceolate; fruit ovoid, much flattened; husk very thin, rugose, coriaceous, usually not splitting; shell thin and elastic; seed large, sweet and edible. In dry uplands. Mich.

10. **Hicoria glàbra** (Mill.) Britt. Pignut (Hickory). A tree with close rough bark. Leaflets 3-7, rarely 9, oblong, oblong-lanceolate or the upper obovate, sessile, acuminate at the apex, usually narrowed at the base; fruit obovoid or obovoid-oblong; husk thin, the valves very tardily dehiscent; nut brown, angled, pointed, very thick-shelled; seed bitter and astringent, not edible. In dry or moist soil. Me. to Ont., Minn., Kan., Tex., Fla., and Ohio.

11. **Hicoria villòsa** (Sarg.) Ashe. Scurfy Hickory. A small or medium-sized tree with deeply furrowed, dark gray bark. Leaflets 5-9, thickly covered beneath with silvery peltate glands, mixed with resinous globules, generally pubescent; fruit obovoid, the husk partly splitting; nut brown, thick-shelled, angled; seed small, sweet. N. J. to Fla. and from Mo. and Ark. to Tex.

Order, FAGALES.

Betulaceae. Birch Family.

16. **Carpinus** L. Blue-beech.

Monoecous trees or shrubs with smooth gray bark and ridged stems. Flowers in aments. Leaves with straight and parallel lateral veins. Nuts small in a large-bracted catkin, bracts leaf-like.

1. **Carpinus caroliniàna** Walt. Blue-beech. A small tree with slender terete gray twigs. Wood white, very compact, strong, and heavy, not durable in the ground; used for turnery, tool handles, etc. The charcoal is used for making powder. In moist soil and along streams. N. S. to Minn., Fla., Tex., and Ohio.

17. **Ostrya** Scop. Hop-hornbeam.

Monoecious trees with the flowers in aments. Leaves with straight and parallel lateral veins. Nuts small, in a hop-like catkin.

1. **Ostrya virginiàna** (Mill.) Willd. Hop-hornbeam. A small tree with scaly bark. Wood white, compact, and very strong. In dry or moist soil. Cape Breton I. to Minn., Fla., Neb., Kan., Tex., and Ohio.

18. **Bétula** L. Birch.

Aromatic, monoecious trees or shrubs; bark usually papery or leathery; nuts small, samara-like, in a cone-like ament.

1. Leaves acute, obtuse, or truncate at the base, rarely cordate, prominently doubly serrate or serrate-dentate; bark chalky white or greenish brown; bark of twigs not with the flavor of wintergreen, usually bitter; fruiting aments peduncled. 2.

1. Leaves usually cordate or rounded at the base, sharply serrate, only slightly doubly serrate; bark brown or yellowish, close or separating into layers; bark of twigs with wintergreen flavor; fruiting aments sessile or nearly so. 5.

2. Bark of trunk and larger branches chalky white, usually peeling off in thin layers; fruiting aments cylindrical, pendant or spreading. 3.

2. Bark greenish brown, hardly peeling in layers; leaves rhombic, acute at both ends; young leaves and twigs tomentose; fruiting aments oblong, erect. *B. nigra.*

3. Leaves deltoid, very long acuminate at the apex; bark not readily separable into thin layers; twigs with numerous resinous glands. *B. populifolia.*

3. Leaves acute or acuminate, usually ovate, in some cultivated forms of various shapes; bark peeling off in thin layers. 4.

4. Leaves various, commonly triangular or rhombic-ovate, on slender petioles; twigs pendulous or weeping; much cultivated, from Europe and Asia. *B. alba.*

4. Leaves ovate or suborbicular; twigs pendulous; native, occasionally cultivated. *B. papyrifera.*

5. Bark not separating in layers, becoming furrowed; leaves shining above; fruiting bracts less than ¼ in. long, lobed at the apex. *B. lenta.*

5. Bark separating in layers or sometimes close, somewhat silvery; leaves dull above; fruiting bracts more than ¼ in. long, lobed to about the middle. *B. lutea.*

1. **Betula populifòlia** Marsh. American White Birch. A slender, short-lived tree with smooth white bark, tardily separating in thin sheets. Autumn leaves pure yellow. Wood soft, white, not durable; used for making spools, shoe-pegs, etc. Leaves tremulous like those of the aspens. In moist or dry soil. N. B. to Ont., and Del.

2. **Betula papyrifera** Marsh. Paper Birch. A large tree with chalky white bark separating in thin layers. The bark is very water-proof and is used for making canoes by Indians and trappers. Wood rather heavy, hard, and very close-grained; decays rapidly when exposed; used for making spools, pegs, shoe-lasts, woodenshoes, wagon hubs, ox-yokes, wood-carving, wood pulp, and in wood turnery. Newf. to Alaska, Penn., Mich., Neb., and Wash.

3. **Betula nigra** L. River Birch. A slender tree with reddish or greenish-brown bark peeling off in very thin layers. Branches long and slender, arched and heavily drooping. Wood rather light, hard, strong and close grained; used for furniture and turnery. "Birch brooms" are made from the twigs. Along streams. Mass. and N. H. to Iowa, Kan., Fla., Tex., and Ohio.

4. **Betula lénta** L. Sweet Birch. A large tree with dark brown, close, smooth bark, becoming furrowed and not separating in layers. Wood hard, fine-grained, of a reddish tint; used for cabinet-work. Newf. to Ont., Fla., Tenn., and Ohio.

5. **Betula lùtea** Mx. f. Yellow Birch. A large tree with yellowish or gray bark, separating in thin layers or close. Autumn leaves pure yellow. Wood hard and close-grained; used in making furniture, wheel-hubs, pill-boxes, etc. Newf. to Man., N. Car., Ga., Tenn., and Ohio

*. *Betula álba* L. European White Birch. A tree with chalky-white bark, much cultivated for ornament, especially the "weeping" and cut-leaved varieties.

19. **Alnus** Gaert. Alder.

Shrubs or trees with the flowers in aments, monoecious. Pith 3-angled; buds stalked. Nuts small, compressed, in woody cone-like catkins, which are persistent throughout the year.

1. Leaves obovate, broadly oval or suborbicular, dull; catkins expanding long before the leaves. 2.
1. Leaves oblong, shining above, catkins expanding in autumn. *A. maritima.*
2. Leaves finely tomentose or glaucous beneath. *A. incana.*
2. Leaves green, glabrous or sparingly pubescent beneath. 3.
3. Leaves finely serrulate, foliage not glutinous. *A. rugosa.*
3. Leaves dentate-serrate; twigs glutinous. *A. glutinosa.*

1. **Alnus incàna** (L.) Willd. Hoary Alder. A shrub or small tree with the young shoots pubescent. In wet soil. Newf. to N. W. Terr., N. Y., Penn., Ohio and Neb. Also in Europe and Asia.

2. **Alnus rugòsa** (DuRoi) Koch. Smooth Alder. A shrub or small tree with smooth bark, the young shoots somewhat pubescent. In wet soil or on hillsides. Me. to Ohio, Minn., Fla., and Tex.

3. **Alnus glutinòsa** (L.) Medic. European Alder. A tree of rapid growth, developing readily in ordinary dry soil. Usually in wet places. Native of Europe, N. Y. and N. J.

4. **Alnus maritima** (Marsh.) Muhl. Seaside Alder. A small tree, glabrous or nearly so. In wet soil. Del. and Md.; also in Okl.

Fagaceae. Beech Family.

20. **Fàgus** L. Beech.

Monoecious trees with smooth, light-gray bark. Leaves 2-ranked, the lateral veins straight and parallel. Twigs with prominent medullary rays and very long-pointed winter buds. Nut 3-angled, and enclosed in a 4-valved burr with soft spines.

1. **Fagus americàna** Sw. American Beech. A large tree, the lower branches spreading. Autumn leaves pure yellow. Nut sweet and edible. Wood hard, heavy, light-colored, rather close-grained, not durable in the ground; used for making chairs, handles, plane-stocks, shoe-lasts, in turnery, and for "acid wood." In rich but not necessarily deep soil. N. S. to Ont. and Wis., Ohio, Fla., and Tex.

21. **Castànea** Adans. Chestnut.

Trees or shrubs, the leaves mostly 2-ranked with straight and parallel lateral veins. Fruit a rounded coriaceous nut, several in a globose, mostly 4-valved, very spiny involucre.

1. Leaves green on both sides; large trees. *C. dentata.*
1. Leaves densely white-tomentose beneath; shrubs or small trees. *C. pumila.*

1. **Castanea dentàta** (Marsh.) Borkh. Chestnut. A large tree of very rapid growth with rough bark in longitudinal ridges. Nut sweet and edible. Wood soft, light, and coarse-grained; used for cabinet-work, railway ties, posts, cooperage, "acid wood," and telegraph poles. Sprouts freely from stumps. In rich or gravelly soil. Me. to Mich., Ga., Ala., and Ohio.

2. **Castanea pùmila** (L.) Mill. Chinquapin. A shrub or small tree. Nut very sweet. Wood much like in C. dentata. In dry soil. N. J. to Ind., Fla., and Tex.

22. **Quércus** L. Oak.

Trees or shrubs with the flowers in aments, monoecious. Pith 5-angled; buds clustered at the tip of the twigs. Fruit a 1-seeded corraceous nut (acorn) in an involucrate cup.

1. Leaves with bristle-tips; acorns maturing in the autumn of the second year. 2.
1. Leaves not bristle-tipped; acorns maturing the first year. 12.
2. Leaves pinnatifid or pinnately lobed. 3.
2. Leaves 3-5 lobed above the middle, or entire, obovate or spatulate in outline. 10.
2. Leaves entire, oblong, linear-oblong or lanceolate. 11.
3. Leaves green on both sides. 4.
3. Leaves white or gray-tomentose below. 8.
4. Cup of the acorn shallow, saucer-shaped, much broader than deep. 5.
4. Cup of the acorn top-shaped or hemispheric. 6.
5. Leaves dull; cup $\frac{1}{2}$-1 in. broad; acorn ovoid. *Q. rubra.*
5. Leaves shining; cup $\frac{1}{4}$-$\frac{1}{2}$ in. broad; acorn subglobose or short-ovoid. *Q. palustris.*
5. Leaves shining; cup $\frac{1}{2}$-$\frac{3}{4}$ in. broad; acorn ovoid. *Q. schneckii.*

6. Inner bark orange; leaves sometimes lobed to beyond the middle; acorn ovoid, more or less longer than the cup. *Q. velutina.*
6. Inner bark gray or reddish; leaves deeply lobed. 7.
7. Leaves dull and paler beneath; acorn ovoid. *Q. borealis.*
7. Leaves shining on both sides, lobed to near the mid-rib; acorn ovoid; cup ½ in. wide, more or less. *Q. ellipsoidalis.*
8. Leaf-lobes lanceolate or linear-lanceolate, long; large trees. 9.
8. Leaf-lobes triangular-ovate, short; shrubs or low trees. *Q. nana.*
9. Leaves rounded or obtuse at the base, 3-5 lobed; lobes linear or lanceolate, often falcate. *Q. digitata.*
9. Leaves cuneate or acute at the base, 5-11-lobed; lobes triangular. *Q. pagodaefolia.*
10. Leaves obovate-cuneate, brown-floccose beneath; cup deep, acorn ovoid. *Q. marylandica.*
10. Leaves spatulate, glabrous on both sides; cup saucer-shaped, acorn globose-ovoid. *Q. nigra.*
11. Leaves linear-oblong, green and glabrous on both sides. *Q. phellos.*
11. Leaves oblong or lanceolate, tomentulose beneath. *Q. imbricaria.*
12. Leaves pinnatifid or pinnately lobed. 13.
12. Leaves crenate or dentate, not lobed. 17.
13. Mature leaves pale, or glaucous and glabrous below. 14.
13. Mature leaves pubescent or tomentose below, lyrate-pinnatifid. 15.
14. Bark separating in thin scales, light gray or light brown; cup shallow; bracts thick and warty. *Q. alba.*
14. Bark furrowed and ridged, not scaly, dark gray or dark brown; cup hemispherical, with imbricated, appressed scales; cultivated in many varieties. *Q. robur.*
15. Upper scales of the cup not awned. 16.
15. Upper scales awned, forming a fringe around the acorn. *Q. macrocarpa.*
16. Leaves yellowish-brown, tomentulose beneath; acorn ovoid. *Q. minor.*
16. Leaves white-tomentulose beneath; acorn depressed-globose. *Q lyrata.*
17. Fruit peduncled; teeth or shallow lobes of the leaves rounded. 18.
17. Fruit sessile or nearly so; teeth or shallow lobes of the leaves acute. 20.
18. Peduncle much longer than the petioles; leaves white-tomentulose beneath. *Q. platanoides.*
18. Peduncle as long or shorter than the petioles; leaves gray-tomentulose beneath. 19.
19. Bark white, flaky; seed sweet and edible; fruit short peduncled or sessile. *Q. michauxii.*
19. Bark close; seed edible; petioles slender; peduncles equalling or shorter than the petioles. *Q. prinus.*

20. Shrub or low tree, leaves obovate or oval; seed edible. *Q. prinoides.*
20. Tall trees. 21.
21. Leaves mostly oblong to lanceolate; cup deep; bark close; seed edible. *Q. acuminata.*
21. Leaves obovate; cup shallow; bark more or less flaky. *Q. alexanderi*

1. **Quercus rùbra** L. Red Oak. A large tree with dark gray bark, somewhat roughened. Leaves oval or somewhat obovate, 4-8 in. long, dull green above, pâler beneath, lobes triangular-lanceolate, tapering from a broad base to an acuminate apex; cup saucer-shaped, its base flat or slightly convex $\frac{1}{2}$-1 in. broad; acorn ovoid, 2-4 times as long as the cup. Autumn leaves purplish red. Wood very coarse-grained, reddish in color, porous, and not very durable; used in carpentry, cooperage, and for clapboards. The most rapid grower of all the oaks. An important tree for tan-bark. Sprouts readily from stumps. N. S. to Ont., Minn., Fla., Kan., Tex., and Ohio.

2. **Quercus palústris** DuRoi. Pin Oak. A medium-sized tree with brown bark, rough when old, the lower branches deflexed. Leaves broadly oblong or obovate, deeply pinnatifid, brighter green and shining above, duller beneath, $2\frac{1}{2}$-5 in. long, the lobes oblong, lanceolate or triangular-lanceolate, divergent; cup saucer-shaped, $\frac{1}{4}$-$\frac{1}{2}$ in. broad, base flat; acorn subglobose or ovoid, 2-3 times as long as the cup. Wood coarse-grained, reddish, and not durable. In moist ground. Mass. to Ohio and Wis., Del. and Ark.

3. **Quercus schnéckii** Britt. Schneck's Red Oak. A medium-sized tree with reddish-brown bark with broad ridges broken into plates. Leaves mostly obovate, bright green and shining above, paler beneath, 2-6 in. long, truncate or broadly wedge-shaped at the base, deeply pinnatifid; lobes oblong or triangular; cup saucer-shaped, $\frac{1}{2}$ inch broad more or less, acorn ovoid, 2-3 times as high as the cup. Ind. to Iowa, Mo., Fla., and Tex.

4. **Quercus coccinea** Wang. Scarlet Oak. A tree with pale reddish or gray inner bark. Leaves deeply pinnatifid, glabrous, bright green above, paler beneath, 4-8 in. long; cup hem-

ispheric or top-shaped, acorn ovoid, about twice as long as the cup. Autumn leaves red. In dry soil. Me. to Minn., Fla., Mo., and Ohio.

5. **Quercus ellipsoidàlis** Hill. Oval-leaf Oak. A tall tree with gray, close, fissured bark, the innermost layer yellowish; lowest branches drooping. Leaves oval to obovate-orbicular, $2\frac{1}{2}$-6 in. long, deeply 5-7-lobed, broadly cuneate to truncate at the base; cup turbinate, short-peduncled, acorn ellipsoid to subglobose, $\frac{1}{2}$-$\frac{3}{4}$ in. long, 1-2 times as long as the cup. Ill., Mich., and Minn.

6. **Quercus boreàlis** Mx. f. Gray Oak. A large tree with leaves like those of *Q. rubra* and acorns like those of *Q. coccinea.* Leaves 7-13-lobed to the middle or somewhat beyond; cup turbinate, peduncled; acorn ovoid, 1-2 times as long as the cup. Quebec to Ont., N. Y. and Penn.

7. **Quercus velutina** Lam. Quercitron Oak. A large tree of rapid growth with very dark brown outer bark, rough in ridges, and bright orange inner bark. Leaves firm, sometimes lobed to beyond the middle, brown-pubescent or sometimes stellate-pubescent when young, glabrous when mature, the lobes broad, oblong or triangular-lanceolate; cup hemispheric or top-shaped, commonly narrowed into a short stalk; acorn ovoid, as long or longer than the cup. The inner bark (quercitron) yields a valuable dye; rich also in tannin. Wood hard, heavy, and strong but not tough. Sparingly self-prunes small twigs by means of basal joints. Me. to Minn., Fla., Neb., Tex., and Ohio.

8. **Quercus digitàta** (Marsh.) Sudw. Spanish Oak. A tree growing in dry soil. Leaves glabrous above, gray-tomentulose beneath, deeply pinnatifid into 3-7 linear or lanceolate lobes; cup saucer-shaped with a turbinate base, about $\frac{1}{2}$ in. broad; acorn subglobose or depressed, about twice as high as the cup. Wood very hard and strong; used for cooperage. An important tanbark oak. N. J. to Fla., Mo., Neb., and Tex.

9. **Quercus pagodaefòlia** (Ell.) Ashe. Swamp Spanish Oak. A tree with spreading branches and dark gray, rough bark. Leaves oval or oblong, cuneate to truncate at the base, 8-12 in. long, deeply 5-11-lobed, persistently white-tomentulose beneath,

lobes narrowly triangular, spreading or somewhat ascending, usually entire; cup sessile, shallow, acorn globose, about $\frac{1}{2}$ enclosed in the cup. In wet or moist soil. Va. and N. Car. to Ga., Ind., and Mo.

10. **Quercus nàna** (Marsh.) Sarg. Bear Oak. A shrub or small tree, often forming thickets. Leaves mostly obovate, 2-5 in. long, short-petioled, grayish-white tomentulose beneath 3-7-lobed, lobes triangular-ovate, acute; cup saucer-shaped, $\frac{1}{4}$-$\frac{1}{2}$ in. broad, with a turbinate or rounded base; acorn globose-ovoid, longer than the cup. In sandy or rocky soil. Me. to Pa., Del., and in mountains of N. C. and Ky.

11. **Quercus marylándica** Muench. Black-Jack (Oak). Usually a small shrubby tree; bark nearly black with very rough ridges. Leaves obovate, 3-5 lobed toward the broad usually nearly truncate apex, cuneate below, the lobes short, stellate-pubescent above, brown-tomentose beneath when young, mature leaves glabrous above; cup deep about $\frac{1}{2}$ in. broad; acorn ovoid, 2-3 times as high as the cup. In dry sterile soil. Hybridizes with *Q. phellos* and *Q. nana*. L. I. to Ohio, Neb., Fla., and Tex.

12. **Quercus nigra** L. Black Water Oak. A tree of rapid growth with gray bark, rough in ridges. Leaves spatulate or obovate, 1-3-lobed at the apex or some of them entire and rounded, short-petioled; cup saucer-shaped, rounded at the base, about $\frac{1}{2}$ in. wide; acorn globose-ovoid, 2-3 times as high as the cup. Wood heavy, hard, and strong; used for fuel. Usually along streams and swamps. Del. to Ky., Mo., Fla., and Tex.

13. **Quercus phéllos** L. Willow Oak. A tree with slightly roughened, reddish brown bark. Leaves narrowly-oblong or oblong-lanceolate, entire, very short petioled; cup saucer-shaped, nearly flat on the base; acorn subglobose, bitter. Wood poor. In moist woods. Hybridizes with *Q. nana* and probably *Q. rubra,* producing the form known as *Q heterophylla* Mx. L. I. to Fla., Mo., and Tex.

14. **Quercus imbricària** Mx. Shingle Oak. A large stout tree, the leaves dying off but remaining on the tree until about April 1. Leaves oblong or lanceolate, entire, persistently gray-tomentulose beneath, 3-7 in. long; cup hemispheric or turbi-

nate, about ½ in. broad; acorn subglobose, bitter. Wood poor; used for shingles and clapboards. Self-prunes twigs by means of basal joints. *Q. leana* Nutt. is a hybrid of this and *Q. velutina*. *Q. tridentata* Engelm. is a hybrid with *Q. marylandica*. Also hybridizes with *Q. palustris* and *Q. rubra*. Pa. to Mich., Neb., Ga., Ark., and Ohio.

15. **Quercus álba** L. White Oak. A large tree with light gray bark scaling off in thin plates. Leaves obovate, pinnatifid, lobes oblong, toothed or entire; cup depressed-hemispheric, its bracts thick and warty, appressed; acorn ovoid-oblong, 3-4 times as high as the cup, sweet and edible. Autumn leaves red and russet. Self-prunes extensively. Wood light-colored, hard and tough; valuable for many purposes; an ideal wood for railroad ties; used for poles, posts, and piling, for fuel and "acid wood," for cooperage, furniture, interior finishing lumber, farm implements, wharves, ship building, and car and wagon work. The most valuable of the American oaks. Hybridizes with *Q. macrocarpa, Q. minor, Q. prinus,* and *Q. acuminata.* Me. to Ont., Minn., Fla., Kan., Tex., and Ohio.

*. *Quercus ròbur* L. English Oak. A large strong tree with stout more or less spreading branches forming a broad round-topped head; self-prunes. Many forms are cultivated for ornament, including yellow-leaved and cut-leaved varieties, also forms with varied branches. Native of Europe.

16. **Quercus minor** (Marsh.) Sarg. Post Oak. A shrub or usually a small tree with a long tap root and with rough gray bark and valuable wood. Leaves broadly obovate, deeply lyrate-pinnatifid, glabrous above, brown-tomentulose beneath, 4-8 in. long; cup hemispheric, nearly sessile; acorn ovoid, 2-3 times as long as the cup, very sweet. In dry soil. Mass. to Ohio and Mich., Fla., and Tex.

17. **Quercus lyràta** Walt. Overcup Oak. A large tree with gray or reddish bark in thin plates. Leaves obovate, lyrate-pinnatifid or lobed to beyond the middle 6-8 in. long, shining above, densely white-tomentulose beneath, cup depressed-globose, peduncled, 1-1¼ in. broad; acorn depressed-globose, nearly or

quite immersed in the cup. Wood like in white oak. In swamps. N. J. to Ind., Mo., Fla., and Tex.

18. **Quercus macrocàrpa** Mx. Bur Oak. A large tree with flaky gray bark and with a long tap root. Leaves obovate or oblong-obovate, irregularly lobed, pinnatifid, or coarsely crenate; shining above, grayish-white-tomentulose beneath, 4-8 in. long; cup short peduncled or sessile, hemispheric or subglobose, ½-1 in. broad, the tips of the bracts forming a fringe around the acorn; acorn ovoid, 1-2 times as high as the cup. Self-prunes abundantly. A very valuable tree with hard and tough wood resembling the White Oak. In rich soil or on river bluffs where it is sometimes small and shrubby. Hybridizes with *Q. acuminata*. N. S. to Man., Mass., Ohio, Kan., and Tex.

19. **Quercus platanoides** (Lam.) Sudw. Swamp White Oak. A large tree with flaky gray bark. Leaves obovate, or oblong-obovate, coarsely toothed or sometimes lobed nearly to the middle, dull and glabrous above, densely white-tomentulose beneath; peduncles of the hemispheric cup 2-5 times as long as the petioles; acorn oblong-ovoid, seed rather sweet. Self-prunes. Wood similar in value to that of the White Oak. In moist or swampy soil. Quebec to Ohio and Mich., Ga., and Ark.

20. **Quercus michaùxii** Nutt. Cow Oak. A large tree with flaky white bark. Leaves obovate or broadly oblong, crenately toothed the teeth often mucronulate, 4-8 in. long, cup depressed-hemispheric, short-peduncled, 1-1¼ in. broad; acorns ovoid, about 3 times as high as the cup, sweet and edible. Wood valuable like the White Oak. In moist soil. Del. to Ind., Mo., Ark., Fla., and Tex.

21. **Quercus prinus** L. Rock Chestnut Oak. A large tree with brown bark, ridged, close or slightly flaky. Leaves oblong, oblong-lanceolate, or obovate, coarsely crenate, glabrous above, finely gray-tomentulose beneath, petioles slender; cup hemispheric, ½-1¼ in. broad, peduncles equalling or shorter than the petioles; acorn ovoid, 2-3 times as high as the cup, seed edible but not very sweet. Self-prunes. Wood hard and strong; used in fencing and for railroad ties. Bark rich in tannin. In dry soil. Me. to Ont., Ala., Tenn., and Ohio.

22. **Quercus acuminàta** (Mx.) Houda. Chestnut Oak. A tree with close gray bark. Leaves oblong, lanceolate, or sometimes obovate, coarsely toothed with acute teeth, shining above, pale and gray-tomentulose beneath, 4-6 in. long; cup sessile or very short-peduncled, hemispheric; acorn ovoid about twice as high as the cup, sweet and edible. Self-prunes abundantly. Wood strong and durable, much like White Oak. Usually in dry soil, commonly on lime stone ridges. Ont. to Minn., Ga., Ala., Tex., and Ohio.

23. **Quercus alexánderi** Britt. Alexander's Chestnut Oak. A tree with gray bark, flaky, especially when old. Leaves obovate or oblong-obovate, broadest above the middle, coarsely toothed; cup short-stalked or sessile, shallow; acorn ovoid, 2-3 times as high as the cup. Self-prunes. Vt. to Mich., and Ind.

24. **Quercus prinoides** Willd. Scrub Chestnut Oak. A shrub or small tree with gray bark. Leaves obovate, coarsely toothed, bright green and shining above, gray-tomentulose beneath, narrowed at the base; cup sessile, hemispheric, thin; acorn ovoid, 2-3 times as long as the cup; seed sweet and edible. Self-prunes. In dry sandy or rocky soil. Me. to Ohio and Minn., Ala., and Tex.

Order, Urticales.

Ulmaceae. Elm Family.

23. **Ulmus** L. Elm.

Trees of rapid growth with 2-ranked inequilateral leaves, the lateral veins straight and parallel. Flowers bisporangiate or imperfectly bisporangiate in clusters or racemes. Fruit a samara.

1. Leaves very rough above; inner bark very mucilaginous; twigs not corky-winged and not self-pruned, but large numbers of lateral buds cut off; samara not ciliate. *U. fulva.*
1. Leaves smooth or sometimes rather rough above; inner bark not mucilaginous. 2.
2. None of the branches corky-winged; twigs smooth, self-pruned by basal joints and by cleavage planes in the nodes of annual growth; samara faces glabrous. *U. americana.*
2. None of the branches with corky ridges; twigs glabrous or nearly so, not self-pruned; samara glabrous or nearly so, deeply notched. *U. campestris.*

2. Some or all of the branches corky-winged, or twigs puberulent, self-pruned; samara-faces pubescent. 3.
3. Most of the branches with corky wing-like ridges; twigs glabrous or nearly so; leaves 1-3 in. long. *U. alata.*
3. Branches often with corky wing-like ridges; twigs puberulent; leaves 2-5 in. long. *U. racemosa.*

1. **Ulmus americàna** L. White Elm. A large tree of rapid growth, with gray flaky bark, much cultivated in cities and along roadsides. Samara ovate-oval, its faces glabrous. Wood heavy, hard, flexible, and very tough; used for wheel-hubs, saddle-trees, rough cooperage and furniture, in boat and ship building, and in the construction of cars and wagons. Common on bluffs and on the flood plains of rivers and creeks. Graceful in form and very suitable for cultivation. Newf. to Man., Fla., Tex., and Ohio.

2. **Ulmus racemòsa** Thom. Cork Elm. A large tree with puberulent young twigs, the branches or some of them with corky wings. Samara oval, its margins densely ciliate. Wood harder, stronger, and more durable than that of the White Elm. In rich soil. Quebec to Ont., Mich., N. J., Tenn, Neb., and Ohio.

* *Ulmus campéstris* L. English Elm. A tree, rather pyramidal in shape, the twigs ascending, not drooping except in "weeping" forms. Samara not ciliate, nearly or quite glabrous. A good timber tree. Cultivated, from Europe.

3. **Ulmus alàta** Mx. Winged Elm. A small tree, branches usually with corky wing-like ridges; twigs glabrous or nearly so. Samara oblong, pubescent on the faces. Wood very compact; used for wheel hubs. In dry or moist soil. Va. to Fla., Ill., Ark., and Tex.

4. **Ulmus fúlva** Mx. Slippery Elm. A medium-sized tree with rough grayish-brown fragrant bark and rough-pubescent twigs. Samara oval-orbicular, pubescent over the seed. Inner bark mucilaginous and medicinal. Wood hard and strong but splitting easily when dry. Along streams, on flood plains and on hills. Quebec to N. Dak., Fla., Tex., and Ohio.

24. **Planera** Gmel. Planertree.

Trees similar to the elms but with a nut-like fruit and the flowers expanding with the leaves. Bark of the trunk scaling off in plates.

1. **Planera aquatica** (Walt.) Gmel. Planertree. A small tree with nearly glabrous leaves growing in swamps and on wet banks. Ind. to Mo., Ky., N. Car., La., and Fla.

25. **Céltis** L. Hackberry.

Trees or shrubs with 2-ranked leaves and the pith diaphragmed. Fruit an ovoid or globose drupe.

1. Leaves sharply serrate; smooth or scabrous above; twigs glabrous, especially the fruiting ones, or pubescent. *C. occidentalis.*
1. Leaves entire or few-toothed, small. *C. mississippiensis.*

1. **Celtis occidentális** L. Common Hackberry. A medium-sized tree with rough bark. Commonly much distorted with "witches brooms." Drupe sweet and edible. Self-prunes the fruiting twigs in winter. Wood heavy, hard, strong, quite tough, greenish-white. In dry soil and on flood plains. Quebec to Man., La., N. Car., Mo., Kan., and Ohio.

2. **Celtis mississippiénsis** Bosc. Southern Hackberry. A medium-sized tree with light gray, rough bark. Usually in dry soil. N. Car., to Ill., Mo., Kan., Fla., and Tex.

Moraceae. Mulberry Family.

26. **Mòrus** L. Mulberry.

Shrubs or trees with 2-ranked leaves and milky sap. Fruit aggregate, berry-like.

1. Leaves scabrous above, pubescent beneath. *M. rubra.*
1. Leaves smooth and glabrous on both sides, or nearly so. *M. alba.*

1. **Morus rùbra** L. Red Mulberry. A small tree with rough gray bark. Fruit dark purple-red, edible, delicious. Wood rather heavy, hard, strong, and rather tough; very durable in contact with the ground, very valuable for posts; used for farm implements, in cooperage, "acid wood," and ship building. In rich soil. Vt. and Ont., to Ohio and Mich., S. Dak., Fla, and Tex.

2. **Morus álba** L. White Mulberry. A small rapid-growing tree with rough light gray bark and spreading branches. Fruit edible but usually rather insipid. Leaves used for feeding silk-worms. Wood suitable for posts. Although growing best in rich moist soil, it does well in quite dry regions and should be much planted on the dry prairies, especially varieties with the better grade of berries. Introduced from the Old World. Me. and Ont., to Fla., Kan., and Ohio.

27. **Tóxylon** Raf. Osage-orange.

A tree with milky sap, sharp thorns, and entire leaves. Fruit a large spherical, greenish or yellowish syncarp.

1. **Toxylon pomiferum** Raf. Osage-orange. A small thorny tree much planted for hedges. Wood very heavy, exceedingly hard, and strong, but not tough, brownish-yellow; valuable for fence posts and fire wood, also used for wagon making. The thorns produce painful wounds. Horses acquire a strong liking for the young shoots and eat them in large quantities without apparent ill effects. Mo. and Kan. to Tex. Escaped in Ohio and other eastern states.

28. **Broussonétia** L'Her. Paper-mulberry.

Trees with 2-ranked leaves and milky sap. Drupes in a globular head.

1. **Broussonetia papyrifera** (L.) Vent. Paper-mulberry. A small, low-branching, large-headed tree with dark scarlet fruit which is sweet but insipid. Native of eastern Asia. In Japan and China the bark is made into paper. Escaped from cultivation. N. Y. to Ga., and Mo.

Order, PLATANALES.

Hamamelidaceae. Witch-hazel Family.

29. **Hamamèlis** L. Witch-hazel.

Trees or shrubs with alternate simple leaves and bisporangiate or imperfectly bisporangiate flowers. Fruit a 2-locular woody or cartilaginous capsule.

1. **Hamamelis virginiàna** L. Witch-hazel. A shrub or small tree with 2-ranked leaves and stalked buds. Blooms in late autumn. In low ground and on banks. N. B. and N. S. to Minn., Mo., Fla., Tex., and Ohio.

30. **Liquidámbar** L. Sweet-gum.

Large trees with resinous, aromatic sap. Capsules in a dense spinose globular head.

1. **Liquidambar styraciflua** L. Sweet-gum. A fine large tree with wide spreading branches, the twigs often covered with corky ridges. Leaves with a peculiar sweet fragrance when crushed. Autumn leaves red, yellow, and brown. Wood valuable, of medium weight, rather soft, strong, tough, and of fine texture, difficult to season. Sometimes used as a substitute for black walnut. Used for furniture, veneer, wooden plates, plaques, baskets, hat blocks and wagon hubs. In low ground. Conn., N. Y. and Ohio. to Fla., Ill., Mo., and Mex.

Platanaceae. Planetree Family.

31. **Plátanus.** L. Planetree.

Large trees, the twigs with complete stipular rings and the axillary buds covered by the base of the petiole. Fruit in a spherical head composed of numerous nutlets.

1. **Platanus occidentàlis** L. Sycamore. A very large tree, the largest in the northeastern United States, with whitish or green bark which peels off freely in thin plates; the largest trunks usually hollow. Autumn leaves brown. Wood rather hard, compact, coarse-grained, difficult to split, tough, and of a light-brown color; used for tobacco boxes, cooperage, cabinet-work, and finishing lumber. Along the banks of streams and in moist ground but grows well in ordinary mesophytic conditions. Me. to Ont. and Minn., Fla., Kan., Tex., and Ohio.

Sub-class, CHORIPETALAE.

Order, RANALES.

Magnoliaceae. Magnolia Family.

32. **Magnòlia** L. Magnolia.

Trees or shrubs with bitter aromatic bark, the twigs showing complete stipular rings. Flowers bisporangiate, large, solitary. Buds covered with conduplicate sheathing stipules. Pith usually diaphragmed but solid. Fruit aggregate, cone-like.

1. Leaves auriculate, glabrous. Leaf buds glabrous. *M. fraseri.*
1. Leaves rounded or truncate at the base, thin. Leaf buds silky pubescent. *M. acuminata.*
1. Leaves acute at the base. 2.
2. Leaves light green beneath, 1-2 ft. long. Leaf buds glabrous. *M. tripetala.*
2. Leaves glaucous beneath, 3-6 in. long. Leaf buds pubescent. *M. virginiana.*

1. **Magnolia fràseri** Walt. Fraser Magnolia. A tree with spreading branches and glabrous leaf buds. Leaves elongated-obovate or oblong, auriculate, ½-2 ft. long; flowers white. In mountain woods. Va. and Ky. to Fla. and Miss.

2. **Magnolia tripétala** L. Umbrella Magnolia. A low tree with glabrous leaf-buds and irregular branches. Leaves obovate, acute, cuneate at the base, 1-2 ft. long, flowers white, slightly odorous. Wood soft and light. Penn. to Ga., Ark., and Miss.

3. **Magnolia virginiàna** L. Laurel Magnolia. A tree with pubescent leaf buds. Leaves oval or oblong, acute at the base, 3-6 in. long; flowers white, deliciously fragrant. In swamps. Mass. to Penn., Fla., and Tex.

4. **Magnolia acuminàta** L. Cucumber Magnolia. A large tree with silky pubescent leaf-buds. Leaves oval, acute or somewhat acuminate, rounded or truncate at the base ½-1 ft. long; flowers greenish-yellow. Wood soft, light, and durable; used for cabinet-work, pump-logs, and water-troughs. N. Y. to Ohio and Ill., Ga., Ala., and Ark.

33. **Liriodéndron** L. Tuliptree.

Trees with alternate truncate leaves, diaphragmed but solid pith, and complete stipular rings. Fruit aggregate, cone-like.

1. **Liriodendron tulipifera** L. Tuliptree. A very large, magnificent, rapid-growing tree with glabrous leaf-buds. Flowers greenish-yellow, orange-colored within. Buds covered with con-

duplicate sheathing stipules. Autumn leaves pure yellow. Next to the Sycamore, probably the largest tree in the Northeastern United States. Wood light, soft, and straight-grained, easily worked; heart wood light yellow or brown; sapwood thin, nearly white. Used for interior finish, shingles, boat-building, panels of carriages, wooden pumps, wooden ware of various kinds, wood pulp, furniture, implements, boxes, shelving, drawers, and for carving and toys. One of the best woods for panelling. Should be extensively cultivated. Vt. and R. I. to Fla., Ohio, Mich., and Ark.

Anonaceae. Custard-apple Family.

34. **Asimina** Adans. Papaw.

Small trees or shrubs with naked silky buds. Leaves 2-ranked; pith diaphragmed but solid; bark with fetid odor.

1. **Asimina triloba** (L.) Dunal. Papaw. A small tree or shrub with smooth dark bark and nodding young twigs. Flowers axillary, nodding; fruit a large fleshy, oblong, greenish-yellow, edible berry which, however, does not agree with some persons. A case of severe poisoning from eating the fruit is recorded. In creek and river bottoms and on hillsides. Ont. and N. Y. to Mich., Neb., Tex., Fla., and Ohio.

Lauraceae. Laurel Family.

35. **Sássafras** Nees and Eberm. Sassafras.

A tree with yellow dioecious flowers and spicy aromatic bark. Fruit a blue drupe.

1. **Sassafras sássafras** (L.) Karst. Sassafras. A large rough-barked tree, the sap of the bark and leaves mucilaginous. Autumn leaves red, yellow, and green. Wood reddish, light and rather soft, of coarse texture, durable; used in cooperage, for small boats, and fencing. The bark of the roots yields a powerful, aromatic stimulant. Fruit pungent, poisonous. Excessive doses of sassafras tea produce narcotic poisoning. In dry or sandy soil. Me. to Ont., Mich., Fla., Tex., and Ohio.

Order, ROSALES.

Rosaceae. Rose Family.

Pomatae. Apple Subfamily.

36. **Sórbus** L. Mountain-ash.

Trees or shrubs with odd-pinnate leaves, the leaflets serrate. Fruit a small red berry-like pome in compound cymes.

1. Leaflets glabrous above. 2.
1. Leaflets pubescent on both sides; calyx and pedicels usually woolly. *S. aucuparia.*
2. Leaflets long-acuminate; fruit less than ¼ in. in diameter. *S. americana.*
2. Leaflets obtuse or short-pointed; fruit more than ¼ in. in diameter. *S. sambucifolia.*

1. **Sorbus americàna** Marsh. American Mountain-ash. A small tree with smooth bark. Bark and unripe fruit very astringent. In moist ground. Much prized for ornamental planting. Newf., Man., N. Car., and Mich.

2. **Sorbus sambucifòlia** (C. & S.) Roem. Elderleaf Mountain-ash. A small tree with smooth bark. In moist ground. Lab. to Alaska, N. Eng., Ohio, Mich., and in Rocky Mts. to Colo. and Utah.

3. **Sorbus aucupària** L. European Mountain-ash. A small tree, native of Europe. Frequently cultivated. Fruit poisonous to man, but eaten by some birds. N. S. to N. H.

37. **Pyrus** L. Pear.

Trees or shrubs with simple leaves. Fruit a pome, its flesh containing grit-cells.

1. **Pyrus commùnis** L. Pear. A pyramidal usually slender tree, often with thorn-like stunted branches. Bark smooth. Cultivated for its large fleshy fruit. Native of Europe and Asia. Me to N. J. and Ohio.

38. **Màlus** Hill. Apple, Crab-apple.

Trees or shrubs with simple leaves. Fruit a fleshy pome without grit-cells.

1. Leaves glabrous, at least when mature. 2.
1. Leaves persistently pubescent or tomentose beneath. 3.
2. Leaves oblong, oval, or lanceolate, narrowed at the base. *M. angustifolia.*
2. Leaves ovate, rounded or cordate at the base, often somewhat lobed. *M. coronaria.*
2. Leaves ovate, acute or acuminate at the apex and acute at the base, on slender petioles; finely and nearly evenly serrate. *M. baccata.*
3. Leaves mostly narrowed at the base; pome 1-2 in. in diameter. 4.
3. Leaves rounded or cordate at the base; pome usually large, 2-4 in. in diameter. *M. malus.*
4. Pedicel slender, pubescent, 1-2 in. long. *M. ioensis.*
4. Pedicel stout, white-tomentose, ½-1 in. long. *M. soulardi.*

1. **Malus angustifòlia** (Ait.) Mx. Narrowleaf Crab-apple. A small tree usually with thorn-like stunted branches or spurs. Leaves oblong, oblong-lanceolate, or oval, thick, shining above, sometimes pubescent beneath when young, dentate or often entire. On low ground. N. J. to Ill., Kan., Fla., La., and Ohio.

2. **Malus coronària** (L.) Mill. Fragrant Crab-apple. A small tree with hard and sour fruit suitable for preserving. Leaves ovate, to triangular-ovate, sparingly pubescent beneath when young, sharply serrate and often somewhat lobed. On low ground. Ont. to Mich., and S. Car., Ohio.

3. **Malus ioénsis** (Wood) Britt. Iowa Crab-apple. A small tree much resembling M. coronaria. Leaves ovate, oval, or oblong, dentate, crenate or with a few rounded lobes, white-pubescent beneath at length glabrous above. Minn., Wis., and Ill. to Neb., Ky., La., and Okl.

4. **Malus soulàrdi** (Bail.) Britt. Soulard Crab-apple. A small tree resembling the two preceding. Leaves ovate, elliptic or obovate, irregularly crenate-dentate or sometimes few-lobed, rugose and densely tomentose beneath. Minn. to Mo. and Tex.

*. *Malus baccàta* (L.) Siberian Crab-apple. A small spreading tree with compact crown. Pedicels very slender; fruit small, not becoming mellow. Cultivated.

5. **Malus màlus** (L.) Britt. Common Apple. A medium-sized tree with spreading branches. Leaves ovate or oval, glabrous or nearly so above, pubescent and often woolly beneath.

Fruit large, various. Introduced from Europe and escaped in many places. The seeds are poisonous. Me. to N. Y., N. J., Ohio, and Ga.

39. **Cydònia** Tourn. Quince.

Shrubs or low, small trees with fleshy pomes.

*. *Cydonia cydònia* (L.) Karst. Quince. A low tree with crooked stem and rambling branches. Cultivated for the large sour fleshy fruit.

40. **Amelánchier** Medic. Juneberry.

Shrubs or small trees with simple mostly 2-ranked leaves and small berry-like pomes.

1. Leaves acute or acuminate at the apex; top of the ovulary glabrous or nearly so. 2.
1. Leaves rounded, obtuse or subacute at the apex; top of the ovulary woolly; petals $\frac{1}{2}$-$\frac{3}{4}$ in. long. *A. rotundifolia.*
2. Leaves glabrous when mature, but pubescent or woolly when young, ovate to ovate-lanceolate; base cordate or rounded. *A. canadensis.*
2. Leaves densely white-woolly beneath, at least when young, oblong to obovate, rarely sub-cordate at the base. *A. botryapium.*

1. **Amelanchier canadénsis** (L.) Med. Common Juneberry. A medium-sized tree with a small, red or purple, sweet and edible, berry-like pome. In dry soil. Newf. to Ont., Fla., La., and Ohio.

2. **Amelanchier botryàpium** (L. f.) DC. Swamp Juneberry. A shrub or small tree growing in swamps and moist soil. N. B. to Man., Fla., La., and Ohio.

3. **Amelanchier rotundifòlia** (Mx.) Roem. Roundleaf Juneberry. A tall shrub or small tree growing in woods and thickets. N. B. to Minn., N. Y., Ohio and Mich.

41. **Crataègus** L. Hawthorn.

Small trees or shrubs usually with typical, sometimes branched thorns. Pome drupe-like with bony ripe carpels. Only the common tree-forms are here included.

1. Corymbs many flowered. 2.
1. Corymbs 1-7 flowered; calyx-lobes deeply incised; leaves obovate or spatulate, obtuse.. *C. uniflora.*

2. Leaves obovate, spatulate, oblanceolate, or flabellate. 3.
2. Leaves ovate, oval, orbicular-obovate, or nearly orbicular. 5.
3. Leaves, calyx, and peduncles glabrous; oblanceolate or obovate, sharply serrate. 4.
3. Lower surface of leaves, calyx, and peduncles more or less pubescent, at least when young; leaves slender-petioled, obovate, dull, irregularly serrate; fruit large, red or yellow, globose or oval. *C. punctata.*
4. Thorns long, slender; leaves shining; fruit globose or slightly pear-shaped, dark red. *C. crus-galli.*
4. Thorns short, stout, leaves dull; fruit globose, purple-black. *C. brevispina.*
5. Leaves, calyx, and peduncles glabrous or nearly so. 6.
5. Lower surface of leaves or their teeth, calyx, and peduncles pubescent or glandular. 9.
6. Leaves mainly truncate or cordate at the base. 7.
6. Leaves narrowed or wedge-shaped at the base. 8.
7. Leaves lobed; fruit depressed-globose, $\frac{1}{4}$ in. or less high, bright red. *C. cordata.*
7. Leaves irregularly serrate; fruit glaucous, sub-globose, $\frac{1}{2}$ in. high. *C. eggerti.*
8. Leaves deeply cleft; fruit globose or globose-ovoid, small, coral-red. *C. oxyacantha.*
8. Leaves serrate or somewhate lobed; fruit globose or oval, persistent into the winter. *C. viridis.*
9. Leaves glabrous or nearly so. 10.
9. Leaves pubescent, especially along the veins beneath. 12.
10. Leaves or most of them truncate or cordate at the base, sharply incised and serrate; fruit globose or oval, red. *C. coccinea.*
10. Leaves or most of them narrowed at the base. 11.
11. Fruit about $\frac{1}{2}$ in. in diameter, globose to oval, red; bractlets and calyx very glandular. *C. rotundifolia.*
11. Fruit about $\frac{1}{4}$ in. in diameter, globose or oval; bractlets and calyx glandular. *C. macrantha.*
12. Leaves mostly truncate or cordate at the base, ovate-orbicular; fruit bright red, hairy. *C. mollis.*
12. Leaves mostly cuneate or narrowed at the base, ovate or oval, sharply dentate or somewhat lobed; fruit oval or oblong, large, crimson or orange-red, eatable. *C. tomentosa.*

1. **Crataegus crús-gálli** L. Cockspur Hawthorn. A small tree with spreading branches and numerous slender thorns. Leaves coriaceous, shining above, sharply serrate. Fruit remain-

ing on the branches until late in the winter. The best hawthorn for hedges. Quebec to Manitoba, N. H., Fla., Tex., and Ohio.

2. **Crataegus brevispina** (Dougl.) Farw. Black Hawthorn. A small tree. Leaves obovate, unequally serrate or somewhat lobed, cuneate or narrowed at the base. Mich., to Br. Col., Colo., and Ore.

3. **Crataegus punctàta** Jacq. Dotted Hawthorn. A shrub or small tree with horizontal wide-spreading branches. Leaves obovate, slender-petioled, irregularly serrate or serrulate. Fruit somewhat edible. Quebec and Ont., to N. H., Ga. and Iowa. Ohio.

4. **Crataegus cordàta** (Mill.) Ait. Washington Hawthorn. A tree with slender thorns. Leaves broadly ovate, generally sharply 3-7-lobed and serrate. A very desirable species for cultivation. Va. to Ga., Ill., anl Tenn. Also from N. J. to Ohio.

5. **Crataegus éggerti** Britt. Eggert Hawthorn. A small tree growing in dry soil. Leaves ovate-orbicular, dull green above, pale beneath, sharply and irregularly serrate or somewhat lobed. Iowa to Mo. and Kan.

6. **Crataegus oxyacántha** L. English Hawthorn. A shrub or small tree with numerous stout thorns. Leaves broadly ovate or slightly obovate, sharply 3-7-lobed. Sparingly escaped from cultivation. Ohio.

7. **Crataegus viridis** L. Green Hawthorn. A small tree often without thorns. Fruit persisting into the winter. Leaves ovate to lanceolate or somewhat obovate, sharply serrate, and somewhat lobed. Mo. and Kan. to Tex., S. Car., and Fla.

8. **Crataegus coccinea** L. Scarlet Hawthorn. A shrub or small low tree with crooked spreading branches and short stout thorns. Leaves broadly ovate or orbicular, sharply incised and serrate, teeth gland-tipped. Fruit somewhat edible. Of considerable decorative value. Petioles with glands. Newf. to Man., Fla., Tex., and Ohio.

9. **Crataegus rotundifòlia** (Ehrh.) Borck. Glandular Hawthorn. A shrub or small tree, the petioles with glands. Leaves oval, ovate, obovate, or nearly orbicular, incised-serrate

with gland-tipped teeth, or sometimes lobed. Conn. to Ind., Fla., Ala., and Ohio.

10. **Crataegus macracántha** Lodd. Longspine Hawthorn. A shrub or small tree with bright brown thorns, the petioles glandular. Leaves sharply and often doubly serrate with gland-tipped teeth. Quebec to N. Dak., Va., Mo., and Ohio.

11. **Crataegus móllis** (T. & G.) Scheele. Downy Hawthorn. A small tree with short stout thorns and with densely pubescent twigs. Leaves usually broadly ovate, incised and sharply serrate with gland-tipped teeth. One of the best hawthorns. Quebec to Mich., Neb., Kan., Penn., La., Tex., and Ohio.

12. **Crataegus tomentòsa** L. Pear Hawthorn. A small thickly branching tree with stout thorns and tomentose twigs. Leaves broadly oval or ovate-oval, sharply dentate or somewhat lobed. Ont. to N. J., Ga., Ohio, Mich., and Mo.

13. **Crataegus uniflòra** Muench. Dwarf Hawthorn. A shrub or small tree, the branches with numerous slender thorns. Leaves coriaceous, nearly sessile, crenate at the apex and entire at the base. In sandy soil. N. Y. to Fla., W. Va., Mo., and La.

Drupatae. Plum Subfamily.

42. **Prùnus** L. Plum, Apricot, Cherry.

Trees or shrubs, the fruit a drupe, mostly edible. Leaves alternate, simple, with glands on the petioles or at the base of the blade; some of the leaves often without glands. Terminal bud sometimes self-pruned, and in some species also twigs of various sizes.

1. Flowers in lateral umbellate clusters or somewhat corymbose, expanding with or before the leaves; stone flattened or globular; terminal bud of twigs absent or present. 2.
1. Flowers in racemes, terminating twigs of the season; stone globular; terminal bud of twigs present. 9.
1. Flowers corymbose, terminating twigs of the season; leaves ovate, abruptly acute at the apex, rounded or slightly cordate at the base; fruit small, stone slightly flattened; terminal bud of twigs present. *P. mahaleb.*

1. Flowers solitary or in twos, appearing before the leaves; fruit velvety, stone compressed; leaves ovate to round-ovate, abruptly pointed; terminal bud of twigs absent. *P. armeniaca.*
2. Leaves mostly convolute in vernation; fruit usually large; stone more or less flattened; terminal bud of twigs absent. 3.
2. Leaves conduplicate in vernation; fruit mostly small; stone mostly globose; terminal bud of twigs present. 8.
3. Leaves abruptly acuminate; drupe red or yellowish. 4.
3. Leaves obtuse, acute, or gradually acuminate; drupe red or purple. 6.
4. Calyx lobes entire, pubescent within; drupe globose; leaves ovate or obovate. *P. americana.*
4. Calyx lobes glandular-serrate; drupe subglobose or oval. 5.
5. Calyx lobes glabrous within; leaves oval or obovate. *P. nigra.*
5. Calyx lobes pubescent on both sides; leaves ovate-lanceolate. *P. hortulana.*
6. Leaves glabrous when mature, acute or acuminate. 7.
6. Leaves pubescent beneath, not pointed, ovate or obovate. *P. domestica.*
7. Leaves lanceolate; drupe red, thin-skinned, with little or no bloom. *P. angustifolia.*
7. Leaves ovate; drupe dark purple with a bloom. *P. alleghaniensis.*
8. Leaves glabrous; inflorescence umbellate; drupe with thick flesh, sour. *P. cerasus.*
8. Leaves glabrous, shining; inflorescence more or less corymbose; drupe with thin sour flesh. *P. pennsylvanica.*
8. Leaves pubescent beneath at least on the veins; inflorescence umbellate; fruit sweet. *P. avium.*
9. Fruit red or purple, astringent; leaves obovate or oval, abruptly acute or acuminate, thin; glands on the petiole usually rounded or disc-like; bark gray. *P. virginiana.*
9. Fruit dark-purple or black, sweet; leaves oval or obovate, acute or obtusish, thick; otherwise much like the preceding. *P. demissa.*
9. Fruit dark-purple or black, sweet; leaves oval-lanceolate to ovate, acuminate or acute; glands on the petiole usually elongated and tooth-like; bark black. *P. serotina.*

Plums and Apricot.

*. *Prunus armeniaca* L. Apricot. A small round-topped tree with reddish bark. Drupe nearly smooth, short stalked, yellow, edible. Cultivated.

1. **Prunus americàna** Marsh. Wild Plum. A shrub or small tree with stunted thorn-like branches and thick black bark.

Leaves ovate, or obovate sharply and often doubly serrate, rounded at the base, slender-petioled. Drupe with a tough skin, globose, red or yellowish, edible. Often used as a stock on which to graft domestic plums. Wood hard, reddish in color. N. Y. to Mont., Fla., Colo., and Ohio.

2. **Prunus nigra** Ait. Canada Plum. A tree with thin bark. Leaves oval, ovate, or obovate, long-acuminate, crenulate-serrate; drupe oval, orange-red, thick-skinned, with little or no bloom. Petals pink in age. Newf. to Man., Mass. and Wis.

3. **Prunus hortulàna** Bail. Wild-goose Plum. A small tree with spreading branches and thin bark. Leaves ovate-lanceolate to ovate, long-acuminate, closely glandular-serrate. Drupe bright red and thin-skinned, edible. Ill. to Kan., Tenn., and Tex.

4. **Prunus angustifòlia** Marsh. Chickasaw Plum. A small tree with thorn-like stunted branches. Leaves acute, serrulate, often rounded at the base. Drupe globose, red, and edible. In dry soil. N. J. to Fla., west to Rocky Mts.

*. *Prunus doméstica* L. Common Garden Plum. A small tree with about 100 cultivated varieties. Drupe of various colors, covered with a thick glaucous bloom.

5. **Prunus alleghaniénsis** Port. Alleghany Plum. A low shrub or small tree, seldom thorny. Leaves acute or acuminate, finely serrate, rounded at the base. Drupe pleasantly acid, globose-ovoid, with a conspicuous bloom. Penn.

Cherries.

6. **Prunus cérasus** L. Sour Cherry. A small tree with globose, red or reddish-black, sour, edible drupes. Leaves ovate or ovate-lanceolate, abruptly acute or acuminate, rounded at the base, very resinous when young. Self-prunes the fruiting branchlets. Native of Europe. N. H. and Mass. to N. Y. and Ohio.

7. **Prunus àvium** L. Sweet Cherry. A medium-sized tree with globose, black or dark red, sweet, edible drupes. Leaves ovate, oval, or slightly obovate, abruptly short-acuminate, irregularly serrate. Native of Europe. Ont. to Mass., Ohio and Va.

8. **Prunus pennsylvánica** L. f. Red Cherry. A small tree with sour globose, red drupes. Leaves oval or lanceolate,

acute or acuminate, mainly rounded at the base, glabrous, serrulate. Leaves poisonous; kernels probably poisonous. In rocky woods. Newf. to Ga., west to Rocky Mts. Ohio.

9. **Prunus mahàleb** L. Mahaleb Cherry. A small tree with pale smooth bark. Leaves ovate, abruptly acute at the apex, rounded or slightly cordate at the base, denticulate, glabrous, fragrant. Drupes with thin flesh and slightly flattened stone. From Europe. Conn. to Ont., N. Y., to Ohiò and Kan.

10. **Prunus virginiàna** L. Choke Cherry. A shrub or small tree with gray bark. Leaves obovate or broadly oval, abruptly acute or acuminate at the apex, rounded at the base, serrulate with slender teeth, glabrous or nearly so. Drupe red to nearly black, sometimes yellow, very astringent, not edible. Leaves poisonous; kernels probably poisonous. Self-prunes leafy fruiting branches. Along river banks and in rocky places. Newf. to Man., Br. Col., Ga., Neb., Tex., Colo., and Ohio.

11. **Prunus demissa** (Nutt.) Walp. Western Choke Cherry. A shrub or small tree; drupe dark purple or black, globose, sweet or somewhat astringent. Leaves similar to those of the preceding, thicker, acute or often obtusish at the apex, with shorter teeth. Probably poisonous like the last. On bluffs, and dry ground. N. Dak. to Kan., N. Mex., Br. Col., and Cal.

12. **Prunus serótina** Ehrh. Black Cherry. A large tree with rough, black, flaky bark; drupe globose, dark-purple or black, sweet but slightly astringent. Leaves oval, oval-lanceolate, or ovate, acuminate or acute, serrate with appressed teeth. Leaves very poisonous to cattle, especially when half-wilted. Kernels very poisonous. Wood rather heavy, hard, strong, of fine texture, of a brown or reddish color; much used in cabinet-work and interior finish, especially in cars and boats, also used in turnery. Self-prunes twigs by means of cleavage planes in basal joints. Ont. to Fla., N. Dak., Kan., Tex., and Ohio.

42. **Amygdalus** L. Peach.

Trees or shrubs. Drupe in our species velvety with a deeply pitted stone.

1. **Amygdalus pérsica** L. Peach. A small tree with

beautiful pink or white flowers and a large edible drupe. Leaves with prominent nectar glands on the petiole or at the base of the blade. Leaves and kernels bitter, poisonous. Native of Asia; abundantly escaped. Ohio.

Fabaceae. Pea Family.

Cassiatae. Senna Subfamily.

44. **Cércis** L. Redbud.

Small trees or shrubs with simple, palmately veined, 2-ranked leaves. Fruit a flat bean.

1. **Cercis canadénsis** L. Redbud. A small tree with bright red-purple flowers before the leaves; fine for ornamental purposes. Wood hard and heavy, beautifully variegated. In rich soil. Easily cultivated. Ont. to Minn., Neb., N. J., Fla., Tex., and Ohio.

45. **Gleditsia** L. Honey-locust.

Large usually thorny trees with evenly once or twice pinnate leaves and superposed buds. Fruit a bean.

1. Pod linear-oblong, many seeded, pulpy within; leaflets short stalked, oblong-lanceolate or oval, obtuse at both ends, inequilateral at the base. *G. triacanthos.*

1. Pod obliquely oval, 1-seeded, not pulpy; leaflets thicker, darker green, usually larger, ovate-lanceolate or lanceolate, the margin more crenulate. *G. aquatica.*

1. **Gleditsia triacánthos** L. Honey-locust. A large tree of rapid growth, usually with stout branching or simple thorns and with rough bark. Used as a hedge plant. Autumn leaves pure yellow. Wood heavy, hard, strong, and tough; used for fencing, fuel and wagon hubs. Sprouts freely from the roots if disturbed by plowing. Grows well in dry or sandy soil. Ont. to S. Dak., Ohio, Ga., Kan., and Tex.

2. **Gleditsia aquática** Marsh. Water Honey-locust. A tree growing in swamps. Ind. to Mo., S. Car., Fla., and La.

46. **Gymnócladus** Lam. Coffee-bean.

Trees with large evenly bipinnate leaves, superposed buds sunken in the epidermis, and large chocolate-colored pith. Fruit a woody bean.

1. **Gymnocladus dioica** (L.) Koch. Coffee-bean. A large, slow-growing tree with rough bark and few branches. Bean short and thick, the greenish pulp within poisonous. The bruised leaves are used as a fly poison, and the seeds have been used as a substitute for coffee. Wood compact, heavy, hard, strong, tough, reddish in color, of coarse texture, and taking a good polish; used to some extent in cabinet-work. In rich soil. Ont to Ohio and Penn., Tenn., S. Dak., and Okl.

Papilionatae. Pea Subfamily.

47. **Cladrástis** Raf. Yellow-wood.

Trees with odd pinnate leaves and showy, fragrant, white flowers. Axillary buds superposed, covered by the base of the petiole. Fruit a slender bean.

1. **Cladrastis lùtea** (Mx.) Koch. American Yellow-wood. Trees with smooth bark, close like in the beech. Wood light-yellow. In rich soil; much planted. Ky., Mo., Tenn., and N. Car.

48. **Robinia** L. Locust.

Trees or shrubs with odd-pinnate leaves and usually with spiny stipules. Fruit a bean.

1. Twigs, petioles and pods glabrous or nearly so; flowers white. *P. pseudacacia.*
1. Twigs and petioles glandular; pods hispid; flowers pinkish. *P. viscosa.*

1. **Robinia pseudacàcia** L. Common Locust. A large slender tree with very rough bark, of rapid growth. Wood very heavy, hard, strong, tough, valuable, and very durable in contact with the ground; used for posts, railroad ties, wagon hubs, furniture, and in ship building. All parts of the plant very poisonous.

It is troublesome from sprouting from the roots. Penn. and Ohio to Ga., Iowa, Kan., and Okl.

2. **Robinia viscòsa** Vent. Clammy Locust. A small tree with rough bark. Underground parts somewhat poisonous. Va. to Ga. Also escaped in Middle and Eastern States. Ohio.

Order, GERANIALES.

Rutaceae. Rue Family.

49. **Xanthóxylum** L. Prickly-ash.

Trees or shrubs with punctate, odd-pinnate leaves and usually with stipular spines. Capsule with 1-2 seeds.

1. **Xanthoxylum americànum** Mill. Prickly-ash. A prickly shrub or small tree with small flowers in sessile axillary cymes. Quebec to Va., S. Dak., Neb., Kan., and Ohio.

50. **Ptèlea** L. Hoptree.

Shrubs or small trees with bitter bark. Fruit a samara with a membranous wing.

1. **Ptelea trifoliàta** L. Hoptree. A shrub or small tree with sunken superposed axillary buds covered by the petiole base. Bark and flowers with a disagreeable odor. Conn. to Fla., Ont., Minn., Kan., Tex., and Ohio.

Simarubaceae. Ailanthus Family.

51. **Ailánthus** Desf. Ailanthus.

Large trees with odd-pinnate leaves; branches robust with large brown pith. Samara linear or oblong, usually twisted.

1. **Ailanthus glandulòsa** Desf. Tree-of-heaven. A large tree of rapid growth with thick branches and smooth bark. Leaves ill-scented; leaflets with green glands under the lobes or teeth. Autumn leaves pure yellow. Wood hard and useful. Sprouts freely from the roots and is easily propagated from root cuttings. A pest in pastures in some states; cows will not eat grass near the young shoots. Water contaminated by the leaves is poisonous. Naturalized from China. Ont. to Mass., Va., Kan., and Ohio.

Order, SAPINDALES.

Anacardiaceae. Sumac Family.

52. **Rhús** L. Sumac.

Small trees, shrubs, or climbing vines with acrid resinous or milky sap. Fruit a small, red or gray drupe, in panicles.

1. Petioles not completely covering the axillary buds; leaflets entire. 2.
1. Petioles covering the axillary buds; leaflets serrate. 3.
2. Rachis of the leaf wing-margined; leaflets 7-31; twigs and the red drupes pubescent. *R. copallina.*
2. Rachis not winged; leaflets 7-13; poisonous to the touch; twigs and the gray drupes glabrous. *R. vernix.*
3. Leaves and twigs velvety-pubescent. *R. hirta.*
3. Leaves and twigs glabrous, somewhat glaucous. *R. glabra.*

1. **Rhus copallina** L. Dwarf sumac. A shrub or small tree with a dense terminal panicle of small globose, crimson drupes, covered with short acid hairs. Leaves used for tanning purposes. In dry soil. Me. and Ont. to Fla., Minn., Neb., Tex., and Ohio.

2. **Rhus hirta** (L.) Sudw. Staghorn Sumac. A small tree or shrub with red, pubescent drupes. Wood very soft and brittle. In dry or rocky soil. A good lemonade or "sumacade" is made by steeping the drupes and sweetening to taste. Leaves used for tanning. N. S. to Ga., Ont., S. Dak., Mo., Miss., and Ohio.

3. **Rhus glàbra** L. Smooth Sumac. A shrub or small tree with dense panicles of small crimson drupes covered with short acid hairs. Noted for its beautiful, brilliant, red-colored leaves in autumn. Leaves used for tanning. Common on hill-sides and bluffs. N. S. to Br. Col., Fla., Miss, Ariz., and Ohio.

4. **Rhus vérnix** L. Poison Sumac. A shrub or small tree, very poisonous to the touch. Drupes gray, glabrous, in loose axillary panicles. In swamps and wet places. N. S. to Fla., Minn., Neb., Ark., and Ohio.

53. **Cótinus** Adans. Smoketree.

Shrubs or small trees with resinous sap, with buds clustered at the tips of the twigs. Drupes compressed, gibbous.

1. Blade of the leaf slightly decurrent on the petiole, thin, glabrous or slightly pubescent beneath. *C. cotinoides.*
1. Leaves mostly rounded or obtuse at the base, coriaceous, more pubescent. *C. cotinus.*

1. **Cotinus cotinoides** (Nutt.) Britt. American Smoketree. A small wide-branched tree. Mo. and Okl. to Tenn. and Ala.

*. *Cotinus cótinus* (L.) European Smoketree. A small tree, native of Europe.

Ilicaceae. Holly Family.

54. **Ilex** L. Holly.

Shrubs or trees with watery sap, and alternate simple leaves. Drupe berry-like, with 4-8 long nutlet-like stones.

1. Leaves thick, persistent, evergreen, spiny. *I. opaca.*
1. Leaves thin, deciduous, not spiny. 2.
2. Leaves small, obovate or spatulate, crenate; nutlets of the fruit ribbed. *I. decidua.*
2. Leaves large, ovate or lanceolate, sharply serrate, nutlets ribbed. *I. monticola.*

1. **Ilex opàca** Ait. American Holly. A tree of slow growth with thick, glabrous, evergreen leaves and globose red or rarely yellow drupes. Twigs with leaves and fruit much used for Christmas decoration. Wood very white, fine-grained, hard, strong, tough, light in weight, and easily worked; used for cabinet-work and in turnery. Bird-lime is prepared from the middle bark. In moist soil. Should be much planted for ornament in suitable places. The leaves should be cut off when transplanted. Me. to Fla., Penn., Mo., Tex., and Ohio.

2. **Ilex decidua** Walt. Deciduous Holly. A shrub or small tree with light-gray, glabrous twigs and red drupes. In swamps and low ground. D. C. to Fla., Kan., and Tex.

3. **Ilex monticola** Gr. Mountain Holly. A shrub or slender, erect tree growing in mountain woods. Drupes red. N. Y. to N. Car. and Ala.

Celastraceae. Stafftree Family.

55. **Euónymus** L. Wahoo.

Shrubs or small trees with opposite leaves and 3-5-locular capsules. Seeds enclosed in a red aril.

1. Flowers purple; cymes 6-15-flowered; winter buds long-pointed with long bud scales. *E. atropurpureus.*
1. Flowers greenish yellow; cymes 3-7-flowered; winter buds very short pointed with short bud scales. *E. europaeus.*

1. **Euonymus atropurpùreus** Jacq. Wahoo. A high shrub or small tree with green, obtusely 4-angled twigs. Leaves dark red and fruit very ornamental in autumn. Self-prunes small twigs by basal joints. Ont. to Fla., Mont., Okl., and Ohio.

2. **Euonymus europàeus** L. Spindletree. A shrub or small tree resembling the preceding. Self-prunes twigs. Cultivated from Europe. Escaped. N. H., N. Y., and N. J.

Staphyleaceae. Bladdernut Family.

56. **Staphylèa** L. Bladdernut.

Shrubs sometimes tree-like with opposite compound leaves and bladdery capsules.

1. **Staphylea trifòlia** L. American Bladdernut. A shrub or rarely small tree with smooth striped bark. In moist soil. Quebec to Minn., S. Car., Kan., and Ohio.

Aceraceae. Maple Family.

57. **Acer** L. Maple.

Trees or shrubs with opposite leaves and with watery often saccharine, or sometimes milky sap. Fruit a 2-winged samara.

1. Leaves pinnate or trifoliate; twigs green, glaucous. *A. negundo.*
1. Leaves simple. 2.
2. Leaves with very large teeth or lobes, the divisions not serrate or serrate-dentate. 3.
2. Leaves with the large divisions or lobes serrate or serrate-dentate. 5.
3. Leaves with stipules which are often large and foliaceous; leaves green and pubescent beneath at least on the veins; flowers corymbose, unfolding with the leaves; wings of fruit diverging a little less than a right angle. *A. nigrum.*

3. Leaves without stipules. 4.
4. Leaves with much milky sap in the petiole, glabrous, dark green above, lighter below, usually with 7 prominent palmate veins; flowers corymbose, unfolding with the leaves; wings of the fruit diverging nearly in a straight line; petals present; winter buds rounded. *A. platanoides.*
4. Leaves with watery or frothy sap, pale and nearly glabrous beneath, usually with 5 prominent palmate veins; flowers corymbose, unfolding with the leaves; wings of the fruit diverging a little less than a right angle; petals none; winter buds pointed. *A. saccharum.*
5. Leaves very sharply and finely serrate, 3-lobed at the outer end, widest above the middle, the lobes abruptly narrow-acuminate, brown pubescent below when young; twigs green, striped with darker lines; flowers racemed, terminal, unfolding after the leaves. *A. pennsylvanicum.*
5. Leaves dentate-serrate or lobed, not abruptly narrow-acuminate; twigs not striped. 6.
6. Leaves broadly 3-5-lobed, the lobes rather regularly and continuously dentate-serrate or dentate-crenate; flowers racemed, terminal, unfolding after the leaves. 7.
6. Leaves usually with 3-7 slender, long and pointed lobes, the lobes irregularly or interruptedly serrate or serrate-dentate; flowers in dense sessile lateral clusters, appearing before the leaves. 8.
7. Leaves longer than wide, slightly 3-lobed at the outer end, usually only very slightly lobed at the lower end, not glaucous below; bark of twigs green or grayish; racemes erect; a shrub, rarely a small tree. *A. spicatum.*
7. Leaves as broad or broader than long, prominently 5-lobed, glabrous and dark green above, pubescent and light glaucous below, on long reddish petioles; bark of twigs reddish-brown; racemes drooping; wings of fruit pubescent, moderately spreading; a large tree. *A. pseudo-platanus.*
8. Leaves usually deeply 5-lobed, lobes slender, acute, white and glaucous beneath; notches between the lobes often somewhat rounded; fruiting pedicel short and stiff, 1-2 in. long; wings divergent; petals none. *A. saccharinum.*
8. Leaves sharply 3-5-lobed, whitish glaucous beneath, notches acute; fruiting pedicel long, slender and drooping, 2-4 in. long; wings incurved; petals present. *A. rubrum.*

1. **Acer saccharinum** L. Silver Maple. A large tree with flaky bark, the twigs often reddish, self-pruned by basal joints. Leaves deeply 5-lobed, the lobes rather narrow, acumi-

nate, coarsely and irregularly dentate, truncate or slightly cordate at the base, green above, silvery white and more or less pubescent beneath. A fine shade tree and much planted. Wood soft and white; used for furniture. Yields a small amount of sugar. Along streams. N. B. to Fla., Ont., N. Dak., Neb., Okl., and Ohio.

2. **Acer rùbrum** L. Red Maple. A tree with flaky or smoothish bark and reddish twigs. Leaves sharply 3-5-lobed, the lobes irregularly dentate, acute or acuminate, cordate at the base, green above, whitish beneath. Wood of considerable value when it shows a "curly grain." Leaves crimson, scarlet or yellow in autumn. Self-pruning like the preceding. In swamps and low ground, also on moist hillsides. N. B. to Man., Fla., Tex., and Ohio.

3. **Acer sáccharum** Marsh. Sugar Maple. A large tree with yellow or sometimes red leaves in autumn. Leaves cordate or truncate at the base, 3-7-lobed, the lobes acuminate, irregularly sinuate, dark green above, pale and nearly glabrous beneath. Its sap is the main source of maple sugar and syrup. An average tree will yield 2-10 lbs. of sugar a season. A fine shade tree. The ashes give large quantities of potash. Wood heavy, hard, strong and tough; used for fuel, interior finish, furniture, keels of boats and ships, implements and machinery, sucker rods, shoe pegs, piano action, school apparatus, large wood type, tool and broom handles, and wood carving. Newf. to Man., south to Fla. Tex., and Ohio.

4. **Acer nigrum** Mx. Black Maple. A large fine tree with rough blackish bark. Leaves cordate or truncate at the base, 3-7-lobed, the lobes broad and short, green on both sides, generally more or less pubescent beneath. It is equally valuable for the making of sugar. Wood much the same as in the Sugar Maple, and used for the same purposes. Ont. and Vt. to Ga., Minn., La., Ark., and Ohio.

5. **Acer pennsylvánicum** L. Striped Maple. A small tree with smoothish green bark striped with darker lines. Leaves broadest above the middle, thin, glabrous above slightly pubescent beneath when young, truncate or somewhat cordate at the base.

3-lobed near the apex. Wood white and soft. In rocky soil. N. S. to Lake Superior, and along the mountains to Ga. and Tenn.

6. **Acer spicàtum** Lam. Mountain Maple. A shrub or small tree, the bark green but not striped. Leaves 3-5-lobed, the lobes acute or acuminate, glabrous above, pubescent beneath at least when young. In damp rocky woods. Newf. to Man., south to N. Car., Tenn., Minn., and Ohio.

*. *Acer platanoi'des* L. Norway Maple. A medium-sized tree with a broad rounded crown, with brown twigs and milky sap. Leaves sharply 5-7-lobed, very dark green above. Much cultivated.

*. *Acer pseudo-plátanus* L. Sycamore Maple. A fine tree with spreading branches. Leaves deeply 3-5-lobed. Self-prunes. Much cultivated.

7. **Acer negúndo** L. Boxelder. A small tree with spreading branches and glabrous, sometimes pubescent, green and glaucous twigs. Leaves 3-7 foliate, leaflets ovate or oval. The sap produces a slight amount of sugar. Wood light and of slight value. Along streams. Planted on the prairies for small groves and wind breaks. Vt. to Man., Fla., Kan., N. Mex., and Ohio.

Hippocastanaceae. Buckeye Family.

58. **Aésculus** L. Buckeye, Horse-chestnut.

Trees or shrubs with opposite digitate leaves, and leathery capsules containing large shining nut-like seeds.

1. Flowers white, mottled with yellow and purple; leaflets abruptly acuminate; winter buds gummy; capsule spiny; bundle scars arranged in a curved line. *AE. hippocastanum.*
1. Flowers yellow or purplish; leaflets acuminate, more or less abrupt; winter buds not gummy; bundle scars arranged in 3 areas. 2.
2. Capsule spiny, stamens exserted. 3.
2. Capsule glabrous; stamens not longer than the petals, corolla yellow or purplish. *AE. octandra.*
3. Leaflets acuminate, finely serrate, 5-7; a tree. *AE. glabra.*
3. Leaflets long-acuminate, unequally serrate, 7-9; a shrub-like small tree. *AE. arguta.*

1. **Aesculus hippocástanum** L. Horse-chestnut. A large tree with very resinous, gummy winter buds. Autumn leaves orange. The seeds are poisonous and symptoms of poisoning have been produced from eating the green rind. The twigs contain Aesculin which is fluorescent in aqueous solution. Escaped from cultivation; native of Asia.

2. **Aesculus glàbra** Willd. Ohio Buckeye. A large tree with rough and fetid bark. Leaves, young shoots, and seeds poisonous to cattle. Wood light and hard to split; used for making artificial limbs, wooden-ware, and paper pulp. Penn. to Ala., Mich., Neb., Okl., and Ohio.

3. **Aesculus argùta** Buckl. Western Buckeye. A shrub-like small tree with smooth bark. On flood plains. Kan. to Tex.

4. **Aesculus octándra** Marsh. Yellow Buckeye. A large tree with brown scaly bark. Seeds poisonous. Wood light and hard to split; used for making artificial limbs, wooden-ware, and paper pulp. **Aesculus octandra hybrida** (DC.) Sarg. has purplish or pink flowers, leaflets pubescent beneath, and light brown bark. Penn. to Ga., Iowa and Tex., Ohio.

Sapindaceae. Soapberry Family.

59. **Sapindus** L. Soapberry.

Trees or shrubs with alternate, odd-pinnate leaves. Fruit a berry.

1. **Sapindus drúmmondi** H. & A. Drummond Soapberry. A tree with white flowers in dense terminal panicles and very saponaceous, globose berries. Kan. and La. to Ariz.

Order, Rhamnales.

Rhamnaceae. Buckthorn Family.

60. **Rhámnus** L. Buckthorn.

Shrubs or small trees, sometimes with thorns, with berry-like drupes, containing 2-4 nutlet-like stones.

1. Leaves with 3 or 4 pairs of lateral veins, the basal pair prominent; nutlets of the fruit grooved; flowers dioecious or imperfectly monosporangiate. *R. cathartica.*

1. Leaves acute, with 6-10 pairs of lateral veins; nutlets smooth; umbels peduncled; flowers bisporangiate. *R. caroliniana.*

1. **Rhamnus cathàrtica** L. Common Buckthorn. A shrub or small tree with black injurious fruit. Somewhat thorny and used for hedges. Introduced from Europe. Eastern states.

2. **Rhamnus caroliniàna** Walt. Carolina Buckthorn. A tall thornless shrub or small tree with a globose sweet drupe. In wet soil. Va. and Ohio to Kan., Fla., and Tex.

Order, MALVALES.

Tiliaceae. Linden Family.

61. **Tilia** L. Linden.

Trees with 2-ranked inequilateral, serrate leaves, the dry drupaceous fruit in cymose clusters, the peduncle subtended by a broad membranous bract.

1. Petals with scales at the base. 2.
1. Petals without scales at the base; leaves glabrous or nearly so; cultivated. *T. europaea.*
2. Leaves glabrous or nearly so on both sides. *T. americana.*
2. Leaves glabrous above, pubescent beneath. *T. pubescens.*
2. Leaves glabrous above, silvery-white beneath. *T. heterophylla.*

1. **Tilia americàna** L. American Linden. A large, straight-trunked tree with spreading branches. Inner bark very tough; used for mats and coarse rope. Wood soft and very white, light and uniform in texture, not liable to crack; called "basswood;" used for wooden-ware, cabinet-work, trunks, panelling of carriages, in cooperage, and for toys. The bark and wood of the other lindens are much the same. In rich soil, on bluffs, and along river bottoms. N. B. to Ga., Manitoba, Kan., Tex., and Ohio.

2. **Tilia pubéscens** Ait. Downy Linden. A small tree growing in moist soil, mostly along the coast. L. I. to Fla., west to Tex.

3. **Tilia heterophylla** Vent. White Linden. A tree with larger leaves than either of the preceding species. N. Y. to Fla., Ala., Ill., Ky., Tenn., and Ohio.

*. *Tilia europaèa* L. European Linden. A large tree much cultivated in parks. Its name, Lin, was the origin of the family name of Linnaeus.

Subclass, HETEROMERAE.

Order, ERICALES.

Ericaceae. Heath Family.

62. **Rhododéndron** L. Rhododendron.

Shrubs or low trees with alternate persistent, coriaceous leaves; usually with a woody capsule and numerous seeds.

1. **Rhododendron máximum** L. Great Rhododendron. A tall shrub or small tree with beautiful flowers and striking evergreen leaves. Leaves poisonous to stock and the nectar said to produce poisonous honey. On rocky hillsides and along streams. Occasionally cultivated. N. S. to Ont., Ohio, and Ga.

63. **Kálmia** L. Kalmia.

Erect shrubs or small trees with evergreen coriaceous leaves. Fruit a capsule.

1. **Kalmia latifòlia** L. Mountain Kalmia. A shrub or small tree with evergreen leaves. All parts of the plant poisonous to cattle, sheep, and other animals. The honey from the flowers is said to be poisonous; also the flesh of game that has fed upon the leaves or fruit. In woods and on rocky hillsides. Occasionally planted. N. B. to Ont., Ohio, Fla., and La.

64. **Oxydéndrum** DC. Sorrel-tree.

A tree with alternate sour leaves and numerous white flowers in terminal panicled racemes. Fruit a capsule.

1. **Oxydendrum arbòreum** (L.) DC. Sorrel-tree. A small tree with smooth bark and brilliantly red-colored leaves in autumn. Wood hard and close-grained; used for handles of tools, bearings of machinery, etc. On hillsides. Ohio and Penn to Va., Fla., and Miss.

Order, EBENALES.

Sapotaceae. Sapodilla Family.

65. **Bumèlia** Sw. Bumelia.

Shrubs or trees with milky sap, usually with thorns, and with very hard wood. Fruit a fleshy berry with a single seed.

1. Leaves glabrous or nearly so; oblanceolate to oblong-ovate, 2-5 in. long. *B. lycioides.*

1. Leaves tomentose or silky, oblong-obovate to cuneate-obovate, usually obtuse, 1-3 in. long. *B. lanuginosa.*

1. **Bumelia lycioides** (L.) Pers. Buckthorn Bumelia. A shrub or small tree usually with thorns and thorn-like spurs and with gray bark. Leaves tardily deciduous. In moist soil. Va. to Ill., Mo., Fla., and Tex.

2. **Bumelia lanuginòsa** (Mx.) Pers. Woolly Bumelia. A shrub or rather large tree with persistent leaves. Ill., to Kan., Tex., Ga., and Fla.

Ebenaceae. Ebony Family.

66. **Diospyros** L. Persimmon.

Trees or shrubs with very hard wood, the fruit a berry.

1. **Diospyros virginiàna** L. Persimmon. A handsome tree with hard, dark, furrowed bark. Pith often with lenticular cavities or diaphragmed. Berry large, pulpy, yellow, exceedingly astringent when green but sweet and edible after frost. Bark astringent and tonic. Wood very hard, heavy, strong, and tough, close-grained and dark-colored; used in turnery, for shuttles, plane stocks, and shoe lasts. R. I. to Ohio and Kan., Fla., and Tex.

Symplocaceae. Sweetleaf Family.

67. **Symplocos** L. Sweetleaf.

Trees or shrubs with alternate leaves, the fruit a small, mostly nearly dry drupe.

1. **Symplocos tinctòria** (L.) L'Her. Sweetleaf. A shrub or small tree, the pith diaphragmed. Flowers bright yellow, fragrant; drupe nutlike. Del. to Fla. and La.

Styracaceae. Storax Family.

68. Mohrodéndron Britt. Silverbell.

Small trees or shrubs, more or less stellate-pubescent, with large, white, bell-shaped flowers and 2-4-winged, dry fruit.

1. **Mohrodendron carolinum** (L.) Britt. Silverbell. A small tree with diaphragmed pith. In woods and along streams. Va. to Ill., Fla., and Ala.

Subclass, SYMPETALAE HYPOGYNAE.

Order, GENTIANALES.

Oleaceae. Olive Family.

69. Fráxinus L. Ash.

Trees with opposite leaves, in our species odd-pinnate. Fruit a samara.

1. Lateral leaflets sessile, 7-11; samara winged all around; calyx none. *F. nigra.*
1. Lateral leaflets more or less stalked; calyx present in the carpellate flower. 2.
2. Body of the samara terete or nearly so, the wing chiefly terminal; twigs not 4-sided. 3.
2. Body of the samara flat, the wing extending around it; twigs 4-sided, often with 4 sharp ridges especially on vigorous shoots; leaflets 7-11. *F. quadrangulata.*
3. Wing almost entirely terminal. 4.
3. Wing extending somewhat down the sides of the body of the samara; leaflets 5-9. 5.
4. Leaves and twigs glabrous or nearly so, pale below, leaflets 5-9. *F. americana.*
4. Leaves and twigs pubescent, leaflets 7-9. *F. biltmoreana.*
5. Wing of the samara spatulate. 6.
5. Wing long linear. *F. darlingtonii.*
6. Leaves, twigs, and pedicels glabrous or nearly so; leaves bright green on both sides. *F. lanceolata.*
6. Leaves, young twigs and pedicels velvety-pubescent; samara 1-2 in. long. *F. pennsylvanica.*

1. **Fraxinus americàna** L. White Ash. A large tree of rapid growth, with glabrous twigs. Leaflets 5-9, ovate, ovate-lanceolate, oblong, or rarely slightly obovate, entire or denticulate,

pale and often pubescent beneath, acuminate or acute; body of the samara terete, not margined, winged only from near the summit, $\frac{1}{4}$-$\frac{1}{2}$ the length of the wing. Autumn leaves brown, purple, and salmon. Wood tough and elastic, of very great value; widely used in the manufacture of agricultural implements, boat oars, and carriage shafts; in cabinet-work, for harness work, hoops, baskets, and clothespins. In rich soil. N. S. to Minn., Fla., Kan., Tex., and Ohio.

2. **Fraxinus biltmoreàna** Bead. Biltmore Ash. A tree with the young twigs pubescent. Leaflets 7-9, ovate to lanceolate, acuminate, entire or obscurely denticulate, more or less pubescent beneath; body of the samara narrowly elliptic, terete; wing linear, or somewhat broadened above, 2-3 times the length of the body. Penn. and Ohio to Ga.

3. **Fraxinus lanceolàta** Borck. Green Ash. A large tree with glabrous twigs. Leaflets 5-9, entire or denticulate, ovate or oblong-lanceolate, acuminate or acute, green on both sides; samara similar to that of the two preceding species, wing usually spatulate and decurrent on the sides of the body below the middle. Wood rather inferior in value to that of the white ash. In moist soil, on flood-plains, and on bluffs. Vt. to N. W. Terr., Fla., Ariz., and Ohio.

4. **Fraxinus pennsylvánica** Marsh. Red Ash. A large tree with velvety-pubescent twigs. Leaflets 5-9, ovate, ovate-lanceolate, or oblong, acuminate or acute, usually denticulate; body of the samara linear margined above by the linear or spatulate decurrent wing. In moist soil. N. B. to S. Dak., Fla., Ala., Kan., and Ohio.

5. **Fraxinus darlingtònii** Britt. Darlington Ash. A tree similar to *F. lanceolata* and *F. pennsylvanica*, the leaves and twigs pubescent or glabrate. Leaflets similar to the two preceding species; pubescent or glabrate; wing of the samara longer than the narrowly linear body and decurrent on it for $\frac{1}{4}$-$\frac{1}{3}$ of its length. N. Y. and Penn.

6. **Fraxinus quadrangulàta** Mx. Blue Ash. A large tree with 4-sided or 4-winged twigs. Leaflets 7-11, ovate, oblong, or lanceolate, acuminate, green on both sides, sharply serrate or

serrulate; samara linear-oblong or cuneate, winged all around, parallel-nerved, the body extending more than half way to the apex. The inner bark furnishes a blue dye. Wood heavy, hard and valuable; used for flooring, carriage-making, etc. Ont., Minn. and Mich. to Ala., Iowa, Ark., and Ohio.

7. **Fraxinus nigra** Marsh. Black Ash. A large tree. Leaflets 7-11 glabrous, green on both sides, sessile, oblong-lanceolate, long acuminate, sharply serrate or serrulate; samara oblong or linear-oblong, parallel-nerved, the body flat, winged all around and extending to or beyond the middle. Wood used for barrel-hoops, baskets, cabinet-work, and interior finish. In swamps and wet soil. Newf. to Manitoba, Va., Ark., and Ohio.

70. **Adèlia** Br. Adelia.

Shrubs or small trees with opposite simple leaves. Fruit a drupe; flowers fascicled or paniculate, from scaly buds.

1. **Adelia acuminàta** Mx. Adelia. A shrub or small tree usually with somewhat thorny branches. On river banks. Ill. to Ga., Mo., and Tex.

71. **Chionánthus** L. Fringetree.

Shrubs or small trees with opposite simple, entire leaves. Fruit a drupe.

1. **Chionanthus virginica** L. Fringetree. A shrub or small tree with handsome, white, fragrant flowers in drooping panicles. In moist soil. Del. and Ohio to Fla. and Tex.

Order, Polemoniales.

Scrophulariaceae. Figwort Family.

72. **Paulòwnia** Sieb. & Zucc. Paulownia.

A large tree with opposite, petioled leaves, the pith with cavities. Fruit an ovoid, acute capsule.

1. **Paulownia tomentòsa** (Thumb.) Baill. Paulownia. A large rapid-growing tree with violet flowers in terminal panicles. Native of Japan; escaped from cultivation.

Bignoniaceae. Trumpet-creeper Family.

73. **Catálpa** Scop. Catalpa.

Trees or shrubs with opposite or verticillate simple leaves and large white or mottled flowers in terminal panicles or corymbs. Leaves with large nectar glands in the axils of the veins on the under side. Capsule long and bean-like.

1\. Young twigs glabrous or nearly so, leaf-blades downy below; flowers large, white, with 2 yellow stripes inside and spotted purplish brown. 2.

1\. Young twigs and petioles with long hairs; leaf blades glabrous below or nearly so, commonly 3-lobed or angled, strong-scented; flowers small, yellow with orange stripes inside and violet spots; capsule very slender. *C. ovata.*

2\. Leaves strong-scented, young petioles glabrous or nearly so; wings of seed usually narrowed at the ends; panicles many-flowered; lower corolla lobe entire; bark thin, flaky. *C. catalpa.*

2\. Leaves not unpleasantly scented, young petioles usually pubescent, wings of seed usually broad, the threads parallel; panicles few-flowered; lower corolla lobe emarginate; bark thick and rough. Usually blooms a week or more earlier than C. catalpa. *C. speciosa.*

1\. **Catalpa catálpa** (L.) Karst. Common Catalpa. A tree with thin flaky bark and spreading branches. Wood much less valuable than that of *C. speciosa.* The flowers are said to produce irritation of the skin. Gulf States. Escaped in the northern states as far as Ohio and N. Y.

2\. **Catalpa speciòsa** Ward. Hardy Catalpa. A large rapid-growing tree with thick rough bark. Wood light, soft, not strong, brittle, of very coarse texture and brown in color, very durable in the ground; used for railroad ties, posts, furniture and interior finish; also suitable for paper pulp. Ill. to Tenn., Mo., Ark., and Ohio.

*. *Catalpa ovata* Don. Japan Catalpa. A small tree, commonly with 3-lobed or angled leaves.

Subclass, Sympetalae Epigynae.

Order, Umbellales.

Araliaceae. Ginseng Family.

74. **Aràlia** L. Aralia.

Herbs, shrubs, or small trees with alternate, pinnately or ternately decompound leaves. Fruit a small berry.

1. **Aralia spinòsa** L. Angelica-tree. A prickly shrub or small tree with long-petioled bipinnate leaves. In low ground and along streams. Sometimes cultivated. Conn. to Fla., Ohio, Mo., and Tex.

Cornaceae. Dogwood Family.

75. **Córnus** L. Dogwood.

Shrubs or small trees with drupes in cymes or heads, the cymes self-pruned when the fruit is ripe.

1. Leaves opposite. 2.

1. Leaves alternate; twigs green, smooth; flowers in cymose panicles, drupe blue. *C. alternifolia.*

2. Leaves oval or ovate, pointed; axillary buds minute, hidden underneath the base of the petiole; flowers in heads with 4-6 large white bracts; drupe red. *C. florida.*

2. Leaves ovate or ovate-lanceolate; axillary buds larger, not covered; flowers cymose; drupe globose, white. *C. asperifolia.*

1. **Cornus flórida** L. Flowering Dogwood. A small very ornamental tree, with rough reticulate bark. Wood solid and valuable; used for shuttles. The drupes are reputed to be poisonous. Me. and Ont. to Fla., Ohio, Mo., and Tex.

2. **Cornus asperifòlia** Mx. Rough-leaf Dogwood. A tall shrub, sometimes tree-like, with reddish brown twigs. In rich or moist ground. Ont. to Fla., Iowa, Kan., Tex., and Ohio.

3. **Cornus alternifòlia** L. f. Blue Dogwood. A shrub or small tree with smooth, greenish, bitter bark. In rich soil. N. S. to Ga., Ont., Minn., W. Va., Ala., and Ohio.

76. **Nyssa** L. Tupelo.

Trees or shrubs with alternate leaves and solid but diaphragmed pith. Fruit a drupe.

1. Leaves mostly entire, mostly acute or acuminate; carpellate flowers 2-14 together; stone little flattened. *N. sylvatica.*
1. Leaves mostly entire, mostly obtuse; carpellate flowers 1-3 together, stone much flattened. *N. biflora.*

1. **Nyssa sylvática** Marsh. Tupelo. A large tree with horizontal branches and with rough bark. Leaves bright crimson, scarlet, or purple in autumn. Wood firm, heavy, strong, tough, close-grained, and hard to split; used for hubs of wheels, pulleys, handles, wooden shoes, wooden ware, etc. Not durable if exposed. In rich moist soil. Not easily transplanted. Me. and Ont. to Fla., Mich., Tex., and Ohio.

2. **Nyssa biflòra** Walt. Water Tupelo. A large tree similar to the preceding, the base swollen. In swamps and along ponds. N. J. to Va., Fla., and Ala.

Order, Rubiales.

Caprifoliaceae. Honeysuckle Family.

77. **Vibúrnum** L. Viburnum.

Trees or shrubs with opposite leaves and 1-seeded drupes.

1. Leaves prominently acuminate; petioles slender, margined. V. lentago.
1. Leaves obtuse or merely acute. 2.
2. Petioles slender, rarely margined; leaves glabrous or nearly so. V. prunifolium.
2. Veins of the lower leaf surfaces and winged petioles tomentose. V. rufotomentosum.

1. **Viburnum lentàgo** L. Sheepberry. A shrub or small tree with glabrous acuminate winter buds. Drupe reddish-black, with a bloom, sweet and edible. Wood hard, ill-smelling. In rich soil. Hudson Bay to Man., N. J., Ga., Kan., and Ohio.

2. **Viburnum prunifòlium** L. Black Haw. A shrub or small tree with acute winter buds, often reddish-pubescent. Drupe

blue-black, glaucous, sweet and edible. In dry soil. Conn. to S. Car., Mich., Kan., Tex., and Ohio.

3. **Viburnum rufotomentòsum** Small. Southern Black Haw. A small tree with elliptic or obovate, mostly obtuse leaves, with brown-tomentose, winged petioles. Wood ill-smelling. On uplands and dry flood plains. Va. to Ill., Mo., Fla., and Tex.

GLOSSARY.

Achene. A one-seeded dry indehiscent fruit with a tightly fitting pericarp around the seed.

Actinomorphic. Radially symmetrical; a flower or organ which can be cut into similar equal halves by two or more planes.

Acuminate. Tapering gradually to the apex.

Acute. Sharp pointed.

Adnate. An organ adhering to another; an anther attached longitudinally to the end of the filament.

Adventive Apparently becoming naturalized.

Alternate. With a single leaf or other organ at each node.

Ament. A slender usually flexible spike of flowers, as in the willows.

Androecium. The whole set of stamens in a flower.

Anther. The spore-bearing part of a stamen; the part which finally contains the pollen sacs.

Anthesis. The period of flowering.

Apetalous. Without petals.

Appressed. Lying close against another organ.

Aril. A fleshy organ around the hilum.

Auricled. With ear-like lobes.

Axillary bud. A bud in the axil of a leaf.

Axil. The point of a stem just above the base of the leaf.

Axile. In the axis of an organ.

Baccate. Berry-like.

Berry. A fruit with a fleshy or pulpy pericarp.

Bilocular (2-locular). Having two cavities.

Bisporangiate. Having both microsporangia and megasporangia; having both stamens and carpels.

Blade. The expanded part of a leaf.

Bract. A small, rudimentary, or imperfectly developed leaf.

Bud scale. One of the scales in the winter bud.

Bundle scar. A scar in a leaf scar produced by a vascular bundle or strand of bundles.

Caducous. Falling away very soon after development.

Calyx. The outer set of sterile floral leaves; the whole set of sepals.

Canescent. With gray or hoary fine pubescence.

Capitate. Arranged in a head.

Capsule. A dry fruit of two or more carpels usually dehiscent by valves or teeth.

Carpel. The megasporophyll of a seed plant; the modified leaf or stem bearing the ovules.

Carpellate. Having only carpels, or carpellate flowers.
Catkin. Same as ament.
Cauline. Pertaining to the stem.
Chaff. Dry thin scales.
Chlorophyll. The green coloring matter of plants.
Choripetalous. Having the petals separate or free.
Ciliate. Provided with marginal hairs.
Ciliolate. Minutely ciliate.
Conduplicate. Folded lengthwise.
Cone. A primitive flower as the carpellate cone of the pine.
Connate. Similar organs more or less united.
Convolute. Rolled around or rolled up longitudinally.
Cordate. Heart-shaped.
Coriaceous. Leathery.
Corolla. The inner set of sterile, usually colored, floral leaves; the whole set of petals.
Cotyledon. A leaf-like organ of the embryo in the seed.
Crenate. With rounded teeth.
Crenulate. Minutely crenate.
Cuneate. Wedge-shaped.
Cuspidate. With a sharp stiff point.
Cyme. An inflorescence of the determinate type, the central flower developing first.

Deciduous. Falling away at the end of the growing period.
Decompound. More than once compound.
Decurrent. Applied to an organ extending along the side of another.
Dehiscence. The opening of an ovulary, sporangium, or pollen sac for the discharge of the contents.
Deltoid. Broadly triangular.
Dentate. With outwardly projecting teeth.
Diadelphous. Having the stamens united into two sets.
Diaphragm. A septum or transverse plate in the pith or other parts.
Dichotomous. Two-forked.
Didymous. Twin-like.
Digitate. Diverging like the spread fingers.
Dioecious. Having the microsporangiate or staminate flowers and the megosporangiate or carpellate flowers on separate plants.
Dissected. Divided into many segments.
Divided. Cleft to the base or to the midrib.
Drupe. A simple usually indehiscent fruit with fleshy exocarp and bony endocarp.
Dwarf branch. A highly specialized and reduced shoot on a twig, as in the pine and larch.

Emarginate. With a notched apex.
Embryo. An incipient plant in the seed.
Embryo sac. The female gametophyte, contained in the ovule of seed plants.
End bud. The bud at the end of the twig in case the terminal bud is self-pruned.
Endocarp. The inner layer of the pericarp.
Endosperm. The nourishing tissue developed around the embryo in the female gametophyte of the angiosperms.
Entire. Without teeth, serrations or lobes.
Ephemeral. Continuing for only a day or less.
Epigynous. Having the calyx, corolla, and androecium above the ovulary.
Evanescent. Disappearing early.
Exocarp. The outer layer of the pericarp.
Exserted. Extending beyond surrounding organs or parts.
Extrorse. Facing outwards.

Falcate. Scythe-shaped.
Fertile. Bearing spores or seeds.
Fertilization. The conjugation of the male and female gametes.
Fetid. Ill-smelling.
Filament. The stalk of an anther.
Flower. The modified spore-bearing branch of the seed plants.
Foliaceous. Leaf-like.
Follicle. A simple fruit dehiscent along one suture.
Fruit. The ripe ovulary with the seeds and whatever parts are consolidated with it.
Fugaceous. Falling soon after development.
Fugitive. Plants not native, but recurring here and there, without apparently becoming established.

Gamete. A sexual cell.
Gametophyte. The sexual generation of plants.
Geophilous. Earth-loving; growing partly or completely subterranean.
Gibbous. Enlarged or swollen on one side.
Glabrate. Nearly without hairs.
Glabrous. Without hairs.
Gland. A group of secreting cells.
Glaucous. Covered with a bluish or white bloom.
Globose. Spherical or nearly so.
Glutinous. Sticky or gummy.
Gynoecium. The whole set of carpels in a flower.

Habit. General aspect.
Habitat. The place where a plant grows.
Hastate. Arrow-shaped with the basal lobes diverging.

Head. A dense, round inflorescence of sessile or nearly sessile flowers.
Herbaceous. Leaf-like in texture and color.
Hirsute. Having rather coarse stiff hairs.
Hispid. With bristly stiff hairs.
Hydrophyte. A water plant.
Hypogynous. Having the calyx, corolla, and androecium below the gynoecium.

Imbricated. Overlapping.
Imperfect. Monosporangiate flowers; having only stamens or only carpels.
Incised. Cut into sharp lobes.
Included. Not projecting beyond surrounding parts.
Indehiscent. Not opening.
Inequilateral. With unequal sides.
Inferior. Situated or arising below other organs.
Inflorescence. The flower cluster of a plant and its mode of arrangement.
Internode. The part of a stem between two successive nodes.
Introrse. Facing inwards.
Involucre. A whorl of bracts subtending a flower or flower cluster.
Involute. Rolled inwardly.
Irregular. A flower with one or more organs of a set unlike the others.
Isobilateral. A flower or organ which can be cut into equal halves by two planes, the halves of the one being unlike those of the other.

Lanceolate. Lance-shaped.
Lateral bud. An axillary bud, any bud not the terminal bud of a branch.
Latex. The milky sap of certain plants.
Leaflet. One of the divisions of a compound leaf.
Leaf scar. The scar or cicatrix formed where the petiole of a leaf separates from the stem or twig.
Legume. A simple, dry fruit dehiscent along both sutures.
Lenticel. A small usually oval or rounded spot on the bark of a twig or stem, produced by a special tissue of cells under a stoma and breaking through the epidermis.
Limb. The expanded part of a petal, sepal, or sympetalous corolla.
Linear. A long and narrow organ with the sides nearly parallel.
Lobed. Divided to about the middle or less.
Loculicidal. A capsule which splits longitudinally through the middle of the back of each cavity or component carpel.

Medullary rays. Strips of cells passing radially through the wood from the pith or annual rings to the bark.

Megaspore. The larger of the two kinds of nonsexual spores produced in the flower. The megaspore develops into the female gametophyte.

Megasporangium. A sporangium which produces megaspores; the ovule in seed plants.

Membranous. Thin and rather soft and pliable.

Mesophyte. A land plant adapted to ordinary conditions of moisture.

Microspore. The smaller of the two kinds of nonsexual spores produced in the flower. The microspore develops into the male gametophyte.

Microsporangium. A sporangium which produces the microspores; the incipient pollen sacs in the seed plants.

Midrib. The central rib of a leaf or other organ.

Monadelphous. Stamens with united filaments.

Monoecious. Having staminate and carpellate flowers on the same plant.

Monosporangiate. Flowers bearing only one kind of spores; a flower with only stamens or carpels.

Mucronate. With a sharp abrupt point.

Mucronulate. Slightly mucronate.

Naturalized. Plants not indigenous to a region but having become established as part of the flora.

Natural pruning. The process by which dead twigs and branches are separated from the tree by the formation of a collar or callus.

Nectary. A nectar-secreting organ.

Node. The place where two internodes join, normally with a single leaf or more.

Nut. An indehiscent one-seeded fruit with a hard or bony pericarp.

Nutlet. A very small nut.

Obcordate. Inversely heart-shaped.

Oblanceolate. Inversely lanceolate.

Oblong. Somewhat longer than broad with the sides nearly or quite parallel.

Oosphere. The unfertilized egg; the female gamete.

Oospore. The fertilized egg.

Ovary. The female organ of reproduction; an egg-producing organ.

Ovate. Shaped like the longitudinal section of a hen's egg.

Ovulary. The ovule-bearing part of a closed carpel or set of carpels.

Ovule. The megasporangium of a seed plant which later develops into a seed.

Ovum. The egg or oosphere.

Palmate. Diverging like the fingers of a hand.

Panicle. A compound inflorescence of the racemose type usually of pyramidal form.

Parasitic. Growing upon other living plants or animals and absorbing their juices and tissues as food.
Parietal. Borne on the wall of the ovulary, or pertaining to it.
Parted. Deeply cleft.
Pedicel. The stalk of a flower or flower cluster.
Peduncle. The stalk of a flower.
Pellucid. Transparent.
Peltate. Shield-shaped, as a leaf with the petiole attached at or near the centre of the blade.
Pentacyclic. Having five cycles.
Pentamerous. Five-parted.
Perfect. A flower having both stamens and carpels.
Perfoliate. Leaves so clasping the stem as to appear as if pierced by it.
Perianth. The calyx and corolla taken collectively.
Pericarp. The wall of a fruit; the carpel wall.
Perigynium. The sac-like envelope around the gynoecium of a Carex flower.
Perigynous. Having the sepals, petals and stamens borne on a disc surrounding the gynoecium.
Persistent. Remaining attached after the growing period.
Petal. One of the leaves of the corolla.
Petiole. The stalk of a leaf.
Pilose. With long soft hairs.
Pinna. The primary divisions of a pinnately compound leaf.
Pinnate. Leaves divided into leaflets or segments along a common axis.
Pinnatifid. Pinnately cleft to the middle or beyond.
Pinnule. A division of a pinna in a compound leaf.
Placenta. The ridge or surface bearing the ovules.
Plicate. Folded like a fan.
Plumose. Resembling a plume or feather.
Plurilocular. Having several or many cavities.
Pollen grain. The male gametophyte of seed plants.
Pome. The fruit of the apple and related plants, with an adnate fleshy perigynous disc.
Prickle. A stiff sharp-pointed outgrowth from the epidermis.
Puberulent. With very short hairs.
Pubescent. Hairy, especially with fine and soft hairs.
Punctate. With translucent dots or glands.
Raceme. An elongated inflorescence with each flower on a peduncle.
Rachis. The axis of a compound leaf, spike, or raceme.
Receptacle. The end of the flower stalk bearing the floral organs.
Reflexed. Bent backward abruptly.
Regular. Having the parts of each set alike in size and shape.
Reniform. Kidney-shaped.

Repand. With a more or less wavy margin.
Retuse. With a shallow notch at the end.
Revolute. Rolled backward.
Rotate. With a flat round corolla; wheel-shaped.

Sagittate. Shaped like an arrow head.
Samara. A simple indehiscent winged fruit.
Scabrous. Rough.
Scale. A highly modified dry leaf as in the winter bud of most plants; also a dry, flat, more or less membranous outgrowth from a leaf or stem.
Scurfy. Covered with scurf, minute membranous scales, as in Chenopodium.
Scarious. Thin, dry, and translucent, not green.
Seed. The matured and modified ovule with a dormant embryo.
Self-pruning. The process by which living buds or twigs are naturally separated from the plant.
Self-pruning scar. A scar produced where a twig or bud has been self-pruned.
Sepal. One of the leaves of a calyx.
Septicidal. A capsule which splits longitudinally through its partitions thus dividing it into its component carpels.
Serrate. With teeth projecting forward.
Sessile. Without a stalk.
Sinuate. With strongly wavy margins.
Sinus. The space between two lobes.
Spermary. The male reproductive organ.
Spermatozoid. The male gamete.
Spike. An elongated inflorescence with sessile or nearly sessile flowers.
Spine. A sharp thorn-like organ not representing a stem in origin, as the spines on the leaves of the Christmas holly.
Spore. A modified reproductive cell.
Sporophyte. The nonsexual generation of plants.
Spur. A short stunted branch not representing a true dwarf branch and not ending in a thorn-like point; any projecting appendage of a flower looking like a spur.
Stamen. The organ of a flower which produces microsporangia, which contain the microspores which later develop into pollen grains.
Staminate. Having only stamens or staminate flowers.
Stellate. Star-like.
Sterigma. A small, short, peg-like projection on which certain leaves, spores, etc., are borne.
Sterile. Not producing spores or seeds.
Stigma. The upper part of the carpel; a special organ of the Angiosperms to catch the pollen grains.

Stipel. The stipule of a leaflet.

Stipular scar. The mark made on the bark by deciduous stipules.

Stipular spine. A spine representing a stipule or having the position of a stipule.

Stipules. Bract-like appendages at the base of the petiole of many leaves.

Strigose. With stiff appressed or ascending hairs.

Style. The narrow top of the carpel or united carpels between the ovulary and stigma.

Subulate. Awl-shaped.

Succulent. Soft and juicy.

Superposed. Placed one above the other.

Sympetalous. With petals more or less united.

Synantherous. Having the stamens united by their anthers.

Syncarp. A fleshy aggregate fruit.

Terete. Circular in cross section.

Terminal bud. The bud at the morphological tip of the twig.

Ternate. Divided into three segments; arranged in threes.

Tetracyclic. A flower with four cycles.

Tetradynamous. With four long stamens and two short ones as in the Brassicaceae.

Tetramerous. Four-parted.

Thorn. A highly modified sharp-pointed branch.

Thorn-like spur. A short stunted branch ending in a sharp point or thorn.

Tomentose. Covered with dense wool-like hairs.

Triadelphous. Having stamens united by their filaments into three bundles.

Trilocular (3-locular). With three cavities.

Trimerous. Three-parted.

Truncate. Terminating abruptly by a nearly straight edge or surface.

Two-ranked. Disposed in two vertical rows along the twig; with the third leaf in line with the first.

Umbel. A determinate inflorescence with all the peduncles or pedicles arising from the same point.

Undulate. With wavy margins.

Unilocular (1-locular). With one cavity.

Utricle. A one-seeded fruit with a loose pericarp.

Valvate. Meeting by the margins in the bud, not overlapping; dehiscent by valves.

Vascular bundle. The conducting strands in the plant body composed of wood and bast in which water and food materials are conducted through the roots, stems and leaves.

Vein. One of the branches of the vascular portion of leaves or other organs.

Venation. The arrangement of the veins.
Vernation. The arrangement of the leaves in the bud.
Versatile. An anther attached at or near its middle to the filament.
Verticillate. Whorled.
Villous. With long, soft hairs not matted together.

Whorled. A group of three or more similar organs radiating from a node.
Winged. With a thin expansion.
Xerophyte. A plant adapted to desert conditions.

Zygomorphic. A flower or organ which can be cut into similar halves by only one plane.

INDEX

Proceedings

of the

Ohio State Academy of Science

VOLUME V, PART 4

Seventeenth Annual Report

PROCEEDINGS OF THE OHIO STATE ACADEMY OF SCIENCE
Volume V, Part 4

Seventeenth Annual Report

of the

Ohio State Academy of Science 1908

Organized 1891 — Incorporated 1892

Publication Committee

J. C. Hambleton — E. L. Rice — Bruce Fink

Date of Publication, September 10, 1909

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Columbus, Ohio

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Report of the Eighteenth Annual Meeting

of the

Ohio State Academy of Science

ANNUAL MEETING

The eighteenth annual meeting of the Academy was held at Denison University, Granville, O., on November 26, 27 and 28, the President, Prof. Frank Carney, presiding. On Thursday evening a reception was given at the residence of President and Mrs. Emory W. Hunt, of the University, where refreshments were served and a most delightful evening was passed by the considerable number of members present. The university authorities had generously placed the dormitories at the disposal of the society while arrangements for meals had been made in the town.

After an informal session of various committees the meeting was called to order by the President of the Academy at 9:00 Friday morning in Barney Memorial Hall. A brief address extending the cordial greetings of the University to the society was made by President Hunt, after which occurred the regular business meeting.

The President called attention to the loss sustained by the society through the deaths of three members since the last annual meeting, Prof. W. A. Kellerman of Ohio State University, Hon. Joseph H. Outhwaite, and John J. Janney. The life of Prof. Kellerman was sacrificed to science, his death resulting from a tropical fever while on a collecting expedition in Guatemala, Central America. He served the society as President in 1897, and rarely an annual meeting occurred that his interest was not manifested through his attendance and participation in the program. Both Mr. Outhwaite and Mr. Janney who were also residents of Columbus, lived long and useful lives, and at various times signified their interest in the affairs of the Academy, Mr. Janney died at the advanced age of 96 years.

After the appointment by the chair of a committee on membership consisting of Professors Osborn, Fink, and Stickney, and a committee on resolutions consisting of Professors Rice, Williams, and Griggs, the report of the Secretary was presented and accepted. This was followed by the report of the Treasurer, Prof. J. S. Hine, which after being referred to an auditing committee consisting of Prof. Lazenby and Prof. Brookover, was accepted. The report of the Treasurer is as follows:

REPORT OF THE TREASURER FOR THE YEAR 1908.

For the year since our last annual meeting the receipts, including balance from last year, have amounted to $169.56, and the expenditures to $154.99, leaving a cash balance of $14.57.

RECEIPTS.

Balance from last year	$0 56	
Membership dues	169 00	
Total		$169 56

DISBURSEMENTS.

180 subscriptions to the Ohio Naturalist	$90 00	
Miscellaneous	64 99	
Balance December 1, 1908	14 57	
Total		$169 56

Respectfully submitted,

JAMES S. HINE.

REPORT OF THE LIBRARIAN 1907-08.

The report of the Librarian of the Society, Prof. W. C. Mills, is as follows:

NOVEMBER 27, 1908.

As Librarian of the Ohio State Academy of Science, I take pleasure in presenting to the Treasurer of the Academy, my report upon the receipts from the sale of the publications of the Academy.

Amount on hand, December 1st, 1907	$0 09	
Sale of Reports and Special Papers	14 25	
Publications sold but money not collected	2 10	
		$16 44
Expenditures for 1908:		
Postage of Special Paper No. 13	$4 10	
Postage of Annual Report	4 00	
Express and Postage	4 80	
		$12 90
Cash on hand		$3 54

Wm. C. Mills,
Librarian.

Prof. Lazenby, chairman of the Board of Trustees, presented the following report which was approved and accepted. Mention was made of the continued interest in the welfare of the Society manifested by Mr. Emerson McMillin through his gift of an additional $250.00 to the "Emerson McMillin Research Fund." The report of the trustees is as follows:

REPORT OF THE BOARD OF TRUSTEES.

The financial statement of the Emerson McMillin research fund, for the year 1907-08, is herewith presented:

RECEIPTS.

1907.			
	Balance on hand, Nov. 1, 1907	$358 23	
	Check from Emerson McMillin, received November 11, 1907	250 00	
	Total		$608 23

EXPENDITURES.

1908.			
Feb.	21.	Dr. A. Dechnowski — Expense in research	$16 80
Mar.	27.	Dr. A. Dechnowski — Expense in research	8 35
Apr.	28.	F. J. Heer Printing Co., 350 copies "Protozoa of Ohio," by F. L. Landacre	40 00
May	12.	Dr. A. Dechnowski — Expense in research	8 71
	22.	H. S. Hammond — Expense in research	9 10
	27.	Sergius Morgulis — Expense in research	7 09
	28.	H. S. Hammond — Expense in research	6 00

June	9.	Dr. A. Dechnowski — Expense in research..	6 14
	11.	H. S. Hammond — Expense in Research.....	6 00
	16.	H. S. Hammond — Expense in research......	3 50
July	6.	Prof. L. B. Walton — Expense in research..	6 75
Aug.	3.	Prof. L. B. Walton — Expense in research..	20 12

Total $138 56

Balance on hand November 1, 1908, $469.67.

A check for $250.00 was received from Emerson McMillin, Nov. 7, 1908. This together with the balance reported is deposited in the Capital City Bank, Columbus.

William R. Lazenby,
Chairman.

The Publication Committee consisting of Professors J. C. Hambleton, Chairman, J. H. Schaffner, and E. L. Rice, presented the following report which was accepted:

REPORT OF THE PUBLICATION COMMITTEE.

During the year two papers have been published. Special paper No. 13, The Protozoa of Sandusky Bay and Vicinity, by F. L. Landacre, containing 52 pages, completed Vol. IV of the Proceedings, which consists of ten parts. The Seventeenth Annual Report, containing 18 pages constitutes Part 1 of Vol. V of the Proceedings.

Under the report of special committees, Prof. Herbert Osborn as chairman of the committee on the Natural History Survey, mentioned the work which had been done in the effort to secure the passage of the bill. It was the sense of the society that the committee should be continued.

Professor L. B. Walton, chairman of the committee on the Revision of the Constitution and By-Laws submitted the proposed Constitution and By-Laws which had previously been printed and distributed to members with the Ohio Naturalist. After a brief discussion, two additional members, J. Warren Smith and Bruce Fink were placed on the committee which in addition to the chairman, consisted of E. L. Rice and F. L. Landacre. The final report of this committee was presented at the subsequent business meeting, and the new Constitution and By-

Laws ordered published in the Proceedings of the Academy. They will be found on subsequent pages.

The secretary as chairman of the committee appointed to consider the advisability of holding joint meetings with the Indiana Academy of Science, reported the correspondence with the secretary of the Indiana Academy, Prof. J. H. Ransom, of Purdue University. There seemed no doubt as to the value to both societies resulting from such a meeting, although plans already made by the Indiana Academy may make it necessary to defer such co-operation until the November meeting in 1910.

After the election of a nominating committee consisting of Professors Osborn, Rice, and Stickney, the business meeting was adjourned until Saturday morning at 8:00 a. m. while the society proceeded with the reading of papers, adjourning at 12 o'clock for luncheon.

The afternoon session opened with the address of the President, Professor Frank Carney, on "The Raised Beaches of the Berea, Cleveland, and Euclid Quadrangles." The section in Biology then met in room "A" the section in Geology remaining in room "B," and the program was continued.

After a recess of 10 minutes, the society convened as a body to listen to papers on "The Preservation and Development of the Natural Resources of Ohio." Professor J. A. Bownocker opened the discussion from the standpoint of Geology, followed by Professor W. R. Lazenby, who presented the Forestry side of the question, while Professor Herbert Osborn considered it from the Biological point of view. An interesting discussion followed. Adjournment was then made for the afternoon.

In the evening the society listened to an interesting address by Professor R. S. Tarr, of Cornell University, on "The Glaciers of Mount St. Elias and Vicinity." This was illustrated by lantern slides.

Saturday at 8:00 a. m. occurred the adjourned business meeting. The report of the nominating committee was received and the following officers were elected for the ensuing year:

President — Professor J. H. Schaffner, Columbus, O.
Vice-Presidents — Professor L. G. Westgate, Delaware, O., Professor S. R. Williams, Oxford, O.
Secretary — Professor L. B. Walton, Gambier, O.
Treasurer — Professor J. S. Hine, Columbus, Ohio.
Executive Committee — Professor Chas. Brookover, Akron, Ohio; Mr. J. Warren Smith, Columbus, Ohio.
Board of Trustees — Professor Frank Carney, Granville, Ohio, 2 years; Professor E. L. Rice, Delaware, Ohio, (in place of retiring member) 3 years.
Publication Committee — Professor Bruce Fink, Oxford, Ohio, (in place of retiring member).

The following members were elected by the executive committee during the year:

Budington, R. A., Zoology, Physiology.........................Oberlin
Coons, C. D., Physics.........................Granville
Davies, Clara A., Botany, Physics.........................Granville
Fetzer, Bertha A., Zoology.........................Granville
Johnson, T. B., Physics.........................Granville
Lett, Gertrude, Biology.........................Granville
Metcalf, M. M., Zoology.........................Oberlin
Mossman, Madge C., Geology.........................Granville
Orcutt, A. S., Botany.........................Granville
Shaw, N. E., Entomology.................Columbus, Dept. Agriculture
Stout, W. E., Chemistry, Geology...........1960 N. High St., Columbus
Trask, B. E., Engineering.........................Granville
Thomas, Lewis, Geology.........................Granville

The membership committee appointed by the President at the opening session reported on the following who were duly elected:

Bell, Edith C., Biology.........................Mt. Vernon
Clark, Howard, Geology.........................Granville
Oxley, Chas. E., Geology, Physics.........................Coshocton
Parkhurst, C. P., Science.....................9 W. Long St., Columbus
Peaslee, L. D., Zoology..................Univ. of Cincinnati, Cincinnati
Scott, L. L., Entomology......................65 16th Ave., Columbus
Smith, A. L., Geology.....................175 W. 10th Ave., Columbus
Wilson, Stella A., Geography, Geology........97 N. 20th St., Columbus
Wineland, L. A., Chemistry.........................Westerville

The names noted below have been approved by the incoming executive committee and are subject to election at the next annual meeting in accordance with article V, section 1, of the new constitution.

Fitzgerald, Dr., Histology, Pathology, O. S. U., Columbus.
Fox, Chas. P., Botany, Chemistry, 395 Doyle St., Akron.
Reinheimer, B. H., Biology, Sandusky, Ohio.

The committee on resolutions reported as follows:

Be it Resolved, That we, members of the Ohio Academy of Science, hereby express our sense of loss in the death, since our last meeting, of three of our members, John J. Janney, Joseph H. Outhwaite, and William A. Kellerman, the latter a charter member of the Academy and president in 1897, and at all times an ardent and enthusiastic supporter of the work and ideals of our organization.

Be it further Resolved, That we signify to Mr. Emerson McMillin our great appreciation of his continued interest in the efforts of the Academy, and for his substantial contributions to the support of the projects of the same, and that we extend to him our sincere thanks for his numerous favors.

Be it further Resolved, That we extend our heartiest thanks to the President and Faculty of Denison University who have so hospitably opened their homes to the visiting members, and to the authorities of the University and the members of the Local Committee for their efficient contributions to the marked success of the Eighteenth Annual Meeting of the Academy.

Edward L. Rice,
R. F. Griggs,
S. R. Williams.

In connection with exchanges received by the society, it was moved, seconded and carried that the librarian be requested to furnish a report of such exchanges at the next annual meeting.

Professor Hubbard made a report for the Library Committee. The report was accepted, the committee continued, and the final report ordered printed in the Ohio Naturalist.

The Committee on the Conservation of the Natural Resources of Ohio consisting of Professor Herbert Osborn, Professor Wm. Lazenby, and Professor J. A. Bownocker presented the following report. The committee was continued and empowered to add two new members. The members added were J. Warren Smith of Columbus, and L. B. Walton of Gambier.

The Ohio Academy of Science at its session in Granville, November 27 and 28, 1908, after a special program devoted to the discussion of the conservation of the natural resources of the state, adopted the following resolutions as expressing its position in regard to the importance and necessity of active measures for state conservation:

Resolved, That it is the desire of this Academy to place itself on record as favoring active efforts in support of the movement for rational protection of the resources of the country; that we cordially indorse the movement that has resulted in the formation of a National Conservation Commission, and urge the extension of its powers that it may direct the movement to a practical end.

We recognize the need in Ohio for action in the conservation of coal, and urge that measures providing for national control be enacted where state supervision is impracticable. We urge the importance of forest conservation and extension as a vital necessity for the future welfare of the state, and the formation of a forestry commission or establishment of a state forest service at the earliest possible time.

We recognize the necessity of immediate attention to the waterways and measures to conserve and utilize the possibilities for power, irrigation and navigation in the water areas, and of a scientific investigation of the biological resources connected with aquatic life, and urge the passage of a bill to establish a Biological Survey.

We would urge the formation by the Governor or General Assembly of a State Conservation Commission, at least one-half the members to be men of scientific training, to consider and report to the Government on important measures for conservation.

We recommend a Committee on Conservation in the Academy, and the arrangement for our next annual meeting of a special session devoted to a discussion of the questions pertaining to the conservation of the resources of the State.

J. A. Bownocker,
W. R. Lazenby,
Herbert Osborn,
Committee.

In connection with the discussion of the value of geological and biological excursions for students in the secondary schools, by Professor Hubbard, it was voted that a committee be appointed by the President of the society to report at the next annual meeting.

A telegram was received from the Indiana Academy of Science then in session, conveying the good will of the members of that society to the Ohio Academy. The following reply was sent: "The Ohio Academy of Science cordially reciprocates the greetings of the Indiana Academy of Science."

At the close of the business session the society proceeded with the reading of the papers.

At 11:45 a. m. the Academy was formally declared adjourned.

The complete program of the meeting was as follows:

1. Notes on *Spondylomorum quaternarium* Ehrb. 3 min. — M. E. Stickney
2. The Pteridophyte Flora of Ohio. 5 min. — J. H. Schaffner
3. Injury to Trees by the season's Drouth. 5 min. — W. R. Lazenby
4. Snails collected at Cedar Point, Ohio, during July, 1908. 5 min. — S. R. Williams and J. K. Breitenbecher
5. The Making of a Naturalist's Directory. 5 min. — F. J. Hillig
6. The Occurrence of a New Species of Land Planarian in Ohio, with notes on the common species, *Rhynchodemus sylvaticus* Leidy. 5 min. — L. B. Walton
7. The Behavior of The Opossum (*Didelphys virginiana*). 5 min. — G. E. Coghill
8. Differentiation of the general Cutaneous and Visceral ganglia in *Ameiurus*. 12 min. — F. L. Landacre
9. Some Aspects of Amitosis in Synchytrium. 5 min. — R. F. Griggs
10. Direction of Flow of Encephalic Fluid in *Amia calva* L. 5 min. — Chas. Brookover
11. Recent Evaporation Investigations. 12 min. — J. Warren Smith

12. Adaptation in a Desert Lichen Flora. 10 min. Bruce Fink
13. Notes on the Ohio Flora. 5 min. J. H. Schaffner
14. The Laboratory Method for Beginning Students. 10 min. Maximilian Braam
15. Protective Encystment in *Phagocata gracilis.* 5 min. L. D. Peaslee
16. Cell Division in the Pollen Mother Cells of *Anthemis cotula* L. 8 min. M. E. Stickney
17. Mitosis in Opalina. 15 min. M. M. Metcalf
18. A Preliminary Report on the Nuclear Divisions in the Pollen Mother Cell of *Convallaria majalis* L. 5 min. L. W. Sauer
19. Is Synizesis an Artifact? 6 min. J. H. Schaffner
20. A Preliminary Note on the Chondrocranium of Eumeces. (Slides.) 10 min. E. L. Rice
21. Notes on the Growth of the Western Catalpa (*Catalpa speciosa*). 8 min. W. R. Lazenby
22. Faulty Specimens for Nature Study, and how Good Ones may be Prepared. 15 min. Chas. Dury
23. Cancer in Mice (*Mus musculus*). 5 min. E. F. McCampbell
24. Relation of Rain Fall to Crop Yield. 5 min. J. Warren Smith
25. Removal of the Showy Parts of Flowers as affecting Fruit and Seed Produced. 5 min. A. H. McCray
26. The Coals of the Monongahela Formation in Ohio. 25 min. J. A. Bownocker
27. Fresh light on the Chronology of the Glacial Epoch in North America. (Slides.) 25 min. G. F. Wright
28. Glacial Erosion in the Canadian Selkirks. (Slides.) 15 min. L. G. Westgate
29. Some effects of Glacial Erosion in the Alps. 10 min. N. M. Fenneman
30. The Raised Beaches of Lake Huron. 15 min. W. M. Gregory
31. Rock Terraces along Streams in the Vicinity of Columbus, Ohio. 12 min. G. D. Hubbard
32. Ecologic Notes from Beechwood Camp. 8 min. Bruce Fink
33. The Systematic Position of *Apathus elatus.* 8 min. A. H. McCray
34. Observations on the Tick, *Bryobia pratensis* Garman. 10 min. S. R. Williams
35. Occurrence of *Paragonimus westermannii* near Cincinnati, Ohio. 5 min. H. M. Benedict
36. Localization of the Excretory Function in *Amoeba proteus.* 7 min. M. M. Metcalf and R. A. Budington
37. Evidence pointing toward a Sexual Reproduction in *Euglena proxima* Dangr. 5 min. L. B. Walton

38. The Discomycetes of Oxford, Ohio. Bruce Fink and Freda M. Bachman
39. Observations on Ohio Species of Disonycha. 5 min. L. L. Scott
40. Observations on Tube Making in Tubifex. 3 min. Cora M. Box
41. Venation of Leaves from Old and Young Plants. 10 min. H. M. Benedict
42. Some noteworthy Species of Plants in Ohio. 3 min. O. E. Jennings
43. The Waverly Formations of East Central Kentucky. 20 min. W. C. Morse and A. F. Foerste
44. Valley Drift at St. Louisville, O. (Slides.) 7 min. Howard Clark
45. Well Records in Licking Co., Ohio. 5 min. Lewis Thomas
46. The Age of the Licking Narrows at Black Hand, Ohio. 20 min. K. F. Mather
47. Post Glacial Erosion of Plum Creek, Oberlin, Ohio. 10 min. G. F. Wright
48. Glacial Deposits Southwest of Wilkins Run, Ohio. 10 min. Madge Mossman
49. The Teaching of Historical Geology. 8 min. L. G. Westgate
50. Preglacial Channels in the Little Miami Valley. 10 min. G. F. Wright
51. The Major Subdivisions of the Lower Silurian Strata in Ohio, with Particular Reference to the Richmond Formation recently mapped by the Ohio Geological Survey. 10 min. A. F. Foerste and W. C. Morse
52. The Value of Geology as an Educational Discipline. 15 min. L. G. Westgate
53. A New Anthracnose of Cereals and Grasses. 8 min. A. D. Selby and T. F. Manus
54. The Reconstruction Method as Applied to Hollow Organs. 3 min. E. L. Rice

DEMONSTRATIONS.

1. Cytological Technique. M. E. Stickney
2. Charts Illustrating the Reaction of Diemyctylus Embryos to Tactile Stimuli. G. E. Coghill
3. Slide Showing Emergence of the Gametes (?) from the small spores arising from the repeated division of an "Encysted" Euglena. L. B. Walton
4. The "Larval" Form of an Interesting Pauropod, *Eurypauropus spinosus* Ryder. L. B. Walton

Gambier, Ohio, March 27, 1909.

L. B. WALTON, *Secretary.*

CONSTITUTION.

ARTICLE I, NAME.

This society shall be known as the "Ohio Academy of Science."

ARTICLE II, OBJECTS.

The objects of this Academy shall be the promotion of scientific research and the diffusion of knowledge concerning the various departments of science.

ARTICLE III, MEMBERSHIP.

1. The Academy shall be composed of *Resident Members, Corresponding Members, Honorary Members,* and *Patrons.*

2. *Resident Members* shall be persons interested in scientific work and resident in the State of Ohio.

3. *Corresponding Members* shall be persons interested in science, and not resident in the State of Ohio.

4. *Honorary Members* shall be persons distinguished for their attainments in science, and not resident of the State of Ohio. Their number shall not exceed twenty-five.

5. *Patrons* shall be persons who have bestowed important favors upon the Academy as defined in the By-Laws.

6. Corresponding Members and Honorary Members are not entitled to vote or to hold office in the Academy.

ARTICLE IV, OFFICERS, COMMITTEES, ETC.

1. The officers of the Academy shall consist of a President, a Vice President of each Section organized, a Secretary, a Treasurer, a Librarian and three trustees of the Research Fund.

2. The President, Secretary, and Treasurer, together with two elective members shall constitute an *Executive Committee.*

3. The *Publication Committee* shall consist of three elective members.

4. The *Program Committee* shall consist of the Secretary and the Vice-Presidents of the various sections.

5. Three trustees elected in accordance with section 14 shall be designated as *Trustees of the Research Fund.*

6. *The President* shall discharge the usual duties of a presiding officer at all meetings of the Academy and of the Executive Committee. He shall take cognizance of the acts of the Academy and of its officers, and cause the provisions of the Constitution and By-Laws to be faithfully carried into effect. He shall also give an address to the Academy at the annual meeting of the year for which he is elected.

7. The duties of the President in case of his absence or disability shall be assumed by one of the Vice-Presidents designated by the Executive Committee.

8. *The Vice-Presidents* shall be chairmen of their respective Sections. They shall further, with the Secretary acting as chairman, constitute a Program Committee to arrange for the presentation of papers at the annual meeting.

9. *The Secretary* shall keep the records of the proceedings of the Academy and a complete list of the members with the dates of their election and disconnection with the Academy. He shall co-operate with the President in attending to the ordinary affairs of the Society and also attend to the preparation, printing and mailing of circulars, blanks and notifications of elections and meetings. The Secretary shall superintend printing ordered by the Executive Committee, which is not within the province of the Publication Committee, and shall have charge of its distribution under direction of the Executive Committee. The Secretary shall also be chairman of the Program Committee as constituted in Section 4.

10. *The Treasurer* shall have the custody of all funds of the Academy. He shall keep an account of receipts and disbursements in detail, and this account shall be audited as hereinafter provided.

11. *The Librarian* shall have charge of the distribution of publications, and in so far as practicable, shall arrange exchanges with other societies. He shall furthermore act as cus-

todian of all property belonging to the Society. All books, periodicals, pamphlets, etc., belonging to the library shall be accessible for consultation by members of the Academy under such regulations as may be provided.

12. *The Executive Committee* is clothed with executive authority and with legislative powers of the Academy in the intervals between the regular annual meetings. No extraordinary act of the committee shall however remain in force beyond the next annual meeting unless ratified by the Academy. The Executive Committee shall receive nominations for membership and on approval shall submit such nominations to the Academy for action. It shall have the power to fill vacancies *ad interim* in any of the offices of the Academy.

13. *The Publication Committee* shall have charge of the preparation and publication of the Annual Report and of such other papers as may be considered by them desirable to have printed.

14. *The Trustees of the Research Fund* shall be three in number. They shall have charge of the allotment and distribution of the income or of the principal of the Research Fund.

15. *Terms of Office.* The President, Vice-Presidents, Secretary, Treasurer, and Elective Members of the Executive Committee and Publication Committee, shall be elected annually at the annual meeting, and shall be eligible to re-election without limitation, with the exception of the President, who shall not be elected for successive terms. The Librarian shall be elected for a period of three years. The Trustees of the Research Fund shall be elected for a term of three years. This shall be so arranged however that the expiration of the terms of office of no two trustees occurs in the same year.

ARTICLE V, VOTING AND ELECTIONS.

1. *Nomination of Members.* (a) Nominations for Resident Membership shall be made by two Resident Members in accordance with a form provided by the Executive Committee. One of such Resident Members must be acquainted with the

nominee and his qualifications for membership. The nominations shall be considered by the Executive Committee and if approved by each of its members, shall be submitted to a vote of the Academy at any annual or special meeting.

(b) Nominations for Corresponding Members, Honorary Members, and Patrons, shall be made by the Executive Committee of the Academy, the elections to take place as in the case of Resident Members.

2. *Election of Members, etc.* All elections shall be by ballot. To elect a Resident Member, Corresponding Member, Honorary Member, or Patron, shall require the assent of three-fourths of all Resident Members voting.

3. *Expulsion.* Any member may be expelled by a vote of nine-tenths of all members present at any annual meeting, provided notice that such a movement is contemplated, be given to members at least three months previous to such action.

4. *Election of Officers.* Nominations for office shall be made by a nominating committee as provided in the By-Laws. The nominations shall be submitted to a vote of the Academy at its regular annual meeting. The officers thus elected shall enter upon their duties at the adjournment of the meeting.

ARTICLE VI, MEETINGS.

1. *Meeting.* The Annual Meeting shall be held during the Thanksgiving recess, the place being determined by the Executive Committee and announced by circular at least thirty days before the meeting. The details of the daily session of each meeting shall be arranged by the Executive Committee, and announced in the official program immediately before the meeting.

2. *Field Meeting.* A field meeting may be called at the option of the Executive Committee.

3. *Special Meeting.* A special meeting of the Academy may be called by the Executive Committee upon the written request of twenty Resident Members.

4. *Quorum.* Fifteen Resident Members shall constitute a quorum for the transaction of business.

ARTICLE VII, SECTIONS.

1. Members not less than fifteen in number may by special permission of the Academy unite to form a Section for the investigation of any branch of Science. Each Section shall bear the name of the science which it represents, thus: The Section of Geology of The Ohio Academy of Science.

2. Each Section is empowered to perfect its own organization as limited by the Constitution and By-Laws of the Academy.

ARTICLE VIII, AMENDMENTS.

1. This Constitution may be amended at any annual meeting by a three-fourths vote of all Resident Members voting, provided that the substance of the amendment shall have been submitted at a preceding Annual Meeting.

BY-LAWS.

CHAPTER I, MEMBERSHIP.

1. No person shall be accepted as a Resident Member or as Corresponding Member unless dues for the year are paid within three months after notification of election. The annual dues shall be one dollar and fifty cents, payable in advance. A single payment of twenty-five dollars however shall be accepted as commutation for life.

2. The sums paid in commutation of dues shall be invested, and the interest used for the ordinary purposes of the Academy during the payer's life, but after his death the sum shall be converted into the Research Fund.

3. Non-payment of annual dues shall deprive a Resident Member of taking part in the management and receiving the publication of the Academy. An arrearage continuing over two years shall be construed as notification of withdrawal. The Secretary, Treasurer, and Librarian shall be exempt from the payment of dues during the year in which they hold office.

4. Any person eligible under Article III of the Constitution may be elected a Patron of the Academy upon payment of one hundred dollars to the Research Fund of the Society.

CHAPTER II, OFFICIALS.

1. The President and the Treasurer shall countersign, if they approve, all duly authorized accounts and orders drawn for the disbursement of money.

2. The Treasurer shall give bonds with two good sureties approved by the Executive Committee in the sum of five hundred dollars, for the performance of his duties and the safe keeping of the funds of the Academy. He may at his discretion deposit the funds in a bank, but shall not invest them without the authority of the Executive Committee. His accounts shall be balanced on the first day of the Annual Meeting of each year.

CHAPTER III, ELECTION OF MEMBERS.

1. Nominations for Resident Members may be proposed at any time on blanks to be supplied by the Secretary.

2. The form for the nomination shall be as follows:

OHIO ACADEMY OF SCIENCE.

To the committee on Membership................190.... I desire to become a member of the Ohio Academy of Science.

Name ....

Address ....

Branches of Science interested in...

Countersigned by Members { ....
....

3. This form when filled is to be transmitted to the Secretary who shall bring all nominations before the Executive Com-

mittee at either the Annual, Special or Field meetings of the Academy, and the Executive Committee shall signify its approval or disapproval of each. The list of candidates approved shall then be presented to the Academy for election.

4. Patrons, Honorary Members and Corresponding Members shall be nominated by the Executive Committee and shall be elected in the same manner as Resident Members.

CHAPTER IV, ELECTION OF OFFICERS.

1. At the Annual meeting the election of officers shall take place and the officers elected shall enter on their duties at the end of the meeting.

2. The Academy shall select by ballot a Nominating Committee consisting of three members who shall nominate a candidate for each office including elective members of the Executive Committee, the Publication Committee, and the Trustees of the Research Fund. Additional nominations may be made by any member of the Academy.

CHAPTER V, FINANCIAL METHODS.

1. No pecuniary obligation shall be contracted without express sanction of the Academy or the Executive Committee. It is understood however that all ordinary expenses in connection with the meetings have the permanent sanction of the Academy without special action.

2. Every creditor of the Academy must present to the Treasurer an *itemized* bill certified by the official ordering it, and approved by the President. The Treasurer may then approve and pay the amount out of any funds not otherwise appropriated, and the receipted bill shall be held as his voucher.

3. At each annual meeting the President shall call upon the Academy to choose two members who are not officers of the society, to whom shall be referred the books of the Treasurer duly posted and balanced to the first day of the Annual Meeting as specified in Chap. II, Sec. 2, of the By-Laws. These Auditors shall examine the accounts and vouchers of the Treasurer

and before the adjournment of the meeting shall render a report, and the Academy shall take appropriate action.

CHAPTER VI, PUBLICATIONS.

1. The publications of the Academy are in charge of the Publication Committee.

2. One copy of each publication shall be sent to every Resident Member, Corresponding Member, Honorary Member, and Patron, while each author shall receive thirty copies of his memoir. This provision shall not be understood as including publications in journals not controlled by the Academy.

3. The official organ of the Academy is the Ohio Naturalist under the following terms of agreement:

(a) The Academy shall pay to the Ohio Naturalist seventy-five cents for each subscription sent to members not in arrears for payment of dues.

(b) The Ohio Naturalist shall publish announcements of meetings, list of publications for sale, etc., whenever the Academy desires. Such matter however may be restricted to one-half page of advertising space in any one issue.

(c) The Ohio Naturalist will print papers of from 300-1,500 words presented at the annual meeting provided such papers are submitted in type written form within two weeks from the time of adjournment of the meeting, and have been passed upon favorably by the Publication Committee and by the Editor of the Naturalist.

4. The Annual Report of the Academy, including list of officers, list of members, presidential address, and such other matter as the publication committee may determine shall be printed as a separate issue by the publication committee.

5. Papers exceeding 1,500 words may be published at the discretion of the publication committee as a part of the series of Special Papers.

6. The publication committee shall assemble the Annual Report and the Special Papers into volumes of proceedings of convenient size, paged consecutively in each volume, under the general title "Proceedings of the Ohio Academy of Science."

CHAPTER VII, RESEARCH FUND.

1. The Research Fund shall consist of moneys paid by the general public for publications of the Academy, of donations made in the aid of research, and of sums paid in commutation of dues according to By-Laws, Chapter I, Paragraph 1.

2. Donors to this fund, to the sum of twenty-five dollars or more, shall be entitled without charge, to publications subsequently appearing.

3. The aim of the Academy shall be to accumulate a fund of which the income alone shall be used for the encouragement of research and for the publication of papers bearing upon the development of science in the state.

CHAPTER VIII, ORDER OF BUSINESS.

1. The order of business at the Fall Annual Meeting shall be as follows:

1. Opening.
   a Call to order by the Presiding Officer.
   b Statements by the President.
   c Appointment by the chair of a committee of three on membership. To secure nominations of new members.
   d Appointment by the chair of a committee of three on resolutions.

2. Reports of officers.
   a Secretary.
   b Treasurer.
   c Librarian.

3. Appointment by the Academy of an Auditing Committee of two members.

4. Reports of Standing Committees.
   a Executive Committee.
   b Publication Committee.
   c Program Committee.
   d Trustees of Research Fund.

5. Reports of Special Committees.
6. New Business.
7. Election of Nominating Committee.
8. Report of Nominating Committee and Election of Officers.
9. Election of Members.
10. Report of Committee on Resolutions.
11. Report of Auditing Committee.
12. Unfinished Business.
13. Adjournment.

2. Items of business under 1 to 7 shall be taken up at the first business meeting where possible and be followed by reading of papers. At an adjourned session the order shall be resumed at the place reached on the previous adjournment, but new announcements, motions, and resolutions, shall be in order before the resumption of the business pending.

3. At a Special Meeting or a Field Meeting items of business under 2, 3, 4, except "a," 7, 8, 11 shall be omitted.

4. At any Special meeting the order of business shall be 1, followed by the Special or Field Meeting, business for which the meeting was called, and this in turn followed by 9, 12, 13, when advisable.

CHAPTER IX, AMENDMENTS.

These By-Laws may be amended by a majority of those voting at any annual meeting.

L. B. Walton,
E. L. Rice,
F. L. Landacre,
Committee on Revision.

THE RAISED BEACHES OF THE BEREA, CLEVELAND, AND EUCLID SHEETS, OHIO.[1]

FRANK CARNEY.

INTRODUCTION.

A Moravian missionary, Rev. John Heckewelder, came into the Tuscarawas valley, Bolivar county, in 1762. He traveled much throughout the State in his labors with the Indians, and in

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[1] Presidential address read before the Ohio Academy of Science at the Granville meeting, November, 1908, representing work carried on under the direction of the Ohio Geological Survey. The author is responsible for the opinions expressed.

1796, drew a map of northeastern Ohio; on this map, he makes the first reference, so far as I can ascertain, to the Lake Erie shore lines. Accompanying the map is a brief description in which he refers more in detail to some of the deposits, now known to be of glacial and lake origin, about the lower part of Cuyahoga river.

In the second annual report of the Geological Survey of Ohio, published in 1838, on p. 55, Col. Charles Whittlesey refers to the beaches skirting Lake Erie. It would indeed be surprising not to find in these early documents references to the lake ridges — they are so conspicuous a feature of the landscape. The Indians selected these ridges for their paths, and the first settlers located their highways and dwellings on them. Colonel Whittlesey's comments are very brief.

The first even casual study of these beaches was by Sir Charles Lyell, the British geologist, in 1842; he followed two of the ridges for much of the distance between the Cuyahoga and Rocky rivers. He suggested methods by which they might be more correctly interpreted, lamenting that he did not have the time to ascertain whether fresh or marine shells were to be found with the gravels. He gave it as his tentative opinion that the "Middle Ridge"[2] (fig. 1) in particular appears to be subaqueous in origin.

In 1870, G. K. Gilbert studied the raised beaches in the Maumee valley; this work is probably the first rigorous study of shore-phenomena associated with ice-front lakes. Gilbert mapped the four beaches which indicated the levels of Lake Maumee and the succeeding bodies of water held up by the Erie lobe. Since his field of investigation was limited to the northwest counties of the State, he did not follow the beaches very far to the east nor to the north. Gilbert's methods of studying these ridges, as well as many of his conclusions, were entirely new to the science of geology; some of his interpretations he himself altered later.

[2] The discussion of these beaches can be followed to better advantage if you have at hand the three topographic sheets involved.

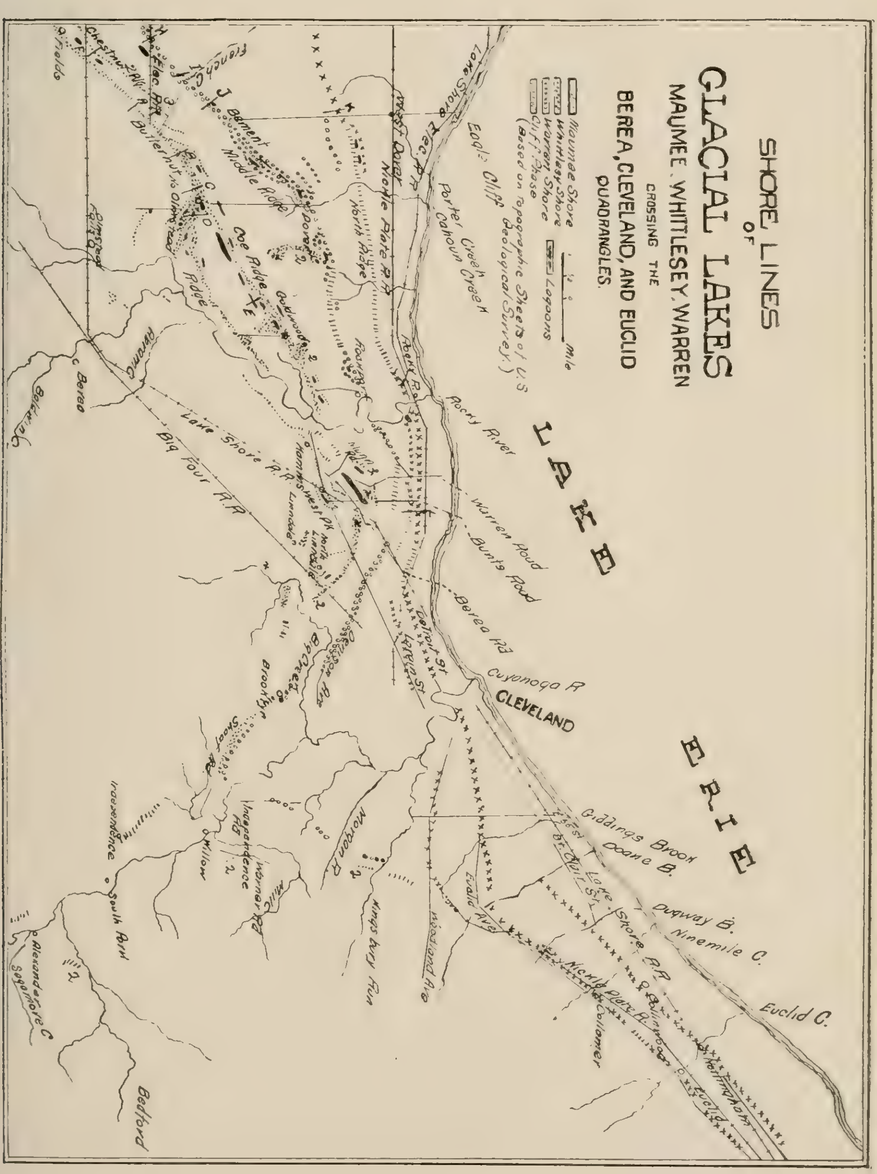
SHORE LINES
OF
GLACIAL LAKES
MAUMEE, WHITTLESEY, WARREN
CROSSING THE
BEREA, CLEVELAND, AND EUCLID
QUADRANGLES.
Maumee Shore
Whittlesey Shore
Warren Shore
Cliff Phase
Lagoons
Mile
(Based on Topographic Sheets of U.S. Geological Survey.)
LAKE ERIE
CLEVELAND
Cuyahoga R.
Rocky River
Berea
Bedford
Euclid C.
Big Four R.R.
Lake Shore R.R.
Nickle Plate R.R.

Fig. 1.

The same volume which contains Gilbert's map on the beaches of the Maumee lobe, also contains J. S. Newberry's article on the Geology of Cuyahoga County; in this, Newberry devotes about four pages to the lake ridges.

In the succeeding volume of the Ohio Survey, A. A. Wright and J. S. Newberry published a more detailed description of these ridges between Elyria and Cleveland. Each ridge was traced for several miles at intervals; no attempt was made to give a detailed description of any particular beach.

From about 1890, the shore-phenomena of ice-front lakes has been given special attention by many trained geologists, either independent workers, State Survey men, or employees of the Canadian and United States Geological Surveys. The descriptions of, and references to, the beaches in the vicinity of Cleveland are numerous and have involved much labor in their correlation. The actuating purpose of each of these workers was the bearing that the ridges of a particular locality have on broader questions of the greater lakes' history; for this reason, we find very few close studies of any of the beaches.

The present investigation concerns the lake ridges of a narrow area; it attempts no contribution whatever to the larger problem of successive ice-front lakes. One of my purposes is the interpretation of the activities along present water-bodies from the standpoint of work done by water-bodies of the past. The activities of wave and shore currents of the present Lake Erie may be intelligently studied in the light of what these same agencies were doing when the lake was one hundred to two hundred feet deeper. At no place in the State can one find in such horizontal nearness, in more complete development, and in better preservation, the shore lines of former water-bodies.

GENERAL CONSIDERATION OF ICE-FRONT LAKES.

When the great ice-sheet attained its maximum development in North America, east of the Mississippi it extended beyond the divide of the present St. Lawrence drainage basin. This position was not reached by an uninterrupted progress.

From the dispersion centers of Labrador and Keewatin the ice fed outward, sometimes maintaining a stationary front because melting and feeding were balanced, retreating when wastage was the more active, and advancing with the ascendancy of the feeding.

Wherever the great plain over which the ice was spreading sloped away from the ice, drainage moved freely; where, however, this plain sloped toward the coming ice, the water gathered, forming lakes.

The record of the bodies of water marginal to the Wisconsin ice-sheet has long been known with much accuracy. As soon as the ice in its retreat came to a halt within the basins of the present Great Lakes, then frontal water accumulated; thus there were small lakes in the Michigan and in the Erie basins, while the remaining basins were buried beneath ice. These small lakes gradually expanded as the ice-cap diminished. So long as each lake maintained an independent overflow southward, it is evident that there had not been disclosed, in the area between these lakes, an altitude lower than the altitude of the overflow channels. As soon as any lower point was disclosed by the retreating ice then the marginal lakes coalesced and continued to drain southward by the lowest col reached. Frequently long intervals of time marked the spacing of these periods of retreat. It is this fact that makes it possible today to deliminate the extent of these temporary lakes. A time did come, however, when the whole front of the gradually receding ice-sheet was skirted by a body of water which reached the ocean by a single overflow channel. The first of these more expanded bodies of water overflowed by way of the Illinois river, past the present location of Chicago. A lower outlet was revealed when the ice withdrew from the Mohawk Valley area; then this great marginal lake reached the Atlantic by the eastern outlet.

The succession of ice-front lakes, as we today read descriptions of their succeeding overflow channels, include so many positions that we fail to comprehend the time involved. We feel that the shore line of any particular one of the present Great Lakes, as Superior, represents a long time period. We have difficulty, perhaps, in realizing that Lake Whittlesey, or Maumee, probably endured quite as long as the present Lake Ontario. When, however, we compare the rock cliffs now bordering the shore of Lake Erie, the constructed beaches, the barriers, the lagoons isolated by development of new bars, the dune sands reaching inland from the shores, with the identical phenomena of these lakes of the past and see how little they differ in scale, in spite of the denuding agencies that have operated upon them since they were formed, then we can better comprehend the very appreciable time intervals represented by the successive stages in the past history of the Great Lakes.

The shore of Lake Maumee in the vicinity of Cleveland was irregular because of the embayments occupying the Rocky river and Cuyahoga river valleys. The arm of the lake extending southward into the former valley was crescent shaped, the western being the shorter of the two segments; but the prevailing winds, by constructing spits and bars, gradually brought that part of the shore into alignment with the general direction of the beach. A more detailed discussion of this is given later.

The valley of Big Creek also formed a small bay during the early part of this lake stage; here again, on its western side, bars gradually developed and straightened the shore line.

The mature Cuyahoga valley was occupied by water of the Maumee level, reaching southward through the entire length of the Cleveland sheet. This arm was the drowned portion of the Cuyahoga valley, for the tributaries of which the lake constituted a local base level into which they spread deltas.

The shore of the Lake Whittlesey stage shows no evidence of a bay in the meridian of Rocky river; there was a slight curve in its outline where the water fronted the lower part of Big creek. In the Cuyahoga valley, however, this stage extended southward through the Cleveland sheets; its altitude is recorded by terraces cut into the deltas of the preceding stage, as well as by the extension of these deltas during the existence of Lake Whittlesey.

The Warren shoreline is characterized by but one embayment, that occupying the Cuyahoga valley which was ponded the entire length of the Cleveland sheet.

THE DEVELOPMENT OF SHORE LINES.

The processes involved in the development of shore lines are chemical and mechanical. The chemical factor is not of great consequence, though from one point of view it demands attention; the mechanical processes are really the ones that need consideration. Winds impel the water into waves and currents producing primarily two movements, on-shore and along-shore. The effectiveness of each movement is controlled directly by the velocity of the wind and the nature of the coast.

The work accomplished by these agencies is influenced in the first place by the nature of the material which the waves are attacking; if the coast is rock it yields less readily than do unconsolidated deposits; in the second place, by the profile of the beach and off-shore slope. Ultimately these agencies under normal exposure to waves will bring about a fairly uniform and constant profile which is a gentle long slope into deeper water. The time required for a given body of water in a particular locality to produce shore line structures, depends very largely upon the original outline of the coast: if sufficiently irregular, and if it yields quickly to these denuding agencies, a supply of material will be at hand for constant work.

It is in the production of this material that the chemical process figures. In the presence of water, chemical disintegration is facilitated. This is important even when the coast being attacked consists of unconsolidated deposits. The basic elements of glacial drift break down more readily, leaving the acidic for distribution by waves.

But the more effective work in the preparation of material is accomplished locally by the waves of translation which erode the shores producing bluffs, that in turn are under-cut by wave-impact and the tools the water has in it. This on-shore movement of water likewise grinds the constituents of the beach, rounding and diminishing the size of all the stones. The along-shore movements also do much attrition work. Furthermore, as the waves of greater size break off-shore, they pick up bits of rock, dashing them again to the bottom, thus continuing the work of attrition begun nearer shore.

All this material is being distributed likewise by the water. Beach ridges represent the ascendency of the work of water moving on-shore over that accomplished by the water moving outward, that is, the under-tow. Whenever the dash of oncoming waves drives material up the slope beyond the effective reach of the under-tow, that material becomes part of the beach ridge. The ridges represent the work of unusually strong and more directly on-shore movements; an equally powerful on-shore wave, striking the coast obliquely, is not so effective in constructing ridges. Since the beach ridge, then, represents a differential of these quite opposing movements of water, it follows that the shape of this ridge is also the result of this difference. The undertow cannot carry any save the smaller bits of rock, and only the finer portions are carried very far off-shore. Material in suspension is always the finest product of destructive work and will be taken farthest from the shore line. The front slope of a beach ridge has a long gentle gradient, save at the edge of the water, where, for a short horizontal distance, the angle is sharper; the back-slope often has a short, sharp angle, and stands more conspicuously above the coast (figs. 2, 3).

When the waves do not strike the shore directly, the oblique movement sets up an along-shore drift; this along-shore drift is a more active distributing agent when the coast is parallel to, or but slightly transverse to, the direction of the prevailing winds. The outlines of these high-level lakes were in general concentric with the present Lake Erie, the shore of which is well exposed to the sweep of the prevailing west winds. It is due to this relationship that headlands have been removed and their products distributed to the east.

Where an angle of water extends into the land, we generally find a *spit* gradually growing out across this reëntrant from its windward side. The along-shore movement of water distributes material in a straight line unless some stronger force tends to deflect the line of deposition. Such a deflecting force is present when we find translatory waves passing landward through the deepening area of the bay; then the spit is bent inward in the shape of a hook. As the height of the spit increases from its tied end, the effectiveness of this deflecting movement is tempered, and we see in consequence, that the spit continues its development in a straight line, leaving the hooked portion as an irregularity on the back slope of the spit; when the bay has been completely shut off, this constructed form is called a *bar*. It not infrequently happens that spits are developed outward from either side of a bay, sometimes uniting, and sometimes passing each other, thus isolating the bay.

In the construction of spits from the windward angle of the bay, sometimes intervening areas are isolated and form lagoons. These lagoons may be developed in series, as when the spit terminates in a hook and later continues to grow forward; more often, however, the lagoons have long axes parallel with the trend of the bars.

Through the interference of shore currents, such interferences often arising from deflected movements of water, the loose materials instead of being carried continuously parallel with the shore, are so deposited as to form a cape which gradually grows out into the water. This constructional form is termed a *cusp*.

When the shores slopes gradually into deeper water, the higher waves break some distance from the shore; the work then done is similar to that accomplished by strong waves breaking at the water-margin, that is, material is piled up; this piling up of detritus in deeper water develops a *barrier* which is, in reality, a submerged beach ridge; barriers therefore, are parallel to the shore. Much of the material which enters into the construction of barriers has been carried back from the shore by the undertow. In time the barrier grows higher, and accordingly interferes with the velocity of along-shore currents, causing the water to drop some of the load it may be carrying. From this time on, the barrier grows through these two methods; it may ultimately rise to the surface of the water and eventually form the shore line proper; when this happens, the space between the beach ridge or cliff and the barrier becomes a lagoon.

We sometimes find a cusp fringed by a barrier; the process of its development is identical with the method above discussed. Between this barrier and the cusp, a lagoon may appear. The barrier may or may not border the entire cusp.

Islands, and shallow places due to irregularities of the lake bed, interfere with the movements of the water; the former undergo wave and current erosion, thus supplying materials for the construction of spits, etc.; the latter, when rising sufficiently near to the surface of the water, may check its velocity and thus grow upward through the accession of deposits. With the continuation of this process, an island may appear, and from it spits will develop with the course of the prevailing winds.

LAKE MAUMEE LEVEL.

I will describe these beaches from west to east across the Cleveland area (fig 1). The altitude usually assigned to the Maumee level ranges from 765 to 785 feet. This lake was about 200 feet deeper than Lake Erie. Two stages are indicated by a higher and lower beach varying 15 to 20 feet in altitude.

From Fields east to the Elyria traction line this shore consists of a cliff and terrace cut in the glacial drift (fig. 2, A); the terrace bears some gravel; thence to the vicinity of Kamms, which is just east of the Rocky river, it is made of gravel and sand. In places this beach has a steep back-slope; throughout most of the distance, the front slope rises from 15 to 20 feet (fig. 2, B, C, D). Southeast from North Olmsted its constituents are fine to coarse sand, and less gravel. For a long period the region about North Olmsted must have formed a point or cape in the shore line as it marked the western limit of the Rocky river embayment. There is evidence of vigorous wave-action here; a few rods south of the corners at North Olmsted is a gravel ridge with a front-slope 3 feet and a back-slope 7 feet high, and containing stones as large as 3 inches in diameter.

The first barrier built in this embayment is traversed by a south-east-trending road connecting the two north-south highways south-east of North Olmsted; this barrier is about three-fourths of a mile long and consists chiefly of fine deposits. Its discontinuance westward where we would normally expect it to join the main ridge may be partly due to removal by erosion;

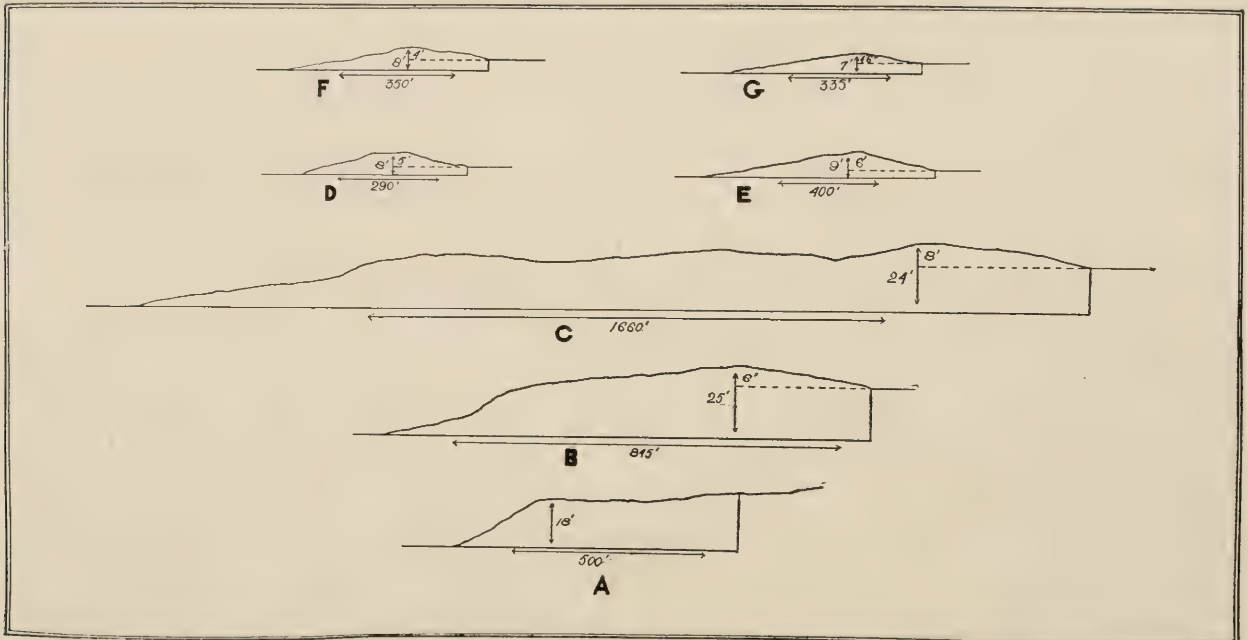

Fig. 2. Cross-sections A-D belong to the upper Maumee level; E-G, to the lower Maumee level. The location of the cross-sections may be found on fig. 1.

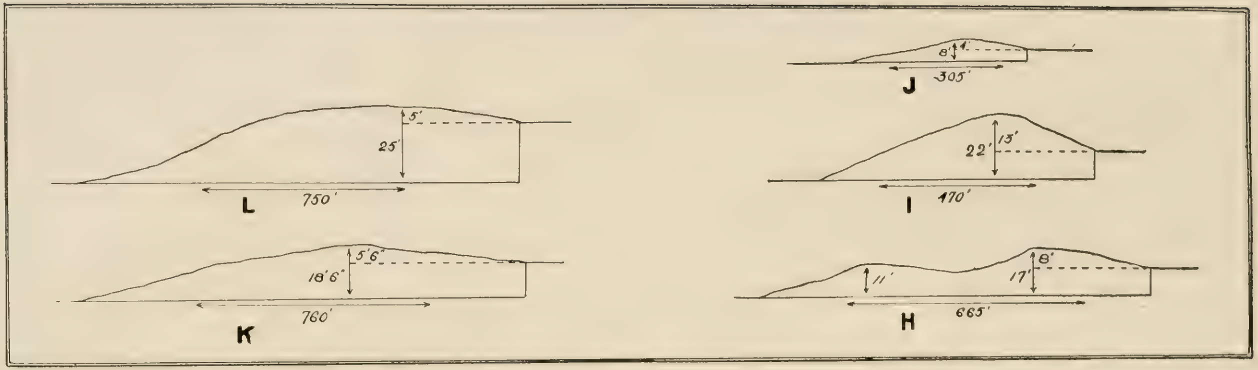

Fig. 3. Cross-sections H-J belong to the Whittlesey level; K and L, to the Warren level. For location of each cross-section consult fig. 1.

eastward it flattens out and disappears within about one-fourth mile of the Rocky river channel. Inland from this I found no evidence of a beach, a condition due to the very low gradient and the consequent wide zone of shallow water. About one-half mile north of the west end of this barrier there is another ridge, terminating near the creek in a slightly recurved spit, apparently subaqueous in origin but later marking the shore line for a relatively brief period, after which it was gradually isolated by the development from the western shoulder of the embayment of still another spit.

The road extending southeast from North Olmsted traverses this bar which tended further to shut out the Rocky river embayment; this bar is coarser in texture than the bar above described, and encloses in its rear several lagoons which were developed consecutively from west to east by the hooked growth of spits as the bar extended farther across the bay. This ridge continues to the edge of the present channel of Rocky river, and there is some evidence of it eastward from the river.

Returning to the shoulder in the main shore line at North Olmsted, we find at the present time a pronounced cliff, swinging at first slightly to the south and then continuing directly east. Between this and the bar last described, there are several marsh areas or lagoons, decreasing in number and size eastward, and each representing an inward bend or temporary hook-terminus of the spit. While this originated as a spit growing into the bay, it came in time to be a typical wave-constructed beach; its front slope is gentle, rising in altitude from 10 to 14 feet; the back slope is nowhere very pronounced, owing to the leveling-up of the lagoon depressions. The beach averages about 10 rods in width; in places, however, the back slope is so slight as to make exact measurement impossible. Over the first mile of this beach, a highway extends, branching at the river into one road running directly north and another skirting the river channel; this latter road continues on a slight gravel ridge, the most pronounced phase of which lies to the east of the highway next to the river cliff. It is probable, however, that the complete development of the shore-ridge in this locality may not now appear for the reason that on its eastern side the river has undercut much of its width. After the first half mile, the beach lies entirely to the east of a highway, at which place it has been worked for a long time as a gravel pit; this is on the farm of W. F. Schultz. Proceeding, the highway again strikes the ridge which at no point for the next mile rises more than 5 feet above the general level; it discontinues within the next one-half mile, terminating directly southeast of Goldwood; but on the opposite side of the river about one-half mile south of Puritas Springs, we find this beach again, and can follow it without a break to within one-eighth of a mile of Kamms, where it becomes a cliff, cut in the Cleveland shale. A few rods east of Kamms, the cliff phase changes to a low gravel ridge which continues through and east of West Park.

In the vicinity of West Park the water deepened so gradually to the north, that no beach ridge was constructed; low spits, however, were developed, apparently of the barrier-type in origin, which were later somewhat modified as the on-shore waves succeeded in forming a true beach. One such spit turns sharply northward of the intersection of Lorain and Davisville streets. This relationship of ridges accounts for the slight lagoon just southeast of the corner at West Park. Other lagoon areas were developed within a mile north of this area, the principal one of which lies between the Berea and Warren roads; apparently, this latter lagoon represents a slight bay which was later enclosed by a barrier.

The West Park area presents some complexities in shore structure largely because of its proximity to the Big Creek embayment. This embayment was in time completely shut off through the successive growth of bars.

The first of these spits ties to the main shore in the vicinity of Linndale, extending north-westward about one-quarter of a mile; this has a pronounced development, being from 5 to 15 feet in altitude; it consists of well worn gravel and sand. No spit correlating with this was found on the opposite side of the bay.

Extending southward from Lorain street, is another spit from 2 to 5 feet in altitude, and for about one-half mile continues a few rods west of Bosworth road, after which this road follows the ridge to Bellaire road, in North Linndale. The western tributary of Big creek runs parallel with this spit for about 80 rods.

Some scattered ridges of gravel exist south of Big creek on the opposite shore of this embayment.

After the Maumee lake level had finally established a continuous shore line across the valley of Big creek, the beach-forming agencies must have worked uninterruptedly for a long period. From the intersection of the Big Four track with the Berea road northeast of Rockport, eastward to the present channel of Big creek in the vicinity of the West Shore railroad, the shore is a beach-ridge and cliff averaging about 23 feet in height and having a sharp front slope. In the northwest part of Rockport village are depressions representing a lagoon developed in the growth of this beach, but eastward to the West Shore railroad, the ridge, simple in construction, consists of ordinary shore gravels. At the West Shore railroad, however, it divides; one of these divisions terminates on the edge of the creek bluff, but probably reappears again in a slight gravel ridge overlying moraine, south of the creek; the other arm, later in development, trends southeast, terminating in the bluff near West Park cemetery.

For the next one-half mile, I was unable to find any gravels, but the shore line appears to be indicated by a cliff cut in the moraine; nearing Brooklyn, however, beach gravels again appear. Street grading and other structural work have so modified topography here that one can not decide whether the ridge through a part of Brooklyn is of barrier origin, or of regular beach construction. South of Brooklyn, as the Schaaf road diverges to the east, the Maumee level is plainly marked; the highest part of the beach here bears much sand, suggesting subaqueous origin.

East from this point the higher Maumee level is not definitely marked. North of Independence, the slope has been steepened possibly by wave-work, and possibly by stream-work when the glacier extended southward into the Cuyahoga valley, ponding the drainage which escaped westward along the edge of the ice. About a mile north of Willow along the Warren road, there is beach gravel, and north of Kingsbury run the rock slope appears to be wave-cut at an altitude correlating with this lake stage.

Returning to the western edge of the Berea sheet, we find a few rods north of this shore line what was probably a barrier, and later a beach, followed now by a highway, locally designated "Chestnut ridge." This ridge is about 15 feet below the shore line above described; it consists generally of fine sand; is from 4 to 6 rods wide and rises 8 feet on the average along its front-slope, which is very gradual (fig. 2, F, G). Between Chestnut ridge and the beach of the higher Maumee level, the interval is very mucky, indicating a former lagoon condition; to the east and north, this ridge blends gradually into the general level. Between this point and North Olmsted, two slender ridges, tied at their western ends to the beach of the higher level, trend with the old shore line.

From North Olmsted to the edge of the present river channel directly west of Kamms, is a sharply defined beach slope changing locally into a constructed shore ridge. Throughout this distance we have the permanent shore line for the lower Maumee level (indicated by 2 on fig. 1), marking the position of the water after the Rocky river embayment had been completely closed; the back slope of the ridge descends into extensive mucky areas which indicate the swampy condition that prevailed for a long period after the embayment had been shut off. Market-gardening is the chief industry in this section at the present time. The most conspicuous spit developed in the process of enclosing the Rocky river embayment is the broad-based ridge extending southward from Goldwood; opposite the end of this, extending northwestward from the other shore of the bay, is a correlating spit; apparently the two approached quite closely but have since been separated by erosion.

Proceeding eastward from Goldwood this shore line takes on more and more the form of a constructed beach, varying in width from 4 to 15 rods, and in height from 12 to 24 feet. Near the river it is slightly modified through erosion.

Another feature of this level of the Maumee stage is found in the off-shore bars which are not strictly of the barrier type. The second highway east of North Olmsted, running to the north, passes along a north-south ridge of gravel and sand. Reaching eastward from the termini of this ridge are compound spits that represent the work of west winds. This bar and its appended spits with their like orientation indicate a shallow place in the water occasioned probably by a ridge of glacial drift. Smooth-surfaced till, rather stony in texture, is found in the fields east and west of this ridge. Wells sunk in the ridge also penetrate drift, but throughout its whole extent the ridge is covered with gravel from 5 to 14 feet in thickness. The spits that have grown from the ends of this ridge present several interesting features, especially in their constant trend to the east, in their gradual variation in texture from coarser gravels to fine sand eastward, and in the lagoons formed by the development of secondary spits from the windward side of the angle made by the main bar and the spit already developed.

A short one-half mile northeast of Goldwood is a cusp fringed by a barrier. The cusp is about 50 rods long; between it and the barrier is a lagoon.

Eastward towards the river, just before crossing the road which leads north to Rockport, is a short barrier with a lagoon in its rear. From the intersection of the Rockport road with the main shore, another ridge extends north-eastward; this, throughout nearly the whole of its one-half mile length, shows a strong development, in places 4 to 6 rods wide on top, and having a sharp back-slope.

Continuing eastward along this lower level of the Maumee Lake, we find on the opposite side of the river, west and north of the Rockport race track, a short slope due to wave work on the shales thus forming a cliff. For some distance this shore line is indistinct, but reappears about one-half mile northeast of Munn road, in a strongly developed gravel ridge which swings due east after crossing Warren road. It shortly blends into a low ridge of clay. The interpretation of this clay ridge was puzzling for some time; it is plainly not of glacial origin, and is so free from gravel or other normal wave-worn products that a shore line genesis did not suggest itself. In this vicinity, the Cleveland shale bears scarcely a veneer of glacial deposits. Wave action in consequence has attacked the shale, and because of the very low slope of the lake basin, cliff cutting did not take place. The shale was ground off by the waves and piled in a low ridge, so slowly that weathering proceeded, it is thought, to a considerable extent before Maumee Lake fell to a lower level.

Going south from Warren road, along Brown road, one crosses two other slight gravel and sand ridges which alternate with lagoons. The southernmost of these formed the north shore line of the lagoon bay, already mentioned, which Brown road crosses before reaching Berea road.

Farther eastward, I have not noted any distinct shore-ridges correlating with this second Maumee level, except the possibility of such a ridge being indicated by the shore gravel extending south-eastward from the intersection of this beach with the West Shore railroad just north of Big creek. The front-slope of the beach along Schaaf road shows some evidence of being modified by the water of this lower level. The Tinkers creek delta has a cliff and terrace which apparently correlates with it. North-east of Willow, on the slope east of a brick plant, are gravels at the proper altitude. And east of 87th street, between Union avenue and Kinsman road, is another area of possible lower Maumee shore deposits.

LAKE WHITTLESEY LEVEL.

The altitude of this shore line is approximately 735 feet, or about 30 feet lower than the preceding stage. From the western border of the Berea quadrangle to the Cuyahoga river, it is practically unbroken, and for the major part of this distance consists of a gravel ridge, in a few places one-quarter of a mile wide, enclosing lagoons. The Cleveland, Elyria, and Western Electric railway enters the Berea sheet on this ridge, but after traversing it for a few rods, swings directly eastward to the shore ridge of the Maumee level.

Cross sections of the western part of this beach are shown in fig. 3, H-J. The compound characteristic of the ridge is apparent in section H. The low front-slope condition here indicated continues to characterize the ridge north-eastward as far as Bement; from Bement to Dover, the ridge is found in its most complex phase; through most of this distance, the outer slope is longer than shown in section J. The ridge top is much broader and for the second half of the distance we find a series of ridges alternating with longitudinal muck basins.

FIG. 4. Looking eastward along the Whittlesey beach one-half mile east of Dover.

From Dover eastward to Rockport the ridge consists of gravel with a short front-slope rising 20 to 22 feet, and a back-slope dropping not more than 7 feet (fig. 4). The compound form of the ridge observed west of Dover is much less characteristic of this portion; nearing Rockport, however, I have noted a few former swamp areas. The shape of the front-slope for several miles here indicates cliff-development, at the western portion in shale, and eastward, where the shore line crosses the buried Rocky river channel, in drift.

Crossing the Rocky river, the course of this beach is indicated for about one mile by Hilliard road, but at the intersection of West Madison avenue, the beach swings directly to the east, and changes from a gravel ridge to a cut cliff shown in the steep slope just north of this avenue. From Ridgewood avenue, eastward to the Lake Shore railway, the course of the beach is not definite; but upon crossing the Lake Shore, it comes in once more in its beach-ridge phase and thus continues to the neighborhood of the intersection of Fulton road and Denison avenue. From Lorain street almost to Fulton road, this ridge originated as a spit developing into the Cuyahoga embayment, and for over one-half of the distance, for some period of time, appears to have formed the shore while the other half apparently was still subaqueous.

From Fulton road to the western part of Brooklyn, whatever development this beach had obtained has since been obliterated by the erosion-work of Big creek. Its course through Brooklyn is somewhat doubtful because of street grading and other destructive work. The best exposure of the beach-ridge in this vicinity is along the west side of Broadview avenue just east of West 25th street; for about 80 rods the beach thus continues; it then swings southward across Broadview and flattens out. A short distance farther to the south I noted a wave-cut cliff parallel to Scarsdale avenue, which turns southward crossing Roanoke and Tate avenues. Beyond this point the shore of Lake Whittlesey was at first parallel to, and later coincided with, the lower beach of Lake Maumee. This horizontal coincidence has given the lower Maumee beach a steep front-slope, the difference in the level of the two lakes measuring the vertical distance through which the older beach may have been over-steepened. On the opposite side of the Cuyahoga river, about one and one-half miles north of Willow, we find parallel with Independence road, a bar one-half mile in length; the southern part of this is nearly north-south in direction, but the northern half swings eastward in conformation with the outlines of the Cuyahoga embayment. Sand and gravel of contemporaneous development were noted along 59th street, south of Harvard avenue. For some distance northward this beach could not be definitely mapped since this interval has been worked over in the street development of Newburg, but for a short distance between 80th street and the Pennsylvania railroad, there is a low ridge of gravel conforming in altitude with this lake level. For over a mile to the northward, I have not mapped any gravel or sand interpreted as representing Lake Whittlesey, but just south of the Fairmount reservoir, and parallel to Baldwin street, there is a low sandy ridge which indicates this shore.

From this point eastward I was unable to satisfy myself that the rock escarpment gives any evidence of wave work that definitely indicates the Whittlesey level; there are scattered salients which bear indefinite notches that may possibly indicate cliff-cutting of this shore; some of these benches may also be explained as the result of differential weathering. It seems preferable to state that the rock cliff which continues north-eastward from Garfield's monument for some eight miles is due to denuding agents in operation long prior to the ice invasion, and has since been altered slightly by the wave work of both the Maumee and Whittlesey levels.

LAKE WARREN LEVEL.

Lake Warren marks a vertical subsidence of the Whittlesey level; the drop is about 50 feet. The evidence west of Rocky River on the Berea sheet suggests that the subsidence was brought about in a very short time, but eastward from Rocky river there is an intermediate beach of slight development suggesting a gradual subsidence of the Whittlesey to the Warren level. This intermediate stage averages 20 feet above the Warren beach proper. From the Rocky river, to Ridgewood avenue, it is practically parallel to Detroit street, and consists of a low broad ridge of fine sand and gravel as far as Arthur avenue, while eastward the level is marked by a cliff cut in the Cleveland shale. The same ridge appears again along West Madison avenue, in the vicinity of 81st street; turning to the northeast, it crosses the Nickel Plate railroad, thence more directly east it crosses West 25th street, a short distance south of Lorain street. On the east side of the Cuyahoga the general direction of this beach is indicated by Woodland avenue, which follows the ridge for over two miles.

Just west of the Berea sheet in Lorain county, the Warren shore bears sharply to the north. This point of land extending into the lake acted as a wind break to the shore directly east. In consequence of this, the first two miles of the Warren shore on the Berea sheet consists almost entirely of sand and very fine gravel; the beach contains a slight terrace (fig. 3, K), a cliff that averages about 20 feet, and for the most of this distance, is a low ridge. A few rods east of the north-south road connecting West Dover and Bement, the Warren level is marked by a cliff cut in

FIG. 5. Looking eastward across the Warren shore line at first highway south of West Dover; the cliff is here cut in shale.

the shales (fig. 5), and this phase continues eastward for a little more than four miles. Contemporaneously with the development of the first mile of this cliff, off-shore deposits gradually widened the beach; throughout part of this distance, two or more barriers developed, giving rise to intervening depressed areas where marshes have persisted till the present time. A cliff and terrace characterizes this shore where it crosses the buried Rocky river.

Between the sandy beach on the west side of the sheet and the till terrace marking the site of old Rocky river, the interval of shales bears locally a few feet of glacial drift. Eastward of

Calhoun creek, there is slight evidence of gravel accumulations at the base of the bluff.

Commencing three-fourths of a mile west of Rocky river, the top of the bluff bears a beach ridge, its crest rising three to four feet. Nearing the river, the ridge becomes composite, inclosing lagoons. Directly east of Rocky river, a cusp, developed from this beach, extends northward from Detroit street across the Nickel Plate railroad. For about two miles this beach consists of a sand ridge locally composite, and from 40 to 80 rods in width. Near Highland avenue, the beach gravels present a sharper front slope (fig. 3, L). Just east of this avenue, the shore line swings slightly southward, changing to a cliff cut in the Cleveland shales. In the vicinity of West 100th street, the Warren level is again indicated by a wide sandy beach, in places, reaching from Detroit avenue southward to Franklin avenue.

On the east side of the Cuyahoga, excepting about one mile west of Wade Park, the Warren level is marked by the Euclid avenue beach. From the vicinity of East 65th street, to the campus of the Women's College of Western Reserve University, the Warren shore is found north of Euclid avenue. Eastward as far as Collamer, a beach-ridge condition continues to the eastern edge of Euclid sheet. There is evidence that the Warren level did some wave-cutting in the shales, developing a gravel-bordered terrace that is wider in some places than in others, the control being a matter of stratigraphy. East of Euclid, the cliff-cutting work of this lake was more pronounced.

In the vicinity of the intersection of Ansel road and Superior avenue, I noted a conspicuous development of rather fine sand. Sand of the same level may exist westward, but on account of extensive building operations, tracing it was not at all satisfactory. Eastward from Doan creek, however, this broad, low ridge of sand may be followed without a break to the intersection of Penobscot and St. Clair avenues; from this point eastward, St. Clair avenue is located on this ridge of sand and gravel, and continues thereon to Nottingham. For three-fourths of a mile east of Nottingham, the gravel ridge is but slightly developed, but reappears again just before St. Clair avenue crosses the

Lake Shore tracks; thence for one and one-fourth miles the gravel ridge swings a little north of the avenue and continues to the edge of the Euclid sheet. From Nottingham eastward, this ridge is not over three feet high, even where it is best developed, but west of Nottingham, the ridge in places is 5 feet to 10 feet high, and contains some rather coarse gravel.

This St. Clair avenue beach ridge is about 30 feet lower than the proper Warren level; its shape and continuity suggest a lake stage. West of the river nearly to Edgewater Park there is much sand and fine gravel at the same altitude. If, however, Lake Warren declined slowly, or by short stages, it is probable that the St. Clair ridge is only a barrier beach.

LIFE RELATIONS OF THESE SHORE LINES.

The flat region bordering Lake Erie has been likened to a coastal plain. There are several reasons for seeing a similarity. In the first place, the escarpment due largely to inequality of rock texture serves as a border for the low smooth strip that belts the lake. This flat bordering strip, as we have seen, is a terraced lake plain. Furthermore, the successive lake-stages have given the streams corresponding local base-levels, hence they have had a drainage history very unlike that of coastal plain streams. Organisms, flora and fauna, have been influenced by this particular physiography with its stretches of gravel ridges, rock cliffs, wide strips of sand and marshes, and extensive clay areas. And man, both Indian and white, dwelling here, has also experienced physiographic reactions. It is our purpose to look briefly into some of man's responses.

These old shore lines in their development witnessed the usual shifting facies of plant habitats, developing societies, and in time families and communities, working out the usual history that always takes place slowly under a changing environment. The ecology of modern shore lines under like climatic conditions must be very similar. Each stage of these high level lakes involved a great lapse of time. Some indications of this time are seen in the numerous swamp areas, many of which had not been eliminated by natural processes when the white man came into the area.

As soon as a given level of the lake gave way to a new and lower level, the deserted beach, as well as the area recently covered by deep water, were spread over by plants in their normal struggle. From the standpoint of the farmer, the plant history of this land is of importance. Residual rock alone does not make a fertile farm. He ploughs the soil which is reduced rock plus the remains of organisms; usually the more of this latter addition the better is his soil. A ridge inhospitable to plants is made artificially hospitable to crops only with the greatest of labor.

Beach societies were never prolific, for here flora always has a struggle and even after the withdrawal of the water insuring a static condition of the beach, the plant societies multiplied very slowly. For this reason humus accumulated slowly. Relatively, then, beaches were never fertile. The sand areas always associated with beaches, either through the development of spits, cusps, or deltas, have a more abundant flora, in consequence of which they have become richer for cultivation. The prolific plant life of lagoons develops an almost ideal soil. Many lagoons are found about the angles of embayments and between barriers and shores; these make rich lands.

Another relation of these shore lines, passive but of importance in the development of the region, is seen in their use by the Indian for trails and the white man for highways. In consequence of this influence, the farms front the shore-ridges, and the houses, in general, are placed on the front-slope where quick and effective drainage is best assured. The shape of the older farms, longer or shorter as the shores converge or diverge, again shows an influence of these successive lake levels.

Furthermore, there is observed in the agricultural evolution of this region a tardy adaptation to natural conditions. The first farmers here were emigrants from New England and carried on general farming, extensive in its application. Land was cheap and there was plenty of it; population was sparse, hence markets were limited. Only the old staple lines of grains and fruits were cultivated. Even in a generation, the descendants of these New England emigrants learned that the muck lands associated with the ridges were especially adapted to the growth of onions; further than this, I have not been able to learn of much ingenuity on the part of these aboriginal farmers. Gradually as more distant outlets were found, the first through the construction of good stage roads, later through the digging of canals and the stimulated lake navigation, and finally through the building of railroads, agriculture became more varied.

More thought was given to adapting crops to the soil. The broad flats below the Whittlesey level were found better suited to the growth of vineyards; the soil here is clay, for the most part either glacial or residual of the old shales. We note in this region at the present time further diversity, particularly where a low swell of gravel breaks the usual clay; these slight ridges may be located, usually by an apple orchard three or four rows of trees wide, but awkwardly long.

With the increasing city population, a growth made up very largely of foreigners attracted by opportunities of labor, there came increasing local demands; but the local farmer was tardy in responding to this demand; he was not so thrifty that he regarded his farm investment as a good one; in consequence, the provident foreigner from his days' labor relentlessly saved and so became a farmer. With this gradual supplanting of the New England farmer by the Danes, Germans, Bohemians, and Polanders, came the installation of European thoroughness in agriculture. Intensive and specialized farming rather than the former extensive method was inaugurated as these men became land owners. Farms that had been barely supplying the expenses of living for a Yankee family later formed the basis of permanent bank accounts. The beach ridges were enriched, crops adapted to them were grown; the sandy fields were so treated as to be made more dependable in times of drought; stubborn clay areas were drained and lightened. As the city of Cleveland continued to grow in population, market-gardening in the hands of these foreigners was made very profitable. These new emigrants from old Europe brought with them a training acquired through generations of ancestors engaged in a struggle for momentary support. This training has made them more valuable as American farmers than as laborers in factories.

In still another direction, we find the lake ridges entering into life relations. For industrial purposes, such as building-blocks and concrete, they furnish a supply of gravel and sand; the extensive deposits of lake and glacial clays have afforded material for brick and tile.

We find a specially interesting physiographic reaction in the influence of the lake-made physiography on railroad construction. In this area, the Cuyahoga was the largest river tributary to these lakes. Into the lake at all stages, the Cuyahoga built an extensive delta and as the lakes dropped from one stage to another, tributary streams have incised this delta which is made up of sand, coarse and fine, and gravels of varying texture. It yields readily to stream work, consequently deep channels were developed. Its lack of stability near the walls of a stream is obvious; for this reason railroads have always hesitated about constructing high bridges.

All railroads centering at Cleveland have either east-west courses bordering the lake, or north-south courses paralleling the Cuyahoga valley. The Lake Shore, as the name implies, belongs to the former class. One other east-west road, however, the Nickel Plate, approaching the city from the east, turns southward near the south side of the delta and descends through the valley of Kingsbury run to the level of the present Cuyahoga river in ascending from which, on the western side, it uses another tributary valley. The Big Four uses this same valley west of the Cuyahoga.

The railroads from the south, that is, the Baltimore & Ohio, Pennsylvania, Wheeling and Lake Erie, with the exception of the Pennsylvania, enter the city through tributary valleys cut in the old delta. The Pennsylvania, however, follows Mill creek to Newburg, then it skirts the Maumee beach for two miles and gradually descends the delta slope to the lake front; the Baltimore & Ohio has a more uniform gradient as it follows the edge of the river channel.

But at the present time, a high level bridge is under construction; this is being built across the Cuyahoga on the delta-top level; it is a part of the recently located "Belt Line" which has become the property of the Lake Shore Railroad Company. From the standpoint of engineering, this is a hazardous venture, a fact which in the light of thousands of dollars spent by this company in the last year, much of which has been sunk in the slumping quicksands of this old delta, needs no further comment.

A vital question today in every large American city is speedy transportation for the urban part of its citizens. This fact has led to the construction, in many large centers of population, of subways. For the most part subways in the city of Cleveland would have to be cut through this old delta. Such an undertaking will doubtless present new questions to subway engineers.

This particular part of the southern shore of Lake Erie, if one can clearly interpret the present movement of industry, is destined to be the most thickly populated portion of Ohio. The lake plain here, so far as the city of Cleveland is concerned, even now is too narrow. It is probable that in this assured development many physiographic reactions, new to this region, will arise. This whole composite of conditions, then, is the result of a pre-glacial physiography upon which has been imposed the work of three lake levels, and which is becoming still further complicated by the shore line now in the making.

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SIX HUNDRED PLANTS OF GENERAL DISTRIBUTION IN OHIO.

JOHN H. SCHAFFNER.

A study of the plants in the Ohio State Herbarium shows 600 species to be of general distribution in the state. Most of these are also common. The number of plants generally distributed is probably much larger, at least 1,000 species, but the collections are still too imperfect to give complete data.

Since the plants thus far collected and incorporated into the herbarium are not at present kept in a fire-proof building, it was thought advisable to publish the list in order that, in case of accident or fire, the labor of so many botanists in the state might not be entirely lost.

Botrychium obliquum Muhl.
Botrychium dissectum Spreng.
Botrychium virginianum (L) Sw.
Osmunda regalis L.
Osmunda claytoniana L.
Osmunda cinnamomea L.
Onoclea sensibilis L.
Filix fragilis (L) Und.
Polystichum acrostichoides (Mx.) Schott.
Dryopteris noveboracensis (L.) Gr.
Dryopteris thelypteris (L.) Gr.
Dryopteris cristata (L) Gr.
Dryopteris marginalis (L) Gr.
Dryopteris spinulosa (Retz.) Ktz.
Phegopteris phegopteris (L.) Und.
Phegopteris hexagonoptera (Mx.) Fee.
Camptosorus rhizophyllus (L.) Link.
Asplenium angustifolium Mx.
Athyrium thelypteroides (Mx.) Desv.
Athyrium filix-foemina (L) Roth.
Adiantum pedatum L.
Pteridium aquilinum (L) Kuhn.
Equisetum arvense L.
Equisetum robustum A. Br.
Equisetum hyemale L.
Tsuga canadensis (L.) Carr.
Juniperus virginiana L.
Typha latifolia L.
Sparganium eurycarpum Englm.
Potamogeton natans L.
Potamogeton pectinatus L.
Naias flexilis (Willd.) R. & S.
Alisma plantago L.
Sagittaria latifolia Willd.
Andropogon scoparius Mx.
Andropogon furcatus Muhl.
Syntherisma sanguinalis (L.) Dulac.
Echinochloa crus-galli (L.) Beauv.
Panicum macrocarpon Le Conte.
Panicum huachucae Ashe.
Panicum virgatum L.
Panicum capillare L.

Chaetochloa glauca (L.) Scrib.
Chaetochloa viridis (L.) Scrib.
Chaetochloa italica (L.) Scrib.
Homalocenchrus oryzoides (L.) Poll.
Muhlenbergia mexicana (L.) Trin.
Muhlenbergia diffusa Willd.
Phleum pratense L.
Cinna arundinacea L.
Agrostis alba L.
Agrostis perennans (Walt.) Tuck.
Agrostis hyemalis (Walt.) B. S. P.
Danthonia spicata (L.) Beauv.
Eleusine indica (L.) Gaert.
Eragrostis purshii Schrad.
Eragrostis major Host.
Eragrostis hypnoides Lam. B. S. P.
Eatonia pennsylvanica (D. C.) Gr.
Dactylis glomerata L.
Poa annua L.
Poa pratensis L.
Poa compressa L.
Panicularia nervata (Willd.) Ktz.
Festuca elatior L.
Festuca nutans Willd.
Bromus purgans L.
Bromus tectorum L.
Bromus secalinus L.
Bromus racemosus L.
Lolium perenne L.
Agropyron repens (L.) Beauv.
Elymus virginicus L.
Elymus canadensis L.
Hystrix hystrix (L) Millsp.
Cyperus strigosus L.
Eleocharis obtusa Schultes.
Eleocharis palustris (L) R. & S.
Scirpus americanus Pers.
Scirpus lacustris L.
Scirpus atrovirens Muhl.
Scirpus lineatus Mx.
Scirpus cyperinus (L.) Kunth.
Carex asa-grayi Bail.
Carex lupulina Muhl.
Carex frankii Kunth.
Carex squarrosa L.
Carex shortiana Dew.
Carex crinita Lam.
Carex triceps Mx.
Carex gracillima Schw.
Carex granularis Muhl.
Carex oligocarpa Schk.
Carex laxiflora Lam.
Carex albursina Sheld.
Carex pennsylvanica Lam.
Carex jamesii Schw.
Carex stipata Muhl.
Carex vulpinoides Mx.
Carex rosea Schk.
Carex sparganioides Muhl.
Carex cephalophora Muhl.
Carex tribuloides Schk.
Carex cristatella Britt.
Arisaema triphyllum (L.) Torr.
Arisaema dracontium (L.) Schott.
Spathyema foetida (L.) Raf.
Acorus calamus L.
Spirodela polyrhiza (L.) Schl.
Lemna Minor L.
Tradescantia virginica L.
Juncus effusus L.
Juncus tenuis Willd.
Juncus acuminatus Mx.
Juncoides campestre (L.) Ktz.
Uvularia perfoliata L.
Uvularia grandiflora Sm.
Hemerocallis fulva L.
Allium cernuum Roth.
Allium canadense L.
Lilium canadense L.
Erythronium americanum Ker.
Erythronium albidum Nutt.
Quamasia hyacinthina (Raf.) Britt.
Asparagus officinalis L.
Vagnera racemosa (L) Mor.
Unifolium canadense (Desf.) Greene.
Salomonia biflora (Walt.) Britt.

Salomonia commutata (R. & S.) Britt.
Medeola virginiana L.
Trillium sessile L.
Trillium grandiflorum (Mx.) Salisb.
Trillium erectum L.
Smilax herbacea L.
Smilax glauca Walt.
Smilax rotundifolia L.
Smilax hispida Muhl.
Hypoxis hirsuta (L.) Cov.
Dioscorea villosa L.
Iris versicolor L.
Sisyrinchium graminoides Bick.
Cypripedium hirsutum Mill.
Galeorchis spectabilis (L.) Ryd.
Aplectrum spicatum (Walt.) B. S. P.
Saururus cernuus L.
Populus alba L.
Populus grandidentata Mx.
Populus tremuloides Mx.
Populus deltoides Marsh.
Salix nigra Marsh.
Salix fragilis L.
Salix alba L.
Salix fluviatilis Nutt.
Salix discolor Muhl.
Salix sericea Marsh.
Salix cordata Muhl.
Salix purpurea L.
Juglans nigra L.
Juglans cinerea L.
Hicoria minima (Marsh.) Britt.
Hicoria ovata (Mill.) Britt.
Carpinus caroliniana Walt.
Ostrya virginiana (Mill.) Willd.
Corylus americana Walt.
Fagus americana Sw.
Quercus rubra L.
Quercus palustris Du R.
Quercus velutina Lam.
Quercus imbricaria Mx.
Quercus alba L.
Quercus macrocarpa Mx.
Quercus platanoides (Lam) Sudw.
Ulmus americana L.
Ulmus fulva Mx.
Celtis occidentalis Mx.
Morus rubra L.
Toxylon pomiferum Raf.
Urtica gracilis Ait.
Urticastrum divaricatum (L.) Ktz.
Adicea pumila (L.) Raf.
Boehmeria cylindrica (L.) Willd.
Parietaria pennsylvanica Muhl.
Commandra umbellata (L.) Nutt.
Asarum canadense L.
Asarum reflexum Bick.
Asarum acuminatum (Ashe) Bick.
Aristolochia serpentaria L.
Rumex acetosella L.
Rumex altissimus L.
Rumex crispus L.
Rumex obtusifolius L.
Fagopyrum fagopyrum (L.) Karst.
Polygonum lapathifolium L.
Polygonum pennsylvanicum L.
Polygonum persicaria L.
Polygonum hydropiperoides Mx.
Polygonum hydropiper L.
Polygonum punctatum Ell.
Polygonum virginianum L.
Polygonum aviculare L.
Polygonum convolvulus L.
Polygonum scandens L.
Polygonum sagittatum L.
Chenopodium album L.
Chenopodium murale L.
Chenopodium hybridum L.
Chenopodium botrys L.
Chenopodium ambrosioides L.
Atriplex hastata L.
Amaranthus retroflexus L.
Amaranthus hybridus L.
Amaranthus blitoides Wats.
Phytolacca decandra L.

Mollugo verticillata L.
Claytonia virginica L.
Agrostemma githago L.
Silene stellata (L.) Ait.
Silene virginica L.
Silene antirrhina L.
Saponaria officinalis L.
Alsine media L.
Alsine longifolia (Muhl.) Britt.
Cerastium vulgatum L.
Cerastium longipedunculatum Muhl.
Arenaria serpyllifolia L.
Anychia canadensis (L.) B. S. P.
Nymphaea advena Sol.
Ceratophyllum demersum L.
Liriodendron tulipifera L.
Asimina triloba (L.) Dun.
Hydrastis canadensis L.
Caltha palustris L.
Actaea alba (L.) Mill.
Aquilegia canadensis L.
Anemone virginiana L.
Anemone canadensis L.
Anemone quinquefolia L.
Hepatica hepatica (L.) Karst.
Hepatica acuta (Pursh) Britt.
Syndesmon thalictroides (L.) Hoffmg.
Clematis virginiana L.
Ranunculus abortivus L.
Ranunculus recurvatus Poir.
Ranunculus septentrionalis Poir.
Ranunculus hispidus Mx.
Ranunculus trichophyllum (Chaix.) Bossch.
Thalictrum dioicum L.
Thalictrum purpurascens L.
Thalictrum polygonum Muhl.
Caulophyllum thalictroides (L.) Mx.
Podophyllum peltatum L.
Menispermum canadense L.
Sassafras sassafras (L.) Karst.
Benzoin benzoin (L.) Coult.
Sanguinaria canadensis L.
Chelidonium majus L.
Bicuculla cucullaria (L.) Millsp.
Bicuculla canadensis (Goldie) Millsp.
Lepidium campestre (L.) R. Br.
Lepidium virginicum L.
Sisymbrium officinale (L.) Scop.
Brassica nigra (L) Koch.
Brassica arvensis (L.) B. S. P.
Barbarea barbarea (L.) MacM.
Roripa palustris (L.) Bess.
Roripa armoracia (L.) Hitch.
Cardamine hirsuta L.
Cardamine pennsylvanica Muhl.
Cardamine purpurea (Torr.) Britt.
Cardamine bulbosa (Schr.) B. S. P.
Dentaria laciniata Muhl.
Bursa bursa-pastoris (L.) Britt.
Arabis hirsuta (L.) Scop.
Arabis laevigata (Muhl.) Poir.
Arabis canadensis L.
Sedum ternatum Mx.
Penthorum sedoides L.
Heuchera americana L.
Mitella diphylla L.
Ribes cynosbati L.
Ribes floridum L'Her.
Hamamelis virginiana L.
Platanus occidentalis L.
Opulaster opulifolius (L.) Ktz.
Spiraea salicifolia L.
Rubus occidentalis L.
Rubus nigrobaccus Bail.
Fragaria virginiana Duch.
Potentilla monspeliensis L.
Potentilla canadensis L.
Geum vernum (Raf.) T. & G.
Geum canadense Jacq.
Geum virginianum L.
Agrimonia hirsuta (Muhl.) Bick.
Agrimonia parviflora Sol.
Rosa setigera Mx.

Rosa carolina L.
Rosa humilis Marsh.
Rosa rubiginosa L.
Malus coronaria (L.) Mill.
Malus malus (L.) Britt.
Aronia nigra (Willd.) Britt.
Amelanchier canadensis (L.) Medic.
Crataegus crus-galli L.
Crataegus punctata Jacq.
Crataegus coccinea L.
Crataegus macracantha Lodd.
Crataegus tomentosa L.
Prunus americana Marsh.
Prunus serotina Ehrh.
Amygdalus persica L.
Cercis canadensis L.
Cassia marylandica L.
Gleditsia triacanthos L.
Gymnocladus dioica (L.) Koch.
Medicago lupulina L.
Melilotus alba Desv.
Melilotus officinalis (L.) Lam.
Trifolium pratense L.
Trifolium hybridum L.
Trifolium repens L.
Robinia pseudacacia L.
Meibomia nudiflora (L) Ktz.
Meibomia grandiflora (Walt.) Ktz.
Meibomia canescens (L.) Ktz.
Meibomia paniculata (L.) Ktz.
Meibomia dillenii (Darl.) Ktz.
Lespedeza frutescens (L.) Britt.
Falcata comosa (L.) Ktz.
Apios apios (L.) Macm.
Geranium maculatum L.
Geranium carolinianum L.
Oxalis violacea L.
Oxalis stricta L.
Oxalis cymosa Small.
Xanthoxylum americanum Mill.
Ptelea trifoliata L.
Ailanthus glandulosa Desf.
Acalypha virginica L.
Acalypha gracilens Gr.
Euphorbia maculata L.
Euphorbia nutans Lag.
Euphorbia corollata L.
Euphorbia commutata Eng.
Euphorbia cyparissias L.
Rhus glabra L.
Rhus radicans L.
Ilex verticillata (L.) Gr.
Euonymus obovatus Nutt.
Euonymus atropurpureus Jacq.
Celastrus scandens L.
Staphylea trifolia L.
Acer saccharinum L.
Acer rubrum L.
Acer saccharum Marsh.
Acer nigrum Mx.
Acer negundo L.
Aesculus glabra Willd.
Impatiens biflora Walt.
Impatiens aurea Muhl.
Ceanothus americanus L.
Vitis labrusca L.
Vitis aestivalis Mx.
Vitis vulpina L.
Parthenocissus quinquefolia (L.) Planch.
Tilia americana L.
Malva rotundifolia L.
Sida spinosa L.
Abutilon abutilon (L.) Rusby.
Hibiscus trionum L.
Hypericum prolificum L.
Hypericum perforatum L.
Hypericum mutilum L.
Viola palmata L.
Viola obliqua Hill.
Viola papilionacea Pursh.
Viola scabriuscula (T. & G.) Schw.
Viola canadensis L.
Viola striata Ait.
Ludwigia alternifolia L.
Epilobum coloratum Muhl.

Onagra biennis (L.) Scop.
Gaura biennis L.
Circaea lutetiana L.
Aralia racemosa L.
Panax quinquefolium L.
Sanicula marylandica L.
Sanicula gregaria Bick.
Sanicula canadensis L.
Chaerophyllum procumbens (L.) Cratz.
Washingtonia claytoni (Mx) Britt.
Washingtonia longistylis (Torr.) Britt.
Erigenia bulbosa (Mx.) Nutt.
Cicuta maculata L.
Cicuta bulbifera L.
Deringa canadensis (L.) Ktz.
Taenidia integerrima (L.) Drude.
Thaspium trifoliatum aureum (Nutt.) Britt.
Thaspium barbinode (Mx.) Nutt.
Pastinaca sativa L.
Daucus carota L.
Cornus florida L.
Cornus amomum Mill.
Cornus asperifolia Mx.
Cornus candidissima Marsh.
Cornus alternifolia L. f.
Nyssa sylvatica Marsh.
Monotropa uniflora L.
Gaylussacia resinosa (Ait.) T. & G.
Lysimachia nummularia L.
Steironema ciliatum (L.) Raf.
Steironema quadriflorum (Sims) Hitch.
Fraxinus americana L.
Fraxinus lancelota Borck.
Fraxinus pennsylvanica Marsh.
Fraxinus nigra Marsh.
Sabbatia angularis (L.) Pursh.
Gentiana andrewsii Griseb.
Vinca minor L.
Apocynum androsaemifolium L.
Apocynum cannabinum L.
Asclepias tuberosa L.
Asclepias incarnata L.
Asclepias exaltata (L.) Muhl.
Asclepias quadrifolia Jacq.
Asclepias syriaca L.
Ipomoea pandurata (L.) Meyer.
Ipomoea purpurea (L.) Roth.
Convolvulus sepium L.
Convolvulus arvensis L.
Cuscuta gronovii Willd.
Phlox paniculata L.
Phlox divaricata L.
Polemonium reptans L.
Hydrophyllum virginicum L.
Hydropbyllum appendiculatum Mx.
Phacelia purshii Buck.
Cynoglossum officinale L.
Lappula virginiana (L.) Greene.
Mertensia virginica (L.) D. C.
Lithospermum arvense L.
Verbena urticifolia L.
Verbena hastata L.
Lippia lanceolata Mx.
Teucrium canadense L.
Scutellaria lateriflora L.
Scutellaria cordifolia Muhl.
Scutellaria nervosa Pursh.
Marrubium vulgare L.
Agastache nepetoides (L.) Ktz.
Nepeta cataria L.
Glecoma hederacea L.
Prunella vulgaris L.
Physostegia virginiana (L.) Benth.
Leonurus cardiaca L.
Lamium amplexicaule L.
Stachys tenuifolia Willd.
Stachys palustris L.
Stachys asper Mx.
Monarda fistulosa L.
Blephilia ciliata (L.) Raf.
Blephilia hirsuta (Pursh) Torr.
Hedeoma pulegioides (L.) Pers.
Melissa officinalis L.
Clinopodium vulgare L.

Lycopus virginicus L.
Lycopus rubellus Moench.
Lycopus americanus Muhl.
Mentha spicata L.
Mentha piperita L.
Mentha canadensis L.
Collinsonia canadensis L.
Physalis heterophylla Nees.
Solanum nigrum L.
Solanum carolinense L.
Solanum dulcamara L.
Lycium vulgare (Ait. f.) Dun.
Datura tatula L.
Verbascum thapsus L.
Verbascum blattaria L.
Linaria linaria (L.) Karst.
Scrophularia marylandica L.
Chelone glabra L.
Pentstemon hirsutus (L.) Willd.
Pentstemon pentstemon (L.) Britt.
Collinsia verna Nutt.
Mimulus ringens L.
Mimulus alatus Sol.
Gratiola virginiana L.
Veronica officinalis L.
Veronica serpyllifolia L.
Veronica peregrina L.
Veronica arvensis L.
Leptandra virginica (L.) Nutt.
Afzelia macrophylla (Nutt.) Ktz.
Gerardia tenuifolia Vahl.
Pedicularis canadensis L.
Conopholis americana (L. f.) Wallr.
Leptamnium virginianum (L.) Raf.
Dianthera americana L.
Phryma leptostachya L.
Plantago major L.
Plantago rugelii Dec.
Plantago lanceolata L.
Plantago aristata Mx.
Houstonia coerulea L.
Houstonia longifolia Gaert.
Cephalanthus occidentalis L.
Galium aparine L.
Galium lanceolatum Torr.
Galium circaezans Mx.
Galium triflorum Mx.
Galium tinctorium L.
Galium concinnum T. & G.
Sambucus canadensis L.
Viburnum acerifolium L.
Viburnum lentago L.
Viburnum prunifolium L.
Triosteum perfoliatum L.
Symphoricarpos racemosus Mx.
Lonicera glaucescens Ryd.
Valerianella radiata (L.) Dufr.
Dipsacus sylvestris Mill.
Micrampelis lobata (Mx.) Greene.
Sicyos angulatus L.
Campanula americana L.
Specularia perfoliata (L.) A. DC.
Lobelia cardinalis L.
Lobelia syphilitica L.
Lobelia spicata Lam.
Lobelia inflata L.
Lobelia kalmii L.
Ambrosia trifida L.
Ambrosia artemisiaefolia L.
Xanthium canadense Mill.
Vernonia maxima Small.
Eupatorium maculatum L.
Eupatorium purpureum L.
Eupatorium perfoliatum L.
Eupatorium ageratoides L. f.
Solidago caesia L.
Solidago ulmifolia Muhl.
Solidago canadensis L.
Solidago nemoralis Ait.
Euthamia graminifolia (L.) Nutt.
Aster macrophyllus L.
Aster shortii Hook.
Aster cordifolius L.
Aster sagittifolius Willd.
Aster novae-angliae L.
Aster prenanthoides Muhl.
Aster laevis L.

Aster paniculatus Lam.
Aster ericoides L.
Aster lateriflorus (L.) Britt.
Erigeron pulchellus Mx.
Erigeron philadelphicus L.
Erigeron annuus (L.) Pers.
Erigeron ramosus (Walt.) B. S. P.
Leptilon canadense (L.) Britt.
Doellingeria umbellata (Mill.) Nees.
Antennaria plantaginifolia (L.) Rich.
Gnaphalium obtusifolium L.
Gnaphalium uliginosum L.
Inula helenium L.
Polymnia canadensis L.
Silphium perfoliatum L.
Heliopsis helianthoides (L.) B. S. P.
Eclipta alba (L.) Hassk.
Rudbeckia hirta L.
Helianthus tuberosus L.
Verbesina alternifolia (L.) Britt.
Coreopsis tripteris L.
Bidens cernua L.
Bidens vulgata Greene.
Bidens bipinnata L.
Bidens trichosperma (Mx.) Britt.
Achillea millefolium L.
Anthemis cotula L.
Chrysanthemum leucanthemum L.
Tanacetum vulgare L.
Erechtites hieracifolia (L.) Raf.
Mesadenia atriplicifolia (L.) Raf.
Senecio aureus L.
Arctium lappa L.
Carduus lanceolatus L.
Carduus altissimus L.
Carduus muticus (Mx.) Pers.
Carduus arvensis (L.) Robs.
Cichorium intybus L.
Adopogon virginicum (L.) Ktz.
Taraxacum taraxcum (L.) Karst.
Sonchus arvensis L.
Sonchus asper (L.) All.
Lactuca virosa L.
Lactuca canadensis L.
Lactuca spicata (Lam.) Hitch.
Hieracium scabrum Mx.
Nabalus altissimus (L.) Hook.
Nabalus albus (L.) Hook.

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The Pteridophytes of Ohio

BY

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PUBLICATION COMMITTEE.

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INTRODUCTION.

Aside from their esthetic value, our native Pteridophytes are of little practical use, and this may be said of most of the species living in the world today. Ecologically considered, however, they are of considerable importance, and in the past geological ages also, the ferns and their allies were most important plants, contributing largely to the formation of coal.

It is hoped that this presentation of the Ohio species will enable all who so desire to become acquainted with these most graceful plant forms.

The keys have been made very complete so that one should be certain of the specimen in hand when the name has been traced out, except perhaps in a few of the more difficult genera. Only brief descriptions have been given in the catalog of species, and usually the characters enumerated in the keys have not been repeated.

The list of Ohio Pteridophytes, as it now stands, contains 61 species and a number of varieties, all being represented by herbarium specimens. Unless otherwise stated the records are based on specimens in the state herbarium of the Ohio State University. It is possible that several other species will be found in the state.

The census of species is as follows:

Ferns — 44 species.
Equisetums — 8 species.
Lycopods — 6 species.
Water-ferns — 1 species.
Quillworts — No species.
Selaginellas — 2 species.

Among those who have published lists of the Ohio ferns and fern allies, either separately or in some more extensive catalog, the following deserve special mention: John L. Riddell, Wm. S. Sullivant, Thos. G. Lea, Joseph Clark, J. S. Newberry, H. C. Beardslee, A. P. Morgan, Joseph F. James, Herbert L. Jones, E. L. Moseley, Wm. A. Kellerman, and Lewis S. Hopkins. Many other botanists have contributed either directly or indirectly to the knowledge of Ohio Pteridophytes, and the names of those who have presented specimens to the collection now in the State Herbarium would make a very extensive list.

Our forefathers considered ferns to be mysterious and uncanny things. They could not quite comprehend what seemed to be real plants without flowers or seeds. Thus many superstitions arose, the chief one of which, perhaps, was in regard to fern seed. It was supposed that the fern seed could be obtained only on the night of St. John's Eve, the 24th of June. Those who went to obtain the seed took a white cloth along in which to catch it. In some parts the fern seed was supposed to be in the keeping of the devil and could be obtained from him only at midnight. In some parts of England the general name for ferns was devil's bushes. On the night of St. John's Eve all the hosts of Elfland were also abroad in their greatest power. The fern would then produce a small blue flower at dusk and the wonderful seed would be ripe and fall from the plant at midnight. The fern seed was said to insure good luck. It would confer on one the strength of thirty or forty men. Another property was that it would enable the possessor to discover hidden treasure and to unlock anything that required opening. The sap of a plant from which fern seed is obtained would confer on the person taking the draft the blessing of eternal youth.

But the greatest property of all which the magic seed possessed was that by it one might become invisible. There is, however, no authentic record of anyone thus becoming invisible by its aid, so fern seed must have been about as scarce then as it is at present. This belief in the power of the fern seed to make men invisible arose in the age when the doctrine of signatures was taught and believed. Nature in giving particular shapes to leaves and flowers plainly taught our credulous ancestors for what diseases they were especially useful. A heart-shaped leaf was a cure for diseases of the heart; a leaf resembling the liver was for liver complaints; a bright-eyed flower was for the eyes; a foot-shaped flower was a certain cure for gout, etc. It was thus a clear conclusion that a plant with invisible reproductive organs would if properly used confer the property of invisibility. Shakespeare refers to this belief in the first part of King Henry IV., Act II., Scene 1: "We have the receipt of fernseed; we walk invisible." Ben Johnson alludes to the same superstition, as follows:

> "I had no medicine, Sir, to go invisible,
> No fern seed in my pocket."

Butler, in Hudibras, Part III., Canto 3, refers to the fern in a more scientific manner:

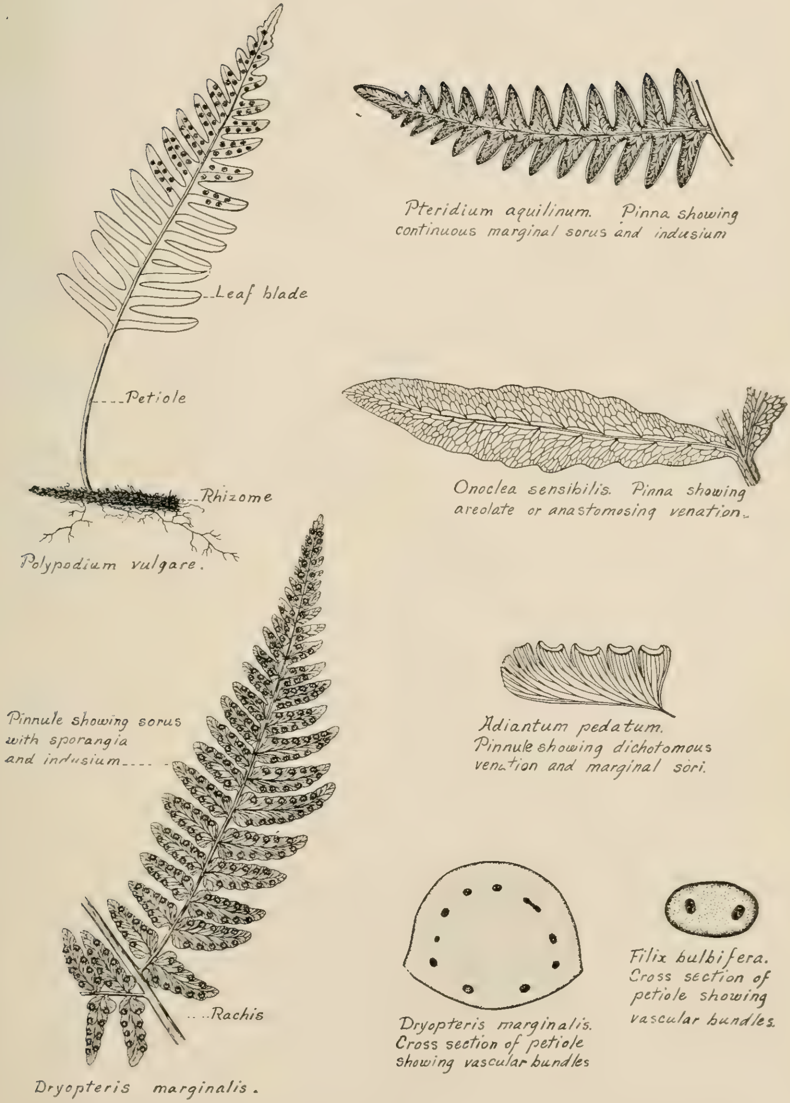
> "Who would believe what strange bugbears
> Mankind creates itself of fears,
> That spring, like fern, that insect weed,
> Equivocally, without seed,
> And have no possible foundation
> But merely in th' imagination?"

It was customary in the seventeenth century to set fire to growing ferns under the belief that the practice would produce rain. The smoke of ferns was also believed to drive away snakes and other noxious creatures. In some places it was believed that by taking a bite from the leaf of the first fern that appeared in Spring the toothache would depart for a year. In the Tyrol, Osmunda is placed over the door for good luck. In some parts of England there was a practice of cutting the rhizome of a fern slantwise, when a picture of an oak tree could be made out; and the saying was that the more perfect the representation the more lucky the person would be who cut it. A certain species of spleenwort was supposed to make the spleen wither away. Thus in the Island of Crete the flocks and herds were said to be without spleens because they browsed on this herb. In some parts of the island where the plant did not grow, the cattle were said to have the usual spleens.

As stated above, the uses of ferns and fern allies in the household and the arts are insignificant. They are, however, much valued as ornamental plants. The species usually cultivated belong to the ordinary ferns and selaginellas. The Male Fern, Dryopteris filix-mas is officinal. It is an anthelmintic which is considered especially effective in removing tape-worms. It is not found in Ohio, but our Dryopteris marginalis is used in the same way as a taenifuge. Equisetum arvense is supposed to be injurious to horses, at least when in the form of hay. Pteridium aquilinum is supposed to be injurious to cattle and horses. Some of the scouring rushes, like Equisetum hyemale, are used for scouring utensils and polishing wood. The petioles of Adiantum pedatum are used by the Indians for basket-work.

The spores of Lycopodium clavatum and other species have a pharmaceutical use for coating pills and other adhesive surfaces. The spores are also used as baby powder to prevent chafing. The spore powder is highly inflammable and is used in the manufacture of fireworks and the artificial representation of lightning on the stage. Some species of Lycopodium, as L. obscurum, are extensively used for Christmas decorations.

A few of the ferns have a culinary value. The rhizome of the eagle fern, Pteridium aquilinum, is gathered and boiled by some savages and used as food. The succulent petioles of the eagle fern also furnish an article of food. They should be gathered just before the leaf-blade begins to unroll, and after cutting off the blade and the lower rather woody part and scraping off the bitter hairs and scales, they may be cooked much like asparagus or greens. The taste is not unpleasant and is agreeable to many persons. The petioles of the royal fern, Osmunda regalis, are used in the same way. Other ferns are also used as pot herbs. Among the more important are the cinnamon fern, Osmunda cinnamomea; Clayton's fern, Osmunda claytoniana; and the ostrich fern, Matteuccia struthiopteris. The leaves are collected just as they are unrolling and boiled as greens.



Drawings of the common parts of fern leaves, by Clara G. Mark.

CLASSIFICATION OF PTERIDOPHYTES.

ARCHEGONIATA. Archegoniates.

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.

1. Sporophyte without roots, leaves or fibrovascular tissue...... ....BRYOPHYTA. Mosses and Liverworts.
1. Sporophyte independent when mature with true roots, leaves, and fibrovascular tissue............................PTERIDOPHYTA. 2.
2. With one kind of nonsexual spores......PTERIDOPHYTA HOMOSPORAE.
2. With two kinds of nonsexual spores....PTERIDOPHYTA HETEROSPORAE.

In this manual the Pteridophytes are still classified in their subkingdoms representing the lower and higher stages of development. They may more properly be classified according to their natural relationships into three great branches or phyla as follows:

I. *Ptenophyta.* About 4,500 known living species. Vascular seedless plants with comparatively large multiciliate sperms and usually with large, commonly compound leaves, the sporophylls not in cones.

Classes, Filices,
Hydropterides,
Isoeteae.

2. *Calamophyta.* 25 known living species. Vascular seedless plants with jointed stems and small whorled leaves with comparatively large multiciliate sperms, and with the sporophylls in cones.

Classes, Equiseteae,
Sphenophylleae (Fossil),
Calamarieae (Fossil).

3. *Lepidophyta.* 660 known living species. Vascular seedless plants with simple, usually small leaves covering the stem, with small biciliate sperms, and with the sporophylls in cones or sometimes forming zones alternating with the sterile leaves.

Classes, Lycopodieae.
Selaginelleae.

KEY TO THE CLASSES OF HOMOSPOROUS AND HETEROSPOROUS PTERIDOPHYTES OF OHIO.

1. With comparatively large, broad, compound or rarely simple, abundantly veined leaves; homosporous, the spores all of one kind; sporangia borne on the foliage leaves or on special sporangiophores.......................................I. FILICES. Ferns.

1. With 4-foliate, slender-petioled leaves from a horizontal rhizome; or small, free-floating plants with small 2-ranked foliage leaves; heterosporous, the spores of two sizes, microspores and megaspores; sporangia in sporocarps........IV. HYDROPTERIDES. Water-ferns.

1. Leaves small, short, and scale-like, scattered or in whorls; or long, grass-like, and in a rosette; plants not floating; homosporous or heterosporous. 2.

2. With minute scale-like leaves in a whorl, forming sheaths at the nodes of the jointed stem; homosporous, the spores with appendages, the peltate sporophylls in cones......................
...............II. EQUISETEAE. Horsetails and Scouring Rushes.

2. With simple, long, grass-like leaves containing a ligule and forming a rosette on a short 2- or 3-lobed stem; heterosporous, the sporangia in the bases of the leaves............V. ISOETEAE. Quillworts.

2. With numerous, small, lanceolate, subulate, or scale-like, 1-nerved leaves covering the stem. 3.

3. Leaves without a ligule; homosporous, sporangia single in the axils of the sporophylls which are arranged in cones or in zones alternating with foliage leaves..........III. LYCOPODIEAE. Clubmosses.

3. Leaves with a ligule; green cells often with only 1 large chloroplast; heterosporous, the sporangia single in the axils of the sporophylls which are arranged in cones....VI. SELAGINELLEAE. Selaginellas.

SUBKINGDOM, PTERIDOPHYTA HOMOSPORAE.

Homosporous Pteridophytes; 4,500 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.

Class I. FILICES. Ferns. About 4,000 living species.

Sporophyte herbaceous or tree-like, usually with a horizontal rhizome, simple or branched; leaves usually large, alternate and mostly compound, rarely slender and grass-like; sporangia borne on the under side of the leaves or on simple or branched sporangiophores; eusporangiate or leptosporangiate; sporophylls not forming cones. Gametophyte comparatively large, tuber-like without chlorophyll and subterranean, or commonly developed as a flat, simple or branched thallus, hermaphrodite or unisexual; spermatozoids multiciliate.

KEY TO THE GENERA OF OHIO FILICES.

Required for identification — perfect leaves with the entire petioles, some of the leaves with sporangia which need not, however, be mature. The vascular bundles should be determined at or very near the base of the petiole. The number following the generic name refers to the list number.

1. Leaf blades areolate, the veins anastomosing to form a network. 2.
1. Leaf blades not areolate, the veins not anastomosing, but dichotomous or pinnate, and ending free. 5.
2. Leaf blades simple, entire, with a distinct sporangiophore with two rows of sporangia, vascular bundles in petiole 3-6.......... .... *Ophioglossum* (1).

2. Leaf blades compound or somewhat lobed, the sporangia on the blade or on distinct leaves. 3.
3. Leaves rooting freely at the long tapering apex, simple or somewhat lobed; sori linear or oblong; vascular bundles in base of petiole 2. ....*Camptosorus* (11).
3. Leaves not rooting at the tip, pinnatifid or pinnate. 4.
4. Sterile pinnae sharply serrate; vascular bundles in base of petiole 2 or numerous, sori oblong in chain-like rows......... ....*Woodwardia* (8).
4. Sterile pinnae coarsely toothed or lobed; vascular bundles in base of petiole 2; sori round, enclosed in the leaflet.....*Onoclea* (19).
5. Vascular bundles in base of petiole 3 or more. 6.
5. Vascular bundles in base of petiole 1 or 2, but additional brown or black sclerenchyma bundles may be present. 11.
6. Sporangia on a more or less branched sporangiophore distinct from the leaf blade; vascular bundles in the base of the common petiole in a ring..............................*Botrychium* (2).
6. Sporangia not on a sporangiophore distinct from the leaf blade. 7.
7. Leaflets with continuous marginal indusia; leaves large, ternate, with nectar glands in the axils of the main divisions; vascular bundles in base of petiole about 12, irregularly arranged... ....*Pteridium* (6).
7. Sori with special indusia or naked, not covered by the leaf margin; vascular bundles in base of petiole 10 or less. 8.
8. With oblong or linear sori in chains parallel to the midrib; leaflets areolate in the middle; vascular bundles in base of petiole 7-9. ....*Woodwardia* (8).
8. Sori round or roundish, indusia less than twice as long as broad. 9.
9. Pinnae strongly auricled on the upper side at the base; fertile part of leaf specialized; indusium orbicular, peltate, without a sinus, fixed by the centre; vascular bundles in base of petiole 4-5. ....*Polystichum* (12).
9. Pinnae not auricled. 10.
10. Leaves simply pinnatifid; petioles articulated to the rhizome; sori naked, circular; vascular bundles in base of petiole 3... ....*Polypodium* (4).
10. Leaves 2- or more- pinnatifid or pinnate; indusium reniform or if orbicular with a narrow sinus..................*Dryopteris* (13).
11. Sporangia borne on specialized leaves, without foliage leaflets, on specialized pinnae at the middle or end of the foliage leaf, or on special sporangiophores distinct from the leaf blade. 12.
11. Sporangia on leaflets of ordinary foliage leaves, some or all of which may be fertile. 14.

12. Vascular bundles 2, often uniting, not incurved; sori on specialized leaves; pinnules pinnately veined, barely dichotomous.......... .... *Matteuccia* (18).
12. Vascular bundles strongly incurved, venation distinctly dichotomous. 13.
13. Sporangiophore distinct, usually on a stalk beside the leafblade; sporangia large, globular........................ *Botrychium* (2).
13. Sporangia on specialized leaflets at the end or sides of the foliage leaves; or on specialized leaves; vascular bundle in base of petiole 1; leaves 2 or more feet long, bipinnatifid or bipinnate.. *Osmunda* (3).
14. Sori with marginal indusia formed by the more or less altered and reflexed edge of the leaflet or its lobes. 15.
14. Sori with special indusia or naked, not covered by the margin of the leaflet. 16.
15. Only the tips of the lobes of the leaflets reflexed as indusia. .... *Adiantum* (5).
15. Entire margin of the leaflets reflexed to form the indusium, rarely interrupted.. *Pellaea* (7).
16. Sori linear or oblong, indusia more than twice as long as broad. 17.
16. Sori round or roundish, indusia less than twice as long as broad. 18
17. Sori elongated, on the upper sides of the veins..... *Asplenium* (9).
17. Sori and indusia somewhat curved, sometimes horseshoe-shaped many of them crossing the veinlet, sometimes with 2 sori placed back to back; leaves bipinnatifid or bipinnate in our species, usually 2-3 feet long................................ *Athyrium* (10).
18. Sori naked, circular; petiole with 2 united vascular bundles; leaf blades triangular or ternate.................... *Phegopteris* (14).
18. Sori with indusia, sometimes inferior and obscure; leafblade not triangular nor ternate. 19.
19. Indusium superior, cordate or reniform, attached by the sinus. .... *Dryopteris* (13).
19. Indusium convex, delicate and partly inferior, attached by a broad base at the side and enclosing the sorus like a hood; leaves sometimes with brood-buds.......................... *Filix* (15).
19. Indusium wholly inferior. 20.
20. Indusium roundish or stellate, delicate, cleft into narrow segments; leaves in our species usually not over 16 inches long. *Woodsia* (16).
20. Indusium cup-shaped, somewhat 2-valved; leaves in ours usually over 2 feet long........................... *Dennstaedtia* (17).

Subclass, EUSPORANGIATAE.

Sporangia arising from the tissues beneath the epidermis.

Order, *Ophioglossàles.*

Ophioglossàceae. Adder-tongue Family.

Sporophyte more or less succulent with fleshy roots; sporangia opening by a transverse slit, spores yellow. Gametophyte subterranean, without chlorophyll.

1. **Ophioglóssum** L. Adder-tongue.

Low plants with simple leaves and sporangia in two rows on a slender sporangiophore. Veins reticulate.

1. *Ophioglossum vulgàtum* L. Adder-tongue.

A low plant with a short rhizome and simple leaves, the sporangia borne on a spike-like sporangiophore. In moist meadows and thickets, on the ground. Rather generally distributed in Ohio, but local and not common.

2. **Botry'chium** Swz. Grape-fern.

Plants with a short erect rhizome and fleshy roots. Leaves pinnately or ternately divided or compound; sporangiophore branched. Veins ending free.

1. Leaf blade pinnate or ternate, sessile on the common petiole or on a stalk not more than 1 inch in length. 2.
1. Leaf blade ternate; on a stalk over 2 inches in length. 6.
2. Leaf blade more or less fleshy, pinnate or bipinnate, or if ternate then small, not much over 2 inches long. 3.
2. Leaf blade membranous, ternately decompound with three main sessile divisions, large; the sporangiophore stalked, usually 6 inches or more in length. Bud enclosed in a cavity at one side of the base of the petiole.........................*B. virginianum.*
3. Sporangiophore stalked. leaf blade usually pinnatifid, pinnate or bipinnate, stalked or sometimes nearly sessile. 4.
3. Sporangiophore sessile or nearly so, leaf blade closely sessile on the common petiole, 3-lobed and 2-pinnatifid............*B. lanceolatum.*
4. Leaf blade simply pinnatifid or pinnate. 5.
4. Leaf blade 2-pinnatifid or 2-pinnate, with narrow segments, occasionally in 3 divisions...........................*B. neglectum.*
5. Leaf blade usually short-stalked, pinnatifid or nearly entire; sporangiophore nearly simple or little branched..............*B. simplex.*

5. Leaf blade pinnate, nearly sessile, with fan-shaped segments; sporangiophore much branched.................................*B. lunaria.*
6. Leaf segments obliquely ovate or oblong, large, ½-1 inch long...*B. obliquum.*
6. Leaf segments finely laciniate, narrow, ⅛ inch wide or less...... ....*B. dissectum.*

1. *Botrychium lunària* (L.) Sw. Moonwort.

A fleshy low plant with the leaf blade usually sessile at about the middle of the common petiole. Lobes of the leaf fan-shaped, 3-8 pairs. Sporangiophore much branched. In open places and fields. Northern. Lake Co.

2. *Botrychium simplex* Hitch. Little Grape-fern.

A delicate plant, 4-10 inches high with the leaf blade simply lobed or pinnatifid and usually short-stalked at about the middle of the common petiole, the lobes only slightly fan-shaped. In moist rich woods and meadows. Cedar Point, Erie Co.

3. *Botrychium negléctum* Wood. Matricary Grape-fern.

A plant 6-12 inches high often very fleshy; leaf blade ovate or oblong 1-2 pinnatifid or pinnate with obtuse divisions and narrow toothed segments. Sporangiophore 2-3-pinnate. (*B. matricariaefolium* A. Br.) In rich grassy woods and swamps. Portage, Ashtabula, Cuyahoga and Erie Cos.

4. *Botrychium lanceolàtum* (Gmel.) Angs. Lanceleaf Grape-fern.

A somewhat fleshy plant with a closely sessile leaf blade near the summit of the common petiole. Blade triangular and ternately twice pinnatifid. Sporangiophore sessile or short-stalked, 2-3-pinnate. In rich woods, meadows and swamps, on the ground. Geauga and Portage Counties.

5. *Botrychium oblìquum* Muhl. Oblique Grape-fern.

Plant robust, the leaf blade on a long stalk arising from near the base of the common petiole, ternate, the segments obliquely ovate or oblong. Sporangiophore long-stalked, much branched. Low woods and open places. Root contraction very prominent. General in Ohio.

6. *Botrychium disséctum* Spreng. Cutleaf Grape-fern.

Plant rather robust with a much dissected leaf blade on a long stalk from near the base of the common petiole, the sporangiophore also long-stalked and much branched. Ultimate segments laciniate. Roots with prominent contraction. In various habitats, meadows and open woods. General in the state.

7. *Botrychium virginiànum* (L.) Sw. Virginia Grape-fern.

A plant from 1-2 feet high with a large, ternate, membranous leaf, sessile on the common petiole; sporangiophore long-stalked, 2-3-pinnate. In rich woods and moist rocky ravines. General and common in the state.

Subclass, LEPTOSPORANGIATAE.

Sporangia arising from the epidermal cells commonly stalked.

Order, *Filicàles.*

Osmundàceae. Royal Fern Family.

Large ferns with 1-2-pinnate leaves with free veins. Sporangia large, globose, without a ring.

3. **Osmúnda** L.

Tall ferns, growing in moist places, swamps or bogs, in large rosettes or crowns. Sporangia opening by a longitudinal cleft into two halves.

1. Leaves truly bipinnate fertile at the apex; veins in the pinnules once and twice dichotomous.................................*O. regalis.*
1. Sterile leaves bipinnatifid. 2.
2. Leaves with fertile pinnae in the middle, sterile pinnae without a tuft of tomentum at the base......................*O. claytoniana.*

2. Fertile leaves distinct from the foliage leaves; pinnae of the foliage leaf with a distinct tuft of tomentum at the base; veins in the pinnules regularly once dichotomous..............*O. cinnamomea.*

1. *Osmunda regàlis* L. Royal Fern.

A large fern with stout rhizome bearing a cluster of bipinnate leaves, 2-6 feet high. Sporophylls with the upper pinnae developed as a specialized sporangiophore. In swamps and wet places. General in Ohio.

2. *Osmunda claytoniàna* L. Clayton's Fern.

A large fern with stout rhizome bearing a rosette of 2-pinnatifid leaves 2-6 feet high. Sporophylls with specialized spore-bearing pinnae in the middle. In moist places. General in the state.

3. *Osmunda cinnamòmea* L. Cinnamon Fern.

A large fern with a very large, widely creeping rhizome bearing a rosette of large sterile leaves with brown colored sporophylls within. Petioles with abundant tomentum when young. Veins in the pinnules regularly once dichotomous. In swamps and wet places. General.

Polypodiàceae. Polypody Family.

Ferns of various habits, the rhizome horizontal or erect. Sporangia opening transversely and provided with a vertical ring.

4. **Polypòdium** L. Polypody.

Ferns with creeping rhizomes articulated petioles and pinnate or simple leaves. Sori hemispherical without indusia. Veins free.

1. Leaves glabrous; plant green...........................*P. vulgare.*
1. Lower surface of the leaf densely scaly; plant grayish........
....*P. polypodioides.*

1. *Polypodium vulgàre* L. Common Polypody.

Rhizome widely creeping, densely covered with brown scales. Leaves evergreen, glabrous, with light-colored petioles. On rocks and rocky banks. General in the eastern half of the state.

1. *Polypodium polypodioìdes* (L.) Hitch. Gray Polypody.

Rhizome widely creeping covered with small brown scales. Leaves coriaceous evergreen, glabrous or nearly so above, densely covered with gray peltate scales below. On trees or occasionally on rocks. Adams and Hamilton counties.

5. Adiántum L.

Graceful ferns with much-divided leaves, with polished and shining petioles and dichotomous venation. Sori marginal under the reflexed tips of the pinnules.

1. *Adiantum pedàtum* L. Maidenhair Fern.

A fern with dichotomously forked leaves with pinnate branches, and with dark-brown or purplish petioles. On the ground in woods and on rocky hillsides. General and common.

6. Pteri′dium Scop.

Large and usually coarse ferns with marginal, continuous sori and indusia and free veins. (Pteris).

1. *Pteridium aquilìnum* (L.) Kuhn. Eagle-fern.

Rhizome horizontal and very extensive, the leaves ternate and large with nectar glands in the axils of the main divisions. The nectar is eaten by ants. In sunny places, especially on hillsides; sometimes also in the shade. Often called Bracken. General in Ohio.

7. **Pellàea** Link. Cliff-brake.

Rather small ferns growing on rocks, with marginal sori and indusia. Leaves pinnate or pinnatifid with dark-colored petioles. Veins free.

1. *Pellaea atropurpùrea* (L.) Link. Purple Cliff-brake.

Rhizome short and densely covered with hair-like scales. Leaves coriaceous, evergreen, simply pinnate or 2-pinnate below. Usually on limestone rocks. Ottawa, Stark, Franklin, Clark, Greene, Highland, and Adams counties.

8. **Woodwàrdia** Sw. Chain-fern.

Large ferns with pinnate or nearly 2-pinnate leaves and oblong linear sori arranged in chain-like rows parallel to the margins of the pinnae. Venation, partly areolate.

1. *Woodwardia virginica* (L.) Sw. Virginia Chain-fern.

Rhizome long, stout and chaffy. Sterile and fertile leaves similar in outline, pinnate, the pinnae linear-lanceolate. In swamps and wet ground. Ashtabula, Defiance, Geauga, Summit, Wayne, and Williams counties.

9. **Asplènium** L. Spleenwort.

Large or small ferns with leaves of various types, the sori linear or oblong oblique to the midribs or rachises. Veins free.

1. Leaves pinnatifid, or pinnate only near the base, tapering to a long point. 2.
1. Leaves once pinnate, with numerous pinnae. 3.
1. Leaves 2-3-pinnate or pinnatifid. 6.
2. Lobes of the leaf rounded or the lowest acuminate. . .*A. pinnatifidum.*
2. Lobes acute or acuminate, the tip of the leaf frequently rooting . . . .*A. platyneuron X Camptosorus rhizophyllus.* (*A. ebenoides.*)
3. Petioles pale, green or straw-colored; pinnae linear-lanceolate with a long point; leaves usually 2-3 feet long. . . . .*A. angustifolium.*

3. Petioles black or dark purple; pinnae mostly rather short and blunt. 4.
4. Pinnae auricled at the upper side of the base. 5.
4. Pinnae not auricled; alternate or opposite on the rachis, oval or roundish oblong, inequilateral.....................*A. trichomanes.*
5. Pinnae opposite, oblong; plants small; rachis dark brown or black. ....*A. parvulum.*
5. Pinnae partly alternate usually lanceolate; plants usually much larger; rachis chestnut brown or reddish..........*A. platyneuron.*
6. Petioles usually green, pinnules fan-shaped, usually incised.... ....*A. ruta-muraria.*
6. Petioles dark at the base, pinnules ovate-oblong, the lowest pinnately cleft into oblong or ovate cut-toothed lobes..........*A. montanum.*

1. *Asplenium pinnati'fidum* Nutt. Pinnatifid Spleenwort.

A fern with a short, chaffy, creeping rhizome and pinnatifid or sometimes somewhat pinnate leaves with long tapering points. Evergreen. On rocks. Licking, Fairfield, Hocking, and Lawrence counties.

2. *Asplenium platynèuron* (L.) Oakes. Ebony Spleenwort.

Rhizome short; leaves linear, 6-18 inches long, tufted, with purplish-brown shining petioles, and 20-40 pairs of lanceolate or subfalcate pinnae auricled on the upper side at the base. Evergreen on rocks and banks, especially in limestone soil. General except in the northeastern fourth of the state.

Hybridizes with *Camptosorus rhizophyllus.* The form known as *Asplenium ebenoides* Scott is probably this hybrid. It is found in Hocking county.

3. *Asplenium párvulum* Mart. & Gal. Small Spleenwort.

A small fern with short, chaffy rhizome and tufted, rather firm, linear-oblong or linear-oblanceolate leaves. Petioles blackish and shining; pinnae mostly opposite, oblong, obtuse, somewhat auricled on the upper side and nearly sessile. On limestone. Southern. In Adams county.

4. *Asplenium trichómanes* L. Maidenhair Spleenwort.

A small evergreen fern with short, nearly erect, chaffy rhizome and tufted linear leaves. Petioles purplish-brown and shining, with one vascular bundle in the base; pinnae oval or roundish-oblong, inequilateral, cuneate at the base, partly alternate and partly opposite. Usually on limestone and other rocks. General except in the northwestern fourth of the state.

5. *Asplenium angustifòlium* Mx. Narrow-leaf Spleenwort.

Rhizome stout and creeping, rooting throughout. Leaves in a rosette, lanceolate, about 2 feet long, with brownish or green petioles. Pinnae 20-30 pairs, linear-lanceolate. In moist woods. General in Ohio.

6. *Asplenium rûta-murària* L. Rue Spleenwort.

A delicate fern with short, ascending rhizome and tufted ovate or deltoid-ovate, glabrous, evergreen leaves, Petioles green, naked; pinnae and pinnules stalked. On limestone. Greene county.

7. *Asplenium montànum* Willd. Mountain Spleenwort.

Rhizome short and chaffy at the summit. Leaves tufted, evergreen, ovate-lanceolate, acuminate at the apex, 1-2-pinnate, delicate; petioles slender, naked, blackish at the base. On rocks. Hocking, Fairfield, and Summit counties. (Tuscarawas county, Hopkins.)

10. **Ath'yrium** Roth.

Sori more or less curved, sometimes horseshoe-shaped, often crossing to the outer or lower side of the fruiting veinlet; veins free. Our species large; leaves usually two feet or more in length. (*Asplenium.*)

1. Leaves 2-pinnatifid; segments blunt, scarcely crenate; vascular bundles of petiole 2............................*A. thelypteroides.*
1. Leaves 2-pinnate, pinnules acute, toothed or pinnatifid, vascular bundles 2..*A. filix-foemina.*

1. *Athyrium thelypteròides* (Mx.) Desv. Silvery Spleenwort.

A large fern with sinuous, creeping, rhizome. Leaves lanceolate in outline; petiole straw-colored, somewhat chaffy below. Segments of the pinnae blunt, scarcely crenate. (*Asplenium acrostichoides* Sw.). In rich moist woods. General in Ohio.

2. *Athyrium filix-fóemina* (L.) Roth. Common Lady-fern.

A large graceful fern with a rather slender creeping rhizome. Leaves broadly oblong-ovate or oblong-lanceolate, acuminate at the apex; pinnules oblong-lanceolate, incised or serrate. On the ground in rich moist woods and more open places. General in the state.

11. **Camptosòrus** Link. Walking-fern.

Slender evergreen ferns with tapering simple leaves rooting freely at the tips. Venation reticulate; sori linear or oblong.

1. *Camptosorus rhizophy'llus* (L.) Link. Walking-fern.

Rhizome chaffy, short, usually creeping; petioles light green; leaves auricled, the auricles sometimes rooting. On rocks, especially limestone. General in Ohio.

12. **Poly'stichum** Roth.

Coarse pinnate or bipinnate ferns with an erect or creeping rhizome and round sori. Indusium orbicular, superior, peltate; petiole not jointed; veins free.

1. *Polystichum acrostichòides* (Mx.) Schott. Christmas Fern.

An evergreen fern with a stout, creeping rhizome. Leaves once pinnate, petioles densely chaffy, pinnae half-halberd-shaped. Fertile leaves contracted at the summit. In woods and rocky places. General in Ohio.

The form, *P. acrostichoides schweinitzii* (Beck.) Small, has toothed or pinnatifid pinnae and has been found in Wayne county.

13. **Dryópteris.** Adans. Shield-fern.

Ferns with 2-3-pinnate or pinnatifid leaves and round sori with cordate-reniform indusia. Veins free; petioles not jointed. (*Aspidium*).

1. Vascular bundles of petiole 2, free or united; veins simple or once forked; leaves thin-membranous. 2.
1. Vascular bundles 5 or more; veins forking freely; texture of the leaf firmer. 3.
2. Lower pinnae very much reduced; vascular bundles usually bridged.....................................*D. noveboracensis.*
2. Lower pinnae little smaller than the middle ones; veins once forked; vascular bundles 2, distinct..........................*D. thelypteris.*
3. Leaves 2-pinnatifid or 2-pinnate, the segments not spinnulose 4.
3. Leaves 2-pinnate or 3-pinnatifid, the segments spinulose-toothed. 6.
4. Sori marginal; petiole densely scaly below; indusia convex...*D. marginalis.*
4. Sori not marginal; petiole with few scales; indusia flat and thinnish. 5.
5. Vascular bundles in petiole 5; pinnae widest at the base. ....*D. cristata.*
5. Vascular bundles in petiole 7; pinnae widest at the middle. ....*D. goldieana.*
6. Leaves ovate-lanceolate, usually not narrowed below....*D. spinulosa.*
6. Leaves elongated-lanceolate, usually narrowed at the base..*D. boottii.*

1. *Dryopteris noveboracénsis* (L.) Gr. New York Shield-fern.

Rhizome slender and creeping; leaves lanceolate, tapering both ways from the middle, 1-2 feet long or more, petioles more or less chaffy. On the ground in moist woods. General.

2. *Dryopteris thely'pteris* (L.) Gr. Marsh Shield-fern.

Rhizome slender and creeping; leaves lanceolate or oblong-lanceolate, scarcely narrower at the base than at the middle, usually two to four feet long. In swamps and marshes. General.

3. *Dryopteris cristàta* (L.) Gr. Crested Shield-fern.

Rhizome stout and densely chaffy; leaves evergreen, linear-oblong or lanceolate, acuminate, gradually and slightly narrowed at the base, rather firm, one to three feet long; pinnae lanceolate or triangular ovate, acuminate; petiole with large scales. In moist woods and swamps. General.

The form *D. cristata clintoniana* (Eat.) Und. has oblong-lanceolate pinnae which are broadest at the base. Wayne county. (Geauga county, Hopkins.)

4. *Dryopteris goldieàna* (Hook.) Gr. Goldie's Shield-fern.

Rhizome stout and chaffy; leaves broadly ovate, rather firm, two to four feet long; petioles chaffy at least below. In rich woods. Rather general, but no specimens from the southern third nor from the northeastern counties.

5. *Dryopteris marginàlis* (L.) Gr. Marginal Shield-fern.

Rhizome ascending, stout with brown shining scales; leaves evergreen, ovate-oblong or ovate-lanceolate, subcoriaceous, two to three feet long; petiole chaffy; sori near the margin of the segments. In woods or on rocks. General in Ohio and common.

6. *Dryopteris spinulòsa* (Retz.) Ktz. Spinulose Shield-fern.

Rhizome chaffy; leaves evergreen, ovate-lanceolate, the pinnae oblique to the rachis; pinnae elongated-triangular; petiole with a few deciduous scales; indusium glabrous. In rich woods. General in Ohio.

The form, *D. spinulosa intermedia* (Muhl.) Und., has oblong-lanceolate spreading pinnae and the indusium beset with stalked glands. Rather general in Ohio.

The form, *D. spinulosa dilatata* (Hoffm.) Und., with broadly ovate or triangular-ovate, commonly three-pinnate leaves and glabrous indusia has been found by Hopkins in Tuscarawas county.

7. *Dryopteris boòttii* (Tuck.) Und. Boott's Shield-fern.

Rhizome ascending; leaves elongated-oblong or lanceolate, thin, acuminate at the apex, slightly narrowed at the base; petiole scaly at least below; pinnae lanceolate, long-acuminate, broadest at the base; pinnules very obtuse, the lower pinnatifid; indusium minutely glandular. In woods. Geauga county. (Wayne county, Hopkins).

14. **Phegópteris** Fee. Beech-fern.

Medium-sized ferns with 2-3-pinnatifid or ternate leaves and small round sori without indusia. Veins free.

1. Leaves 2-pinnatifid, triangular pinnae sessile; rachis winged. 2.
1. Leaves ternate with the three nearly equal divisions petioled; rachis wingless..*P. dryopteris.*
2. Leaves longer than broad, usually dark-green; upper part of the petiole usually pubescent..........................*P. phegopteris.*
2. Leaves as broad as long or broader, usually light-green; petiole mostly smooth................................*P. hexagonoptera.*

1. *Phegopteris phegópteris* (L.) Und. Long Beech-fern.

A fern with a slender, creeping, somewhat chaffy rhizome. Leaves triangular, mostly longer than broad, acuminate and pubescent. Pinnae broadest above the base, pinnately parted very nearly to the rachis into oblong obtuse, entire segments, the lower pair deflexed. (*P. polypodioides* Fee). In moist woods. Rather general but apparently local.

2. *Phegopteris hexagonóptera* (Mx.) Fee. Broad Beech-fern.

A fern with a creeping, chaffy, somewhat fleshy rhizome. Leaves triangular, as broad as long or broader, slightly pubescent, acuminate at the apex; the lowest pair of pinnae broadest near the middle, pinnately parted into linear-oblong, obtuse segments. In dry rich woods. General in the state.

3. *Phegopteris dryópteris* (L.) Fee. Oak-fern.

A fern with a creeping rhizome and thin, broadly triangular ternate leaves. Petioles slender, chaffy near the base; the three main divisions of the leaf stalked. In most woods and swamps. Geauga, Lake, Ashtabula, and Wayne counties.

15. **Fi'lix** Adans. Bladder-fern.

Delicate ferns with 2-4-pinnate leaves and slender petioles. Sori roundish on the backs of the free veins; indusium hood-like and attached by a broad base partly beneath the sorus. (*Cystopteris*).

1. Leaves broadest at the base, elongated into a tapering point, bearing brood-buds beneath; vascular bundles of the petiole oval or flat..*F. bulbifera.*
1. Leaves scarcely broader at the base, short-pointed, without brood-buds; vascular bundles of the petiole rondish..........*F. fragilis.*

1. *Filix bulbi'fera* (L.) Und. Bulbiferous Bladder-fern.

Ferns with a short rhizome and elongated leaves lanceolate with a broad base, 2-3-pinnatifid or pinnate, the pinnules crowded. Rachis wingless bearing fleshy brood-buds. On moist rocks, especially limestone. General in the state but no specimens from the northwest.

2. *Filix frágilis* (L.) Und. Fragile Bladder-fern.

Ferns with a short rhizome and thin oblong-lanceolate, 2-3-pinnatifid or pinnate leaves slightly tapering below; pinnae lanceolate-ovate, irregularly pinnatifid. Rachis margined or winged, without brood-buds. On rocks and in moist grassy woods and ravines. General. The variety, *F. fragilis magnasora* (Clute), is reported from Wayne county by Hopkins.

16. **Woódsia** R. Br.

Small or medium-sized ferns with 1-2-pinnate or pinnatifid leaves and round sori, with inferior often evanescent indusia, on the backs of the free veins.

1. *Woodsia obtùsa* (Spreng.) Torr. Obtuse Woodsia.

A graceful evergreen fern with a short rhizome and broadly lanceolate, minutely glandular-pubescent leaves without joints in the petiole. Leaves 6-12 inches long. Indusium distinct splitting into jagged lobes. On rocks. Apparently common in the southern half of the state.

17. **Dennstaédtia** Bernh.

Large beautiful ferns with 2-3-pinnatifid leaves and small, globular, marginal or submarginal sori with membranous, cup-shaped, inferior indusia, which open at the top. Veins free. (*Dicksonia.*)

1. *Dennstaedtia punctilobula* (Mx.) Moore. Boulder Fern.

Rhizome creeping, not chaffy; leaves usually two feet long or more, thin and delicate, minutely glandular and pubescent; petiole pale green, stout, chaffless, and sweet-hay-scented, usually producing "leaf shoots" at its base. Growing under various conditions, especially on open hillsides. In the southern and eastern parts of the state. (Erie Co. Moseley Herb.)

18. **Matteúccia** Todaro.

Large ferns with erect rhizomes and large leaves in a crown. Sporophylls unlike the foliage leaves. Veins free. (*Onoclea.*)

1. *Matteuccia struthiopteris* (L.) Todaro. Ostrich Fern.

Rhizome stout and ascending, bearing a circle of sterile leaves with one or more sporophylls within. Leaves 2-6 feet high, bipinnatifid; sporophylls simply pinnate, the pinnae lobed. In moist thickets, especially along streams. Cuyahoga county. (Erie Co. Moseley Herb.)

19. **Onoclèa** L.

Coarse ferns with slender creeping rhizomes with leaves growing separately. Sporophylls unlike the foliage leaves. Veins forming small areolae.

1. *Onoclea sensi'bilis L.* Sensitive Fern.

Rhizome slender and rooting; leaves 1-4 feet high, broad, deeply pinnatifid; easily injured by frost; sporophylls bipinnate, persisting over winter, the pinnules unrolling at maturity. Young petioles red. In moist soil. General in Ohio.

Class II. EQUISETEAE. Horsetails and Scouring-rushes. 25 species.

Sporophyte perennial, herbaceous, with a rhizome, and with jointed, mostly hollow, simple or branched aerial stems which are either annual or perennial; vascular bundles in a circle; leaves reduced to sheaths around the joints, the sheaths toothed; sporangia borne on small peltate sporophylls arranged in whorls on a terminal cone; eusporangiate; spores with four narrow, strap-like, hygroscopic appendages. Gametophyte a small green thallus, usually unisexual; spermatozoids multiciliate.

Order, *Equisetàles.*

Equisetàceae, Horsetail Family.

20. **Equisètum** L. Horsetail. Scouring-rush.

1. Aerial stems annual, mostly with numerous branches except in some of the fertile stems; cones rounded not with a point; stomata scattered in the grooves. 2.
1. Aerial stems annual or evergreen, mostly unbranched, not tuberculate; cones with or without a point; stomata in a single regular row on each side of the groove, ridges with broad transverse or diagonal wart-like protuberances; sheaths funnel-shaped, constricted at the base.......................................*E. laevigatum.*
1. Aerial stems evergreen, sheaths nearly cylindric or appressed; cones with a rigid point, stomata in regular rows; simple or sparingly branched. 5.
2. Aerial stems of two kinds, the succulent pale and brownish fertile ones sometimes appearing before the green sterile ones. 3.
2. Aerial stems, all alike with whorls of simple, usually short, branches; sheaths nearly cylindric; central cavity four-fifths the diameter.......................................*E. fluviatile.*

3. Fertile stems soon withering, silex of the sterile stems in dots; branches of the sterile stems simple or compound......*E. arvense.*
3. Fertile stems branched and becoming green when old, only the apex withering. 4.
4. Branches of the sterile and fertile stems simple; silex of broad spinules on the ridges................................*E. pratense.*
4. Branches compound; silex of the fertile stems in 2 rows of prominent spinules....................................*E. sylvaticum.*
5. Stems low and slender, tufted, usually 5-10 grooved, central cavity one-third the diameter of the stem; sheaths 5-10-toothed.. ....*E. variegatum.*
5. Stems tall and rigid, rough and tuberculate, usually many-grooved; central cavity large, sheaths appressed. 6.
6. Ridges of the stem with 2 indistinct lines of tubercles; ridges of the sheath obscurely 4-carinate; stems less robust than in the following..*E. hyemale.*
6. Ridges with 1 line of tubercles; ridges of the sheath tricarinate; stem very stout....................................*E. robustum.*

1. *Equisetum arvénse L.* Field Horsetail.

Stems annual, 6 inches to 2 feet high, with scattered stomata, the fertile appearing in early spring before the sterile. Fertile stems not branched, soon withering; sterile stems green, much branched, rather slender. Stomata of the branches in two rows in the furrows. Quite a variable species. In moist soil and on hillsides and railroad embankments. General and abundant in the state.

2. *Equisetum praténse* Ehrh. Thicket Horsetail

Stems annual, 6-18 inches high, with scattered stomata, the fertile appearing in spring before the sterile. Fertile stems branched when old, only the apex withering. In sandy soil. Apparently general in Ohio.

3. *Equisetum sylváticum* L. Wood Horsetail.

Stems annual with scattered stomata, 1-2 feet high; the fertile appearing in early spring before the sterile, developing whorls of compound branches when old. Silex of the fertile stems in two rows of prominent spinules. In moist, sandy woods. Auglaize and Cuyahoga counties.

4. *Equisetum fluviátile* L. Swamp Horsetail.

Stems all alike, annual, 1-4 feet high, branched, the branches hollow and slender. Rhizome hollow. In swamps and wet places. Not common but to be found in most parts of the state in suitable habitats.

5. *Equisetum laevigàtum* A. Br. Smooth Scouring-rush.

Stems annual or perennial, 1-5 feet high, simple or little branched, pale green; sheaths funnel shaped. Stomata in regular rows; ridges with broad transverse or diagonal, wart-like protuberances. Cones pointed or without a point and merely acute. In sandy soil and on clay banks. General but apparently not common in Ohio.

6. *Equisetum variegàtum* Schleich. Variegated Scouring-rush.

Stems evergreen, slender, usually simple, 6-18 inches high. Central cavity small, stems 5-10 furrowed, with stomata in regular rows. In sandy places. Lake county. (Erie Co., Moseley herbarium.)

7. *Equisetum hyemàle* L. Common Scouring-rush.

Stems slender and stiff, evergreen, 1-4 feet high, sometimes branched, often with water or ice in the central cavity in winter; ridges with two indistinct lines of tubercles, ridges of the sheath obscurely 4-carinate. Cones pointed. In wet places and on banks, especially along streams. General in Ohio.

8. *Equisetum robu'stum* A. Br. Great Scouring-rush.

Stems very stout, sometimes branched, evergreen, 2-8 feet high, 20-48-furrowed, the ridges with a single series of siliceous tubercles. Ridges of the sheath 3-carinate. Cones pointed. In wet places and on banks. Apparently general in Ohio.

Class III. Lycopodieae. Lycopods. 155 species.

Sporophyte perennial, herbaceous, with or without rhizome, the aerial stems upright or trailing; branching monopodial or dichotomous; leaves small, without a ligule, scattered on the stem, in two or many ranks; sporangia solitary on the upper surface of the leaves or in their axils, eusporangiate; sporophylls in bands alternating with the sterile leaves or arranged in spirals in terminal cones; spores small, not appendaged. Gametophyte small, sometimes subterranean, with or without chlorophyll, hermaphrodite; spermatozoids biciliate.

Order, *Lycopodiàles.*

Lycopodiàceae, Club-moss Family.

21. **Lycopòdium** L. Club-moss.

1. Sporangia borne on leaves similar to the foliage leaves, not in terminal cones. 2.
1. Sporangia or specialized, scale-like sporophylls which are arranged in terminal cones. 3.
2. Stems dichotomously branched only at the base. the branches long; leaves nearly linear and entire, rather short and rigid, but not uniformly ascending.................................*L. porophilum.*
2. Stems branched successively; leaves larger, widely spreading or reflexed, minutely toothed, and usually widest above the middle. ....*L. lucidulum.*
3. Leaves many-ranked on the cylindrical stem, not spreading into two ranks. 4.
3. Smaller branches flattened, or the leaves spreading into two ranks; stems with erect or ascending tree-like branches. 5.
4. Cones usually single, sporophylls much like the foliage leaves. ....*L. inundatum.*
4. Cones usually in twos or long peduncles, sporophylls very unlike the foliage leaves...................................*L. clavatum.*
5. Sterile stems with linear-lanceolate spreading leaves; cones erect, closely sessile...................................*L. obscurum.*
5. Sterile stems flattened, with fan-like ascending clusters of branches, leaves of two forms; cones clustered on long peduncles..... ....*L. complanatum.*

1. *Lycopodium poróphilum* Lloyd & Und. Rock Club-moss.

Stem dichotomously branched only near the base, the prostrate portion rooting freely; sporophylls in zones alternating with the sterile leaves; sterile leaves broadest at the base but very gradually tapering, entire or minutely denticulate; sporophylls minutely denticulate above the middle or entire, acuminate, only very slightly broadened above the middle. Plants evergreen, commonly with brood-buds. On sandstone rocks. Licking, Fairfield, Hocking, and Portage counties.

2. *Lycopodium lucídulum* Mx. Shining Club-moss.

Stems lax and successively, dichotomously branched, ascending or spreading, the plants evergreen, about six to twelve inches long; leaves dark green, shining, widest above the middle; sporophylls alternating with zones of sterile leaves. Plants commonly bearing brood-buds. On sandstone rocks and in cool, damp woods. General in the eastern half of the state.

3. *Lycopodium inundàtum* L. Bog Club-moss.

Stems long, creeping, flaccid, forking, and brittle, closely appressed to the earth; fertile stems erect, solitary, slender, terminating in short cones; leaves lanceolate or lanceolate-subulate, with hyaline margins. In sandy bogs. Portage county. (Hopkins).

4. *Lycopodium obscùrum* L. Tree Club-moss.

Stems erect, bushy, with fan-like branches, six to twelve inches high, from a slender subterranean, horizontal rhizome; leaves lanceolate-linear, entire, eight-ranked on the main stem; cones, one to ten on each plant, sessile. Plants evergreen. In moist woods. Ashtabula, Lake, Medina, Licking, Fairfield, and Defiance counties.

5. *Lycopodium clavàtum* L. Common Club-moss.

Stems creeping with similar short irregular ascending or decumbent densely leafy branches; leaves evergreen, linear-subulate, incurved, bristle-tipped; cones one to four on long peduncles. In rich woods. Geauga county. (Stark county, Hopkins).

6. *Lycopodium complanàtum* L. Trailing Club-moss.

Stems creeping extensively, with erect or ascending, fan-shaped, evergreen branches; leaves minute, appressed, four-ranked, the lateral rows with somewhat spreading tips; peduncle slender, dichotomous, with two to four cones. In woods. Cuyahoga, Carroll, Geauga, Licking, Fairfield, Hocking, and Lake counties. (Erie county, Moseley Herb; Wayne county, Hopkins.)

SUBKINGDOM, PTERIDOPHYTA HETEROSPORAE.

Heterosporous Pteridophytes. 700 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.

Class IV. Hydropterides. Water-ferns. About 75 living species.

Sporophyte with a horizontal rhizome or floating on the surface of the water; leaves alternate or whorled; microsporangia and megasporangia borne together enclosed in sporocarps, leptosporangiate. Gametophytes developing entirely within the spore walls or protruding only slightly, very short lived; spermatozoids large, spirally coiled, multiciliate.

1. Floating plants with minute leaves spreading into two ranks and with rootlets on the under side. *Azolla* (Salviniales.)
1. Leaves four-foliate with slender petioles.................. .... *Marsilea* (Marsileales.)

Order, *Salviniàles.*

Small floating plants with small leaves with globose sporocarps containing the megasporangia and microsporangia.

Salviniàceae. Salvinia Family.

Besides the native species below *Salvinia natans* (L.) Hoffm. is often kept in green houses and conservatories.

22. Azólla Lam.

1. *Azolla caroliniàna* Willd. Carolina Azolla.

Small greenish or reddish plants, deltoid or triangular-ovate in outline, pinnately branching, and free-floating, with minute two-lobed, imbricated leaves and delicate rootlets. Sporocarps of two kinds, the smaller ovoid containing a single megaspore, the larger globose, producing many stalked microsporangia, which contain several peculiar spore-containing masses beset with arrow-like processes. Sometimes covering large surfaces of water. Hamilton, Lucas, and Lake counties.

Order, *Marsileàles.*

Herbaceous perennials with slender creeping rhizomes and four-foliate or filiform leaves. Sporocarps borne on the petioles, containing both megasporangia and microsporangia.

Marsileàceae. Marsilea Family.

Water-ferns with four-foliate leaves on slender petioles; leaflets turning with the light.

23. Marsi′lea L.

1. *Marsilea quadrifòlia* L. European Marsilea.

Occasionally cultivated and found as a waif in Franklin county.

Class V. Isoeteae. Quillworts. 60 species.

Sporophyte with a short tuberous stem with a peculiar type of secondary thickening and with long, erect, grass-like leaves which have a ligule; roots dichotomous; microsporangia and megasporangia large, borne singly, sunken in the expanded bases of the leaves, eusporangiate. Gametophytes very much reduced; spermatozoids spirally coiled, multiciliate.

Order, *Isoetàles.*

Isoetàceae. Quillwort Family.

24. **Isòetes** L.

Aquatic or marsh plants rooting in the mud, with a short 2-lobed or 3-lobed stem. One species of Quillwort might possibly be found in Ohio.

Class VI. Selaginelleae. Selaginellas. 500 species.

Sporophyte dorsiventral or erect, with monopodial or apparently dichotomous branching and dichotomous roots; leaves small, opposite or spirally arranged, ligulate; cells often with a single chloroplast; sporophylls in bisporangiate cones, the eusporangiate microscorangia and megasporangia single in the axils of the sporophylls. Gametophytes small and short-lived; spermatozoids very minute, biciliate.

Order, *Selaginellàles.*

Selaginellàceae. Selaginella Family

25. **Selaginélla** Beauv.

Terrestrial annual or perennial plants with branching stems and scale-like leaves, either 4-ranked or many-ranked.

1. Leaves all alike and uniformly imbricated and many-ranked, the stem much branched in close tufts.....................*S. rupestris.*
1. Leaves 4-ranked, shorter above and below, stipule-like, the lateral ones spreading into two planes; plants small and delicate...*S. apus.*

1. *Selaginella rupéstris* (L) Spring. Rock Selaginella.

Low, evergreen, tufted plants with occasional sterile runners and subpinnate branches, commonly curved when dry. Leaves rigid, appressed-imbricated, linear or linear-lanceolate, convex on the back, tipped with a distinct transparent point; cones sessile at the ends of the branches, strongly quadrangular. On dry rocks and sandy ground. Licking, Fairfield, and Hocking counties.

2. *Selaginella àpus* (L.) Spring. Creeping Selaginella.

Annual, light green, delicate plants with creeping, much-branched flaccid stems, angled on the face. Leaves minute, 4-ranked, membranous, of two kinds, spreading into two planes; cones obscurely quadrangular. In moist, shady places. Lake and Trumbull counties.

GLOSSARY.

Acuminate — Tapering gradually to the apex.
Acute — Sharp-pointed.
Anastomosing — Connecting so as to form a network.
Annual — Living but one year; yearly.
Annulus — The ring of cells partly or completely surrounding the sporangium.
Antheridium — The male organ of reproduction; a spermary.
Asiphonogamic — Not with a pollentube but having the spermatozoids discharged from the antheridium.
Archegonium — A female organ of reproduction; a special kind of ovary.
Areola — A space enclosed by anastomosing veinlets.
Areolate — Mapped off into small areas, or areolae.
Ascending — Growing obliquely upward.
Auricled — With ear-like lobes or appendages.

Bipinnate — Twice pinnate.
Bipinnatifid — Twice pinnatifid.
Bisporangiate — Having both microsporangia and megasporangia

Cambium — The cylinder of growing cells in some stems.
Carinate — With a keel or longitudinal ridge.
Caudate — Tailed; pointed like a tail.
Cell — The unit of plant and animal structure; usually consisting of a small mass of protoplasm containing a nucleus and with a cell wall.
Chlorophyll — The green coloring matter of plants.
Chloroplasts — The minute green, chlorophyll-bearing color bodies in the cell of a plant.
Ciliate — Provided with marginal hairs; having cilia.
Circinate — Rolled inward from the apex.
Clavate — Club-shaped.

Compound — Composed of several parts or divisions.
Cone — A primitive flower; a specialized branch of sporophylls whose apical growth has ceased.
Cordate — Heart-shaped.
Coriaceous — Leathery.
Crenate — With rounded teeth.
Crenulate — Minutely crenate.
Cuneate — Wedge-shaped.

Decompound — More than once compound.
Decurrent — Applied to an organ extending along the sides of another.
Deltoid — Broadly triangular.
Dentate — With outwardly projecting teeth.
Denticulate — Finely toothed.
Dichotomous — Two-forked.
Divided — Cleft to the base or to the midrib.

Emarginate — With a notched apex.
Entire — Without teeth, or serrations.
Epidermis — The external layer of cells of a plant.
Eusporangiate — Having the sporangia developed from sub-epidermal cells.

Falcate — Scythe-shaped.
Fertile — Bearing spores, gametes, or seeds.
Fibro-vascular — Containing fibers, vessels, and tubular cells.
Filiform — Thread-like.
Flaccid — Soft and weak.
Frond — Sometimes wrongly applied to the leaves of ferns.
Fruiting — Bearing spores, seed or fruit.
Gamete — A sexual cell.
Gametophyte — The sexual generation of plants.
Glabrous — Without hairs.
Gland — A secreting hair, or group of secreting cells.
Glaucous — Covered with a bluish or white bloom.

Habit — General aspect.
Habitat — The place where a plant grows.
Halberd-shaped — Same as hastate.
Hastate—Arrow-shaped with the basal lobes diverging.
Herbaceous — Having the texture of common leaves.
Hermaphrodite — An individual having both male and female sexual organs.
Heterosporous — Having microspores and megaspores.
Homosporous — Having only one kind of spores on the sporophyte.
Hyaline — Clear and translucent.
Hygroscopic — Readily absorbing and giving off water, by which means movements are produced.

Imbricate — Overlapping.
Incised — Cut into sharp lobes.
Indusium — The membranous covering of the sori in many species of ferns.
Inequilateral — With unequal sides.
Inferior — Situated or arising below other organs.

Laciniate — Cut into narrow segments or lobes.
Lamina — The blade of a leaf.
Lanceolate — Lance-shaped.
Leaflet — One of the divisions of a compound leaf.
Ligulate — Provided with or resembling a ligule.
Ligule — A strap-shaped organ, sometimes minute.
Linear — A long and narrow organ with the sides nearly parallel.
Lobed — Divided to about the middle or less.
Lunate — Crescent-shaped.

Megaspore — The larger of the two kinds of nonsexual spores produced by heterosporous plants.
Megasporangium — A sporangium which produces megaspores.
Membranous — Thin and rather soft and pliable.

Microspore — The smaller of the two kinds of nonsexual spores produced by heterosporous plants.
Microsporangium — A sporangium which produces microspores.
Midrib — The central rib of a leaf or other organ.
Mucronate — With a sharp, abrupt point.

Nectary — A nectar-secreting organ.
Node — The place where two internodes join, normally with one or more leaves.

Oblong — Somewhat longer than broad, with the sides nearly parallel.
Obovate — Inversely ovate.
Oösphere — The unfertilized egg; the female gamete.
Oospore — The fertilized egg.
Orbicular — Nearly circular in outline.
Ovary — The female organ of reproduction.
Ovate — Shaped like the longitudinal section of a hen's egg.

Palmate — Diverging like the fingers of a hand.
Panicle — An open cluster, consisting of more or less branching stems bearing fruit.
Peltate — Shield-shaped.
Perennial — Growing for many years.
Petiole — The stalk of a leaf.
Pilose — With long, soft hairs.
Pinna — The primary division of a pinnately compound leaf.
Pinnate — Leaves divided into leaflets or segments along a common axis.
Pinnatifid — Pinnately cleft to the middle and beyond.
Pinnule — A division of a pinna in a compound leaf.
Prothallium — Sometimes applied to the thalloid gametophytes of the Pteridophytes.
Pubescent — Hairy, especially with fine, soft hairs.

Rachis — The axis of a compound leaf, spike or raceme.
Receptacle — The part to which the sporangia are attached.
Reniform — Kidney-shaped.
Reticulate — Arranged as a network.
Revolute — Rolled backward.
Rhizoid — The filamentous, root-like outgrowths from the thallus of the gametophyte.
Rhizome — An underground stem.
Rootstock — Same as rhizome.

Sagittate — Shaped like an arrow-head.
Sclerenchyma — Bundles of thick walled fibers, in ferns usually brown or black.
Segment — One of the divisions of a pinnatifid or compound leaf.
Serrate — With teeth projecting forward.
Sessile — Without a stalk.
Silex — The silicious coating in the Equisetums.
Sinuate — With strongly wavy margins.
Sinus — The split or space between two lobes.
Sorus — A cluster of sporangia in the ferns.
Spatulate — Widened at the top like a spatula.
Spermatozoid — The male gamete.
Spinulose — With small, sharp spines.
Sporangiophore — A leaf or other organ bearing sporangia.
Sporangium — A spore-producing organ.
Spore — A modified reproductive cell.
Sporocarp — A carpel-like spore-bearing organ.
Sporophyll — A spore-bearing leaf.
Sporophyte — The nonsexual generation of plants.
Stellate — Star-shaped.
Sterile — Not producing spores or seeds.
Stipe — Sometimes used for the petiole of a fern leaf.
Stoma — The transpiring pores in the epidermis of the higher plants. (Plural, Stomata.)
Subcoriaceous — Somewhat coriaceous.
Subulate — Awl-shaped.

Succulent — Soft and juicy.
Superior — Above.

Ternate — Divided into three segments; arranged in threes.
Thalloid — Having the form of a typical thallus.
Thallus — The plant body of a thallophyte, or of the gametophyte of the Archegoniates.
Tomentose — Covered with dense wool-like hairs.
Truncate — Terminating abruptly by a nearly straight edge or surface.

Undulate — With wavy margins.
Unisexual — Having only ovaries or spermaries on one individual.

Vascular bundle — The conducting strands in the plant body composed of wood and bast.
Venation — The arrangement of the veins.
Vernation — The arrangement of the leaves in the bud.
Villous — With long, soft hairs not matted together.

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Nineteenth Meeting

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Clevenger, J. F., *Botany*...................838 E. 57th St., Chicago, Ill.

COGHILL, GEO. E., *Zoology, Neurology*........................Granville
COLE, A. D., *Physics*..Columbus
COLTON, GEORGE H..Hiram
COMSTOCK, FRANK M., *Vert. Zoology*...........Case School, Cleveland
COTTON, E. C., *Entomology*...........Experiment Sta., Knoxville, Tenn.
COPELAND, W. F..Athens
CRAMER, WILLIAM G., *Zoology*............273 Southern Ave., Cincinnati
DABNEY, CHAS. W.......................Univ. of Cincinnati, Cincinnati
DACHNOWSKI, ALFRED, *Botany*......................O. S. U., Columbus
DAVIES, CLARA A., *Botany, Physics*..........................Granville
DAVIS, V. H., *Horticulture*........................O. S. U., Columbus
DAVIS, B. M., *Zoology*...Oxford
DETMERS, FREDA, *Botany*.........................O. S. U., Columbus
*DICKEY, MALCOLM G., *Botany*....................O. S. U., Columbus
DOREN, JANE MACARTNEY, *Botany, Zoology*.....................
.............................1659 Franklin Park South, Columbus
DURRANT, E. P., *Biology, Geology*..........................Westerville
DURY, CHAS. ....537 Ridgway Ave., Cincinnati
DUTTON, C. F., JR.........................4816 Franklin Ave., Cleveland
EDWARDS, E. H., *Zoology, Physiology*..........................
.............................7317 Clinton Ave., N. W., Cleveland
FEIEL, ADOLPH ....520 E. Main St., Columbus
FENNEMAN, N. M., *Geology, Geography*...Univ. of Cincinnati, Cincinnati
FETZER, BERTHA A., *Zoology*.................................Granville
FINK, BRUCE, *Botany, Zoology*.................................Oxford
FISCHER, WALTER, *Botany*..................................Para, Brazil
FITZGERALD, A. D., *Histology, Pathology*...................Reynoldsburg
FLETCHER, M. H................................11 E. 7th St., Cincinnati
FLYNN, MAUD, *Zoology*.......................338 W. 6th Ave., Columbus
FOOTE, E. H., *Biology*...Granville
FOX, CHAS. P., *Botany, Chemistry*.................395 Doyle St., Akron
FOWKE, GERARD, *Glacial Geology, Archaeology*................Chillicothe
FRANK, J. N., *Botany, Entomology*.........................Colleton, S. C.
FULLMER, E. L., *Botany*...Berea
FULTON, B. B., *Entomology, Botany*...........................Newark
GARY, L. B., *Geology*......................263 Hoyt St., Buffalo, N. Y.
GIBBS, DAVID ....Milan
GROVER, F. O., *Botany*...Oberlin
GRIGGS, R. F., *Botany*..............................O. S. U., Columbus
GUYER, M. F............................Univ. of Cincinnati, Cincinnati
HAMBLETON, J. C., *Botany, Zoology*..........212 E. 11th Ave., Columbus
HANSEN, MRS. HERMINA J., *Biology*....Hughes High School, Cincinnati

*Subject to ratification of the Society at the annual meeting, 1910.

Hathaway, Edward S., *Zoology, Botany*..Univ. of Cincinnati, Cincinnati
Hawk, J. F., *Biology*..............................Box 302, Lancaster
Hawkins, L. A., *Botany*.......Bureau of Plant Ind., Washington, D. C.
Hayes, Seth..................................135 Center St., Dayton
Henninger, W. F., *Ornithology, Entomology*...............New Bremen
Herms, W. B.........................Univ. of California, Berkeley, Cal.
Herzer, H., *Paleontology*....................................Marietta
Hillig, Fred J.............................St. John's College, Toledo
Hine, J. S., *Entomology, Ornithology*................O. S. U., Columbus
Hobbs, P. L., *Chemistry*.......Western Reserve Med. College, Cleveland
Hollister, Emily S..............................O. S. U., Columbus
Holt, W. P., *Botany*.........................2113 Putnam St., Toledo
Hood, G. W., *Entomology, Horticulture*.......57 W. 8th Ave., Columbus
Houser, J. S., *Entomology*................Santiago de las Vegas, Cuba
Hubbard, G. D., *Geology, Physiography*..............O. S. U., Columbus
Hyde, J. E., *Geology*......................................Lancaster
Jackson, C. F., *Zoology*...........................Durham, N. H.
James, C. B...............................Adelbert College, Cleveland
Jennings, O. E., *Botany*........Carnegie Museum Annex, Pittsburg, Pa.
*Johnson, Dora E., *Botany, Physiography*......................Medina
Jones, Lynds, *Ornithology*...................College Museum, Oberlin
Judson, C. A., *Botany*.....................235 Columbus Ave., Sandusky
King, J. Lional, *Botany, Entomology*.......................Cleveland
Krecker, Frederick H., *Biology*..............................Marietta
Lamb, G. F., *Biology, Geology*...............Mt. Union College, Alliance
Landacre, F. L., *Zoology*.........................O. S. U., Columbus
Lazenby, Wm. R., *Horticulture, Botany*............O. S. U., Columbus
Lee, Mary E., *Geology*...................................Westerville
Lett, Gertrude, *Biology*....................................Granville
Library, Ohio State University..............................Columbus
Lindahl, Josua, *Zoology*..................5700 Peoria St. Chicago, Ill.
Lloyd, John Uri......................Court and Plum Sts., Cincinnati
Luginbill, Philip, *Entomology*.............247 E. 11th Ave., Columbus
Mackenzie, Mary D., *Biology*..................................Oxford
Mally, C. W., *Entomology*....................Grahamstown, S. Africa
March, Cora, *Biology*.......................................Wyoming
Matheny, W. A..................Clark University, Worcester, Mass.
Mather, Kirtley F., *Geology*................................Granville
Mathews, Mary E...Painesville
McCall, A. G., *Agronomy*.........................O. S. U., Columbus
McCampbell, Eugene F., *Bacteriology*.............O. S. U., Columbus
McCleery, Edna, *Botany*....................................Lancaster

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McCoy, C. T., *Botany*....................................Lancaster
McCray, Arthur H., *Zoology and Entomology*..................Duval
McDaniel, J. E., *Biology*..............................Olathe, Colo.
McFadden, L. H., *Chemistry*...................40 Warden St., Dayton
McKean, T. L., *Botany*...................................Berea
Mead, Chas. S., *Zoology, Botany*......2020 Orrington Ave., Chicago, Ill.
Mercer, W. F., *Biology*......................Ohio University, Athens
Metcalf, C. L., *Botany, Zoology*............86 E. 11th Ave., Columbus
Metcalf, M. M., *Zoology*..................................Oberlin
Metcalf, Zeno P...................................Raleigh, N. C.
Mills, W. C., *Archaeology, Biology*...............O. S. U., Columbus
Moody, A. E...Flushing
Morgulis, S., *Zoology*...............Harvard Univ., Cambridge, Mass.
Morse, W. C., *Biology, Geology*...................O. S. U., Columbus
Moseley, E. L., *Zoology, Botany, Physiography*..............Sandusky
Nelson, James A., *Zoology, Embryology*........................
..............U. S. Dept. Agricul. Div. Entom., Washington, D. C.
Nichols, Susan P., *Botany*,....................Oberlin College, Oberlin
Oberholser, H. C............1445 Girard St., N. W., Washington, D. C.
Odenbach, F. L., *Meteorology*...........St. Ignatius College, Cleveland
Orcutt, Alfred S...Granville
Osborn, Herbert, *Entomology, Zoology*.............O. S. U., Columbus
Osburn, Raymond C., *Zoology, Ichthyology*......................
...............................Columbia Univ., New York, N. Y.
Oxley, Chas. E., *Geology, Physics*.........................Coshocton
Pallister, H. D....................3754 Independence Road, Cleveland
Parkhurst, C. P., *Science*..................9 W. Long St., Columbus
Peaslee, L. D., *Zoology*...........................U. of C., Cincinnati
Pickel, Geo. J., *Chemistry*..............St. Ignatius College, Cleveland
Piwonka, Thomas................226 Superior Ave., N. W., Cleveland
Prosser, C. S., *Geology*..........................O. S. U., Columbus
Rice, Edward L., *Zoology*................................Delaware
Roudebush, Lowell..................R. F. D. No. 3, New Richmond
Royer, John S., *Biology*...................................Bradford
Sanders, J. G., *Entomology, Botany*.....................Madison, Wis.
Sanders, A. E.........................Steele High School, Dayton
Sanger, U. G., *Botany*.....................................Newark
Sauer, Lewis W., *Botany*...Central Ave. and Bay Miller St., Cincinnati
Schaffner, J. H., *Botany*..........................O. S. U., Columbus
Scheffel, Earl R., *Geology*...........469 College Ave., Appleton, Wis.
Scott, L. L., *Entomology*....................................Kent
Seaton, Miss F...........................1943 E. 86th St., Cleveland
Selby, A. D., *Botany*.....................Experiment Station, Wooster
Sessions, Elizabeth, *Botany and Zoology*....59 Wilson Ave., Columbus

SHADE, ERNEST F., *Physiography, Botany, Physics*...............Medina
SHATZER, C. G.........................Wittenberg College, Springfield
SHAW, N. E., *Entomology*.........................O. S. U., Columbus
SIM, ROBERT J...................................O. S. U., Columbus
SMITH, A. L., *Geology*...........................O. S. U., Columbus
SMEAD, ANNA, *Biology*.........................624 Nestle St., Toledo
SMITH, ETHEL M...............................Stevens Point, Wis.
SMITH, G. D., *Botany, Zoology*.......................Richmond, Ky.
SMITH, J. WARREN, *Meteorology*........Weather Bureau, St. Louis, Mo.
SNYDER, F. D., *Zoology, Ethnology*............................Ashtabula
STAIR, L. D...............................611 Y. M. C. A., Toledo
STAUFFER, CLINTON R., *Geology*..................W. R. Univ., Cleveland
STERKI, VICTOR, *Conchology, Botany*..................New Philadelphia
STICKNEY, M. E., *Botany*...................................Granville
STOCKBERGER, W. W., *Botany*......Dept. Agriculture, Washington, D. C.
STOVER, W. GARFIELD, *Botany*.............Miami University, Oxford
STOUT, W. E., *Chemistry, Geology*...........1464 S. High St., Columbus
SURFACE, F. M., *Zoology, Botany*.......................Orono, Maine
SWEEZEY, OTTO H........................12th Ave., Honolulu, Hawaii
TODD, JOSEPH H., *Geology, Archaeology*.......Christmas Knoll, Wooster
THOMAS, LEWIS, *Geology*...................................Granville
TRUE, H. L...McConnelsville
TYLER, F. J., *Botany*...............................Perry, Lake County
WAITE, F. C....................Western Reserve University, Cleveland
WALTON, L. B., *Biology*....................................Gambier
WEBB, R. J., *Botany*..................................Garrettsville
WEBSTER, F. M., *Entomology*....U. S. Dept. Agricul., Washington, D. C.
WERTHNER, WILLIAM, *Botany*................Steele High School, Dayton
WESTGATE, LEWIS G., *Geology*...............................Delaware
WETZSTEIN, A., *Botany*.........748 Pleasant St., Hot Springs, Arkansas
WIEMAN, HARRY L., *Biology*.............Univ. of Cincinnati, Cincinnati
WILLIAMS, STEPHEN R., *Biology*..............Miami University, Oxford
WILLIAMSON, E. B., *Ichthyology, Ornithology*.............Bluffton, Ind.
WILSON, STELLA S., *Geography, Geology*........97 N. 20th St., Columbus
WINELAND, L. A., *Chemistry*............................Westerville
WITTENMYER, J. G., *Zoology*................................Peebles
WOLFE, E. E., *Botany*......................Marietta College, Marietta
WRIGHT, G. FREDERICK, *Geology*..............................Oberlin
YORK, HARLAN H., *Botany*...............Univ. of Texas, Austin, Texas
YOUNG, R. A., *Botany*...
............Div. Seed and Plant Introduction, Washington, D. C.

Report of the Nineteenth Annual Meeting

of the

Ohio State Academy of Science

ANNUAL MEETING

The nineteenth annual meeting of the Academy was held at Ohio Wesleyan University, Delaware, O., on November 25, 26 and 27, the President, Prof. J. H. Schaffner, presiding. On Thursday evening an informal reception was held in Merrick Hall, where refreshments were served and acquaintances renewed. Through the generosity of the university authorities acting in co-operation with various fraternities, accommodations were provided for all visiting members.

The meeting was called to order on Friday morning at 9:00 in Merrick Hall by the President of the Academy after a preliminary meeting of various committees. An address was made by President Welch extending the cordial greetings of the University to the society and calling attention to the influence of science in promoting accuracy, in broadening scholarship, and in the adjustment of theory to fact rather than fact to theory.

In the regular business meeting which followed a committee on membership consisting of Professors Moseley, Rice, and Miss Davies, and a committee on resolutions consisting of Professors Osborn, Guyer, and Metcalf, were appointed by the President. The report of the Secretary was presented and accepted. This was followed by the report of the Treasurer, Prof. J. S. Hine which after being referred to an auditing committee consisting of Professors Stickney and Guyer was accepted. The report of the Treasurer is as follows:

REPORT OF THE TREASURER FOR THE YEAR 1909.

The revised constitution of the Academy adopted at the annual meeting for the year 1908 at Granville provides that a single payment of twenty-five dollars shall be accepted from any member as commutation of dues for life, also that the payment of one hundred dollars at one time shall constitute eligibility to election as a patron of the society. Money paid in according to this plan is intended eventually to constitute a research fund of which the income alone shall be used for the encouragement of research and for the publication of papers bearing upon the development of science in the state.

Dr. Charles E. Slocum, of Defiance, was the first to respond with a hundred dollars and at the present time is the only patron of the Academy. Dr. Slocum's example is one worthy of emulation and a long list of patrons would look well at the head of our membership role.

For the year since our last annual meeting the receipts, including balance for last year, have amounted to $342.49, and the expenditures to $286.12, leaving a cash balance of $56.37.

RECEIPTS.

Balance from last year	$14 99
Dr. C. E. Slocum — payment on becoming a patron of the Academy	100 00
Membership dues	227 50
Total	$342 49

DISBURSEMENTS.

170 subscriptions to the Ohio Naturalist	$127 50
Annual report for 1907	25 50
Annual report for 1908	82 50
Miscellaneous expenses	50 62
Balance December 1, 1909	56 37
Total	$342 49

Respectfully submitted,

James S. Hine.

The report of the Librarian, Prof. W. C. Mills, was then presented as follows:

REPORT OF THE LIBRARIAN FOR THE YEAR 1909.

COLUMBUS, OHIO, November 26, 1909.

As Librarian of the Ohio Academy of Science I take pleasure in presenting my report upon the receipts from the sale of publications of the Academy and the expense of sending out the publications:

Cash on hand November 27, 1908	$3 54	
Sale of publications	33 79	
		$37 33

Expenditures from November 27, 1908 to November 26, 1909:

Letter postage	$1 22	
Sending out Special Paper No. 14, 220 @ .04	8 80	
Sending out Special Paper No. 15, 210 @ .06	12 60	
Sending out Seventeenth Annual Report, 215 @ .04.	8 60	
Sending out publications during year	2 41	
Envelopes for sending out publications	2 35	
Stationery	1 00	
Paste	15	
		$35 91
Balance		$1 42

It is gratifying to note the increased sale in our publications. Last year our entire sales amounted to $16.35, while this year the sales were more than doubled. This is perhaps due to the sale of special paper No. 15 by Prof. Schaffner.

The increased number of answers to inquiries can be seen in the amount expended for letter postage, which is $1.22. Many more contained stamp for return postage. During the year 212 letters have been written, averaging more than 4 letters per week.

Our exchanges have also been somewhat increased, and during the year we have been sending our publications to the following scientific and educational institutions: Academy of Natural Sciences of Philadelphia, Brooklyn Institute of Arts and Sciences, Buenos Aires National Museum, Buffalo Society of Natural Sciences, Connecticut Academy of Arts and Sciences, New Haven, Cincinnati Society of Natural History, Denison University Scientific Laboratory, Davenport Academy of Sciences, Illinois State Laboratory, Kansas Academy of Science, Topeka, New York Botanical Garden, University of California, Wisconsin Academy of Sciences, Arts and Letters, University of Missouri, Columbia, British Museum of Natural History, Missouri Botanical Garden, and Chicago Academy of Science.

The reports and bulletins received from these exchanges are placed in a section in the Library of the Ohio State Archaeological and Historical Society. These volumes can be consulted by the members of the Academy at any time.

Respectfully submitted,
WM. C. MILLS,
Librarian.

The report was followed by a discussion relative to the prices which should be charged for the publications of the Society. A resolution was finally adopted that the Publication Committee be instructed to increase the prices for the papers published by the Society.

Under reports of Standing Committees, the Program Committee advised the papers presented "in absentia" be transferred to the end of the program.

Professor Lazenby, chairman of the Board of Trustees presented the following report which was approved and accepted. The continued interest of Mr. Emerson McMillin in the welfare of the society was made known through his gift of $250 to the research fund. The report of the trustees is as follows:

REPORT OF THE BOARD OF TRUSTEES.

The financial statement of the Emerson McMillin research fund for the year 1908-1909, is herewith presented:

RECEIPTS.

1908.			
	Balance on hand November 1, 1908..........	$469 67	
	Check from Emerson McMillin, November 20, 1908	250 00	
	Total		$719 67

EXPENDITURES.

1908.			
Dec. 26.	Bucher Engraving Co., illustrations for S. Morgulis	$6 50	

1909.			
Feb.	8.	Dr. A. Dachnowski, expense in research in physiological botany	10 00
Mar.	8.	Prof. G. E. Coghill, expense in research in zoology	27 94
Apr.	12.	Prof. L. B. Walton, expense in research in zoology	17 50
	20.	Dr. A. Dachnowski, expense in research in physiological botany	26 10
May	26.	Prof. G. E. Coghill, expense in research in zoology	7 84
	26.	F. J, Heer Printing Co., 500 copies Discomycetes in the vicinity of Oxford, Ohio, by Freda M. Bachman....................	44 00
	26.	F. J. Heer Printing Co., 700 copies, Trees of Ohio, by J. H. Schaffner...............	124 50
June	8.	Prof. L. B. Walton, expense in research in zoology	5 63
Aug.	16.	Miss Freda Detmers, expense in research in systematic botany	20 75
Oct.	19.	Miss Freda Detmers, expense in research in systematic botany	9 25
	20.	Prof. G. E. Coghill, expense in research in zoology	7 75
	20.	Mr. R. J. Sim, expense in research in ornithology	40 47

Total $348 23

Balance on hand Nov. 1, 1909.................. $371 44

Of this balance there has been appropriated a grant of $50.00, which is not yet expended, leaving an unappropriated balance for the year 1908-1909 of $321.44.

WILLIAM R. LAZENBY,
Chairman.

The Publication Committee consisting of Professors J. C. Hambleton, E. L. Rice, and Bruce Fink, presented the following report which was accepted:

REPORT OF THE PUBLICATION COMMITTEE.

The following publications have been issued the past year: Special Paper No. 14, Discomycetes in the Vicinity of Oxford, Ohio, by Freda

M. Bachman. Special Paper No. 15, The Trees of Ohio, by John H. Schaffner, and the Seventeenth Annual Report.

Respectfully submitted,

J. C. Hambleton, *Chairman.*

Under the reports of special committees, the Natural History Survey committee was continued. The Committee on joint meetings with the Indiana Academy reported on the desirability of such a meeting. This was referred to the Executive Committee for consideration in 1910. The Committee on the Conservation of Natural Resources consisting of Professor Herbert Osborn, chairman, Professor Lazenby, Professor Bownocker, and Professor Walton was continued, while the chairman of the committee was given power to appoint a member in place of J. Warren Smith who, much to the regret of the members of the society, has been transferred in connection with the Weather Bureau Service.

After the election of a Nominating Committee consisting of Professors Rice, Osborn and Stickney, the business meeting was adjourned until Saturday morning at 8:00 a. m., while the society proceeded with the reading of papers, adjourning at 12:00 m. for luncheon.

The afternoon session opened with the address of the President, Professor J. H. Schaffner, which will be found on another page. This was followed by the reading of papers, the society adjourning at 5:00 p. m.

At 5:30 dinner was served in Monnett Hall by the university, following which the aims and history of the Academy were presented in a series of speeches from some of the older members of the society. The social evening which followed was one of the particularly enjoyable features of the meeting.

Saturday at 8:00 p. m. occurred the adjourned business meeting. The report of the nominating committee was received and the following officers were elected for the ensuing year:

OFFICERS OF THE OHIO ACADEMY OF SCIENCE FOR 1909-10.

President — Professor W. F. Mercer, Athens, Ohio.

Vice-Presidents — Botany, Professor Bruce Fink, Oxford, Ohio; Geology, Professor G. D. Hubbard, Columbus, Ohio; Zoology, Professor M. M. Metcalf, Oberlin, Ohio.

Secretary — Professor L. B. Walton, Gambier, Ohio.

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

Librarian — Professor W. C. Mills, 3 years, Columbus, Ohio.

Trustee — Professor W. R. Lazenby, 3 years, Columbus, Ohio.

Publication Committee — Professor J. C. Hambleton, 3 years, Columbus, Ohio.

Executive Committee — Professor L. G. Westgate, Delaware, Ohio; Dr. A. D. Selby, Wooster, Ohio.

HERBERT OSBORN,
EDWARD L. RICE,
MALCOLM E. STICKNEY,
Committee.

The following members were upon the report of the membership committee appointed at the opening session:

NEW MEMBERS ELECTED AT THE DELAWARE MEETING, 1909.

Badertscher, J. A., Histology, Embryology, Physiology............Athens
Barrows, William Martin, Experimental Zoology.....O. S. U., Columbus
Braun, Annete F., Zoology...............Univ. of Cincinnati, Cincinnati
Fulton, B. B., Entomology, Botany.............................Newark
Hathaway, Edward S., Zoology, Botany...Univ. of Cincinnati, Cincinnati
Hollister, Emily S., Zoology........................O. S. U., Columbus
Hood, G. W, Entomology, Horticulture.......57 W. 8th Ave., Columbus
King, J. Lional, Botany, Entomology........................Cleveland
Krecker, Frederick H., Biology..............................Marietta
Lamb, G. F., Biology, Geology..............Mt. Union College, Alliance
Luginbill, Philip, Entomology...............249 E. 11th Ave., Columbus
McCleery, Edna, Botany.....................................Lancaster
Metcalf, C. L., Botany, Zoology..............86 E. 11th Ave., Columbus
Nichols, Susan P., Botany......................Oberlin College, Oberlin
Shade, Ernest F., Physiography, Botany, Physics.................Medina
Stover, Wilmer Garfield, Botany..............Miami University, Oxford

The names of members proposed by the executive committee and provisionally placed on the list of membership were also ratified.

The committee on resolutions reported as follows:

Be it resolved, That we express to Mr. Emerson McMillin our great appreciation of his continued interest. His substantial contributions have done and are doing much in promoting the scientific accomplishments of the Academy and we extend to him our sincere thanks.

Be it further resolved, That we extend our hearty thanks to the President, Trustees and Faculty of Ohio Wesleyan University, to the fraternities of the university, to the residents of Monnett Hall and to the local committee for our delightful entertainment and their careful arrangements which have insured the success of our meeting.

HERBERT OSBORN,
MICHAEL F. GUYER,
MAYNARD M. METCALF,
Committee.

In connection with the new business the following resolution was adopted. It is assumed that the resolution only applies to papers exceeding three minutes in length.

1. That the presiding officers be required to close the reading of papers at the expiration of the time set on the program.
2. That a signal be given two minutes previous to the time when the paper must be closed.
3. That this procedure be printed as a note on the program of papers for the meeting.

Telegrams extending cordial greetings were exchanged with the Indiana Academy of Science in session at Indianapolis.

At the close of the business session the society proceeded with the reading of papers.

At 11:45 a. m. the Academy was formally declared adjourned.

The complete program of the meeting was as follows:

1. A Suspected Belgian Hare — Cat Hybrid (Demonstration). 5 min. — E. L. Rice
2. The Film Test for Crude Rubber. 5 min. — Chas. P. Fox
3. Development of Skeletal System in young leaves. 10 min. — H. H. Benedict
4. The Relation of Bodily Strength to Correlation of height and arm length in some College Students. 10 min. — W. M. Barrows

5. On Mitosis in *Synchtrium* with some observations on the Individuality of the chromosomes. 12 min. R. F. Griggs
6. The Life History of *Corizus lateralis* Say. 10 min. J. C. Hambleton
7. The Orchids of Ohio. 5 min. Kate R. Blair
8. The Inheritance of the Abnormality of the Human Hand. 10 min. (Lantern slides.) S. R. Williams
9. A Theory as to the Factor causing Death among Organisms. 5 min. L. B. Walton
10. The Color Pattern of Guinea-Chicken Hybrids. 8 min. M. F. Guyer
11. Relation of starch grains to Pyrenoids in green algae. 8 min. M. L. Stickney
12. Organization of protoplasm in Amœba. 5 min. R. A. Budington
13. Milk-Sickness in Sandusky County during 1909. 10 min. E. L. Moseley
14. Fossil sponges. 7 min. Herman Herzer
15. A Method for Rendering Plant Tissues Transparent. 3 min. H. M. Benedict.
16. Some Minute Parasites of Amœba. 5 min. M. M. Metcalf
17. New and Rare Ohio Plants. 5 min. J. H. Schaffner
18. The Relation of Soil Temperature and Evaporation to Plant Growth in Bogs. 10 min. Alfred Dachnowski
19. The Rate of Evaporation in a Bog Habitat. 12 min. Malcolm Dickey
20. Interesting Fungi from the Miami Valley. 15 min. W. G. Stover
21. Fossil Sponges. 10 min. Herman Herzer
22. Raised Beaches in the Bellevue Quadrangle. 10 min. (Lantern slides.) Frank Carney
23. Notes on the Work of Small Streams crossing the Ohio Shales. 8 min. E. B. Branson
24. The Mount Tabor Cave. 10 min. G. D. Hubbard
25. The Glaciation of the Newark-Zanesville Divide Area. 15 min. K. F. Mather
26. A Detailed Study of a portion of Ohio Stratigraphy. 8 min. G. F. Lamb
27. Buckeye Poisoning. 8 min. E. L. Moseley
28. Additions to the Flora of Cedar Point, O. 3 min. Clara Davies
29. Dichotomous Panicums of Ohio. 5 min. Freda Detmers
30. Notes on the Supposed Hybrid of the Black and Shingle Oaks. 8 min. E. H. Foote
31. Discomycetes of the Cuyahoga Valley. 10 min. (Lantern slides.) G. D. Smith

32. Nutrition of Egg in *Leptinotarsa synaticollis.* 15 min. H. L. Wieman
33. Notes on a New Species of Gregarine. 10 min. R. A. Budington
34. A case of Unusual Abundance of one of the Moth-flies. 5 min. J. S. Hine
35. Phylogeny of the Lithocolletid Group. 10 min. Annete F. Braun
36. The Eggs and Young of *Lepisma domestica* Pack. 5 min. S. R. Williams
37. The Place of Origin of the Lateral Line Organs in Ameiurus. 5 min. F. L. Landacre
38. Notes on the Life History and Behavior of the Opossum (*Didelphys virginiana*). 10 min. (Lantern slides.) G. E. Coghill
39. Isolation and Specialization in the Mallophaga. 15 min. E. P. Durrant
40. The Plant Productions of Burbank. 20 min. (Lantern slides.) G. D. Smith
41. Notes on Lichens — Ecologic Studies. 15 min. (Lantern slides.) Bruce Fink
42. The Lichens of the Kentucky Mountains. 10 min. (Lantern slides.) G. D. Smith
43. The Development of the Metacarpal Bones of Domesticated Animals. 20 min. J. A. Badertscher
44. The Chromosomes of *Leptinotarsa synaticollis.* 15 min. H. L. Weiman
45. The Carboniferous Deposits of Jackson and Vinton Counties. 15 min. W. F. Mercer
46. Some New Fishes from the Ohio Shales. 10 min. E. B. Branson
47. Fossil Fish Teeth. 10 min. Herman Herzer
48. Notes on the Naiades of Grand River, O., and of Cedar Point, O. 5 min. L. B. Gary
49. The Land Planarians of North America. 5 min. L. B. Walton
50. Notes upon Plant Crystals. 5 min. W. R. Lazenby
51. Early History of Germ Cells in *Leptinotarsa synaticollis.* 15 min. H. L. Wieman

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THE NATURE AND DEVELOPMENT OF SEX IN PLANTS.*

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ORIGIN OF SEXUALITY.

Sexuality is all but universal in the organic kingdom. It is only in the lowest forms that sexual qualities are apparently lacking. Some of the intermediate and higher plants also show a lack of the sexual process but their morphology and relationships clearly point to a sexual ancestry. They are degenerate or specialized forms which have lost their sexual organs to a greater or less degree.

Now the question arises as to whether the simplest nonsexual plants, like the blue-green algae and bacteria, are not also such degenerate forms derived from sexual progenitors? In other words, were the primitive, original plants nonsexual in character like some of the present protophyta or did they possess sexual properties like the vast majority of the lower and higher plants of today? Is sexuality a property of the protoplasm normally coming to expression at some stage of the life cycle or is it an acquired character developed through mutation or the struggle for existence? There is of course no known scientific answer to these questions at present. The answer can be only a speculation or an hypothesis but apparently the general evidence points to a nonsexual starting point for the organic kingdom.

Since the nonsexual condition is evidently less complex than the sexual, it is probably proper to accept the hypothesis with-

* Contribution from the Botanical Laboratory of the Ohio State University, 54.

out definite proof that the primitive plants were without sex. With such an assumption the development of sex in all of its phases becomes an evolutionary process,—a process becoming more and more complicated as we go up the scale of organic beings. If the archaic organisms were nonsexual, it is probable that most of our lowest nonsexual forms have come through all the geological ages in this primitive condition. They were probably specialized before their cells had developed a conjugation process. It is evident that if plants came from nonsexual progenitors there should be no insurmountable difficulty in the way of their return to the same condition after developing sexuality. Vegetative propagation and parthenogenesis are present all along the scale of organic ascent and are not impossible in any group of plants.

In the lower plants zoospore production is very general outside of the fission plants, and it is probable that sexuality had its origin in practically all groups at the naked, motile stage of the life cycle. Whenever conjugation takes place between walled cells we may reasonably look upon the process as derived from a naked cell conjugation. Such forms as Spirogyra and Mucor become, from this point of view, extremely specialized types rather than primitive ones.

Now whatever may have been the ultimate cause of the evolution of a conjugation process, it is commonly believed that the immediate cause was a need of nutrition or rejuvenescence. If an interchange of food could be brought about when a weaker zoospore met a stronger one, the habit might become established, and if two protoplasmic masses could learn to fuse more or less completely on the approach of adverse conditions the fused individuals might have the advantage in passing through the unfavorable period. For after conjugation the number of individuals would be but half of the previous number and the protoplasm would be more dense. In the lower forms conjugation frequently takes place before the appearance of adverse conditions and the zygote passes into a resting stage in which it can endure both dryness and cold or a lack of food. There is also a considerable reduction of the surface in proportion to the volume. In the primitive forms conjugation was probably developed mostly for protection. It preceded an encysted resting condition. In the lower algae Sphaerella, Spirogyra, Ulothrix, and Vaucheria are examples. In the higher plants the conjugation was finally followed shortly by germination because the gametes are protected in the tissue of the parent. Thus in the higher plants and animals conjugation often appears to have a very different purpose from its primitive significance, since it appears here to be especially a stimulus to further growth.

In the algae it is evident that the purpose of sexuality was not to obtain the advantage of a double number of chromosomes, for in most of the lower forms the number is reduced as soon as the zygote germinates. If, however, there is a mixture of the maternal and paternal chromosomes such temporary conjugations of nuclei may be important in inducing greater variation. But by continued conjugations all the more important combinations would finally be accomplished and sexuality would thus have a tendency to produce uniformity. Of course, it is probable that the original conjugations were merely cytoplasmic, the two nuclei learning to fuse but gradually.

Our hypothesis, then, is that organisms learned to conjugate through the taking of food, the weaker from the stronger. When this habit was established it led to other habits, the plants which were able to conjugate obtained the advantage at the approach of adverse conditions, because they were thus enabled to reduce their numbers by one-half and the resulting cells could pass more readily into a resting stage because of the greater density of the protoplasm. Finally the mixing of chromosomes in conjugation had an influence on hereditary transmission. Conjugation then is a purposeful process and an advantage to the individual. The habit is acquired and developed like any other instinct. It becomes a protoplasmic memory, an hereditary character.

As stated above, outside of the brown and red algae there is only a temporary association of the double number of chromosomes in the lower green plants, and there seems to have been a gradual development of the diploid sporophyte in the higher plants not because of the advantage coming from the greater number of chromosomes but because the sporophyte happened to acquire the habit of being nourished by the parent gametophyte in its embryonic condition. In some of the red algae where both generations start as independent individuals the sexual and nonsexual generations are practically alike in appearance and complexity of structure.

Wherever a sexual process is established a reduction division must also occur in the life cycle. The reduction may take place at three different stages. First, at the germination of the zygote; second, just before the formation of the gametes; or third, where an antithetic alternation of generations is present, just before the formation of the nonsexual spores on the sporophyte.

In the evolution of sex, it was the gametes which were first differentiated, both being produced on an hermaphrodite individual in nearly all the lower multicellular forms. As is well known, a decided sexual dimorphism appears in the gametes and often also in the sexual organs. The egg is large, stationary, and with an abundant food supply. The sperm is comparatively small, active and with a minimum of food stored in its body. The first evolution or differentiation of sexuality is then an expression of difference in nutritive qualities. Now what is the hereditary apparatus that determines that the incipient gametes shall develop as eggs in one part of the body and as sperms in another part? As stated, the reduction in most of the lower forms takes place at the germination of the egg spore. The cause then which determines the development of gametes of one kind or the other in the hermaphrodite body is a matter of the becoming active or latent of characters common to all parts of the organism. It is not at all the case that the sex of the gametes is determined by the association or disassociation of an x or a 2x number of chromosomes. It is a process similar in character to that which determines that one leaf shall be a foliage leaf and the one next to it a sporophyll; or that one branch shall continue as a vegetative shoot and the other one develop as a flower.

SEXUAL DIMORPHISM.

If we are right in assuming that the difference in gametes is an expression of a difference in nutritive function and that the advantage of heterogamy is one merely of specialization in the two cells, we may next inquire as to the probable cause of a difference in the size, shape, color, etc., of the ovaries and spermaries, and finally of the unisexual individuals in the higher forms.

In such plants as Vaucheria the difference in shape and size of the gametangia is remarkable, when the simplicity of the other parts of the plant is taken into consideration. Whether this difference is merely an expression of the activity of different hereditary characters set free by the determination of the sex of the part, we may not be able to discover. But it is certainly apparent that the sexual differentiation is brought about like any other differentiation in the growth of the hermaphrodite individual. The sexual dimorphism of the parts is of no special significance. The twist in the antheridium does not appear to be of any special advantage; for it does not result in bringing about the discharge of the sperms in any constant direction in respect to the oogonium. In Chara, the oogonium and antheridium are exceedingly complex and also remarkably differentiated in shape, size, and finally in color. The oogonium is green corresponding to its further nutritive function in ripening the oospore which becomes packed with food material, while the antheridium is a bright red. Whatever purpose the bright red color of the antheridium may have, it is not the result of any sexual selection. If it has any significance, that significance is purely physiological and is probably an expression of internal activities closely bound up with the nutritive hereditary tendencies which produce the male gametes.

In certain species of Oedogonium the plant produces eggs and the so-called androspores. These androspores produce dwarf males whose sperms fertilize the eggs of the original parent plant. Now, these dwarf males are of peculiar shape and size. There is thus a very striking sexual dimorphism produced here apparently by the fact that the androspores are very small spores when compared with those which produce the egg-bearing plant. Indeed the androspore appears to be a modified spermatozoid which developing parthenogenetically produces a stunted individual with male sexuality.

When one goes into the higher groups where unisexual individuals appear in species whose close relatives are hermaphrodite, one occasionally has a most striking sexual dimorphism between normal males and females. Thus in species of the common mosses belong to the genus Polytrichum the sexual branches are not only distinguished by having terminal scales of a different shape and size, but the female is entirely green while the tip of the male plant in which the antheridia are hidden is red. In the Liverwort, Marchantia, the difference in shape of the branches which bear the sexual organs is also very great but there is no difference in color.

The Heterosporous Pteridophytes show an extraordinary difference in the size of the sexual individuals and the same condition exists in most of the Gymnosperms. Finally, in the Angiosperms, when one meets with a dimorphism of the sporophytes, there is often a decided difference in the color of the flower-clusters; as in the common cottonwood where the carpellate catkins are green and the staminate ones red. At the time of blooming, therefore, there is a great contrast in the appearance of the two individuals. Examples like this could be multiplied indefinitely. It is sufficient to repeat again that similar developments and dimorphisms appear whether the sexual organs or branches are borne on unisexual or hermaphrodite individuals. It has commonly been assumed that the sexual dimorphism of the higher animals arose through sexual selection, either through a preference shown by the male or the female or both for some pattern or color. Evidently such an explanation to the similar phenomena observed in many plants would be the extreme of absurdity whatever one may think of its fitness as an explanation of sexual dimorphism in the intelligent animals.

I believe that sexual dimorphism or polymorphism whether of the sexual organs themselves or of sexual individuals is fundamentally of the same nature as vegetative dimorphism. There is nothing more extraordinary in the difference between male and female or between the staminate and carpellate flower of a monœcious plant than there is in the vegetative dimorphism to be seen in such plants as the Mermaid-weed (Proserpinaca palustris), Bidens beckii, or other similar forms. The same phenomena are seen in the change of a root to a shoot or vice versa. Root and shoot hereditary characters are present in both parts but only one group is active under a given set of conditions.

SEX RATIO.

We are wont to assume that the ratio of the sexes is about equal and this seems to be the case in the higher animals. For some plants, however, it is very wide of the mark. Take for example the gametophytes of Selaginella kraussiana: every cone produces one megasporophyll and about 18 microsporophylls. The number of microsporophylls varies somewhat. Now normally each megasporophyll produces four megaspores all from one megasporocyte. There are several megasporocytes but one destroys the others in its development. In the microsporangia, on the other hand, there are numerous microsporocytes each of which produces 4 microspores. The ratio between the spores is therefore 4: 18x4n, n representing microsporocytes. Roughly speaking the ratio is sometimes as high as 1:5000. Since the megaspores produce females only and the microspores males only, the ratio of the spores is also the ratio of the gametophytes coming from them. Now this ratio, as will appear later, is fixed by some process which takes place in the nuclei of the sporophyte during vegetative growth before the reduction division has been accomplished.

In the case of the staminate and carpellate sporophytes of the common hemp, the following condition has been found by ordinary statistical methods. Hayer discovered by examining 40,000 plants of Cannabis that there were 100 staminate to 114.93 carpellate individuals; Haberlandt in Austria found the ratio in the same species to be 100 staminate to 120.4 carpellate plants; while Fisch counting 66,000 plants at Erlangen found a ratio of

100 staminate to 154.24 carpellate individuals. Noll in experiments with hemp found that the percentage of staminate and carpellate offspring derived from the seeds of a single plant varied materially from the normal ratio whatever that may be. In some extreme cases only 10% were carpellate, in others 90% were carpellate. He concluded that the egg does not determine the ratio, otherwise there would not be such extreme variation. Then he crossed individual carpellate plants with pollen from a single anther with the result that the ratio of the offspring showed a very close approximation to the normal. A plant crossed with pollen from a single anther produced 100 staminate to 117.3 carpellate offspring while a plant crossed with pollen from a single inflorescence produced 100 staminate to 121.6 carpellate offspring. Noll concluded from these experiments that the ratio of staminate to carpellate plants in the offspring is determined by the sperm in the pollengrain and not by the egg. But I fail to see any evidence whatever for such a conclusion; even were the ratio 1:1 in the first case and 1:1.5 in the second. If the ratio is determined by the sperm, why should there be any difference in behavior between pollen taken from one anther and pollen taken from an indefinite number of anthers from various individuals, when a certain per cent. of the pollengrains from each anther is supposed to contain the male determining characters and the remainder the female? So far as we know the cell changes in all the anthers is essentially the same. There is nothing in fact on which to establish a case, for the ratios Noll determined in his experiments are far within the ratios obtained in nature by the statistical method. If the difference obtained proves anything at all, which is very doubtful, it shows merely that the sperms or eggs of some individuals or some flowers are more prepotent than others. In the case of the hemp, all we can say at present is that the ratio between staminate and carpellate plants seems to be exceedingly variable. The sex tendency may be so evenly balanced that some small external or internal factor may determine the condition. Thus under a normal environment the ratio should be rather constant in the numbers of carpellate and staminate plants.

In the pine which is monœcious, the staminate cones are greatly in excess of the carpellate and the enormous difference in the number of male and female gametophytes is again, as in Selaginella, determined by the spores which in turn are predetermined in the floral branches. For normally all the sporophylls of a cone are of one type. Here then the future sex is determined even in the incipient flowers from their very nature and position on the branch. In rare cases the determination may not be complete. Part of the cone may be carpellate and part staminate as reported by Fischer. Here the fixing of the sex tendency was evidently delayed to a later stage than usual.

In the flowers of the higher plants, the organs which produce the spores in which the sex of the gametophyte is determined are sometimes variable and sometimes constant. In the lower forms the numbers are usually exceedingly variable, as for instance in Sagittaria latifolia. In the more highly developed forms the numbers are very constant as in a lily where there are nearly always six stamens to three carpels. Since the males produced in a stamen are fairly constant in number and also the females in the carpels the sex ratio of the gametophytes would be 6 x males: 3 y females, x being a much larger number than y.

The ratio of Selaginella kraussiana has been given above. On some Selaginellas as S inaequalifolia, according to the illustrations, the number of microsporophylls and megasphorophylls seems to be about equal. Here then the proportion of females to males produced must be much larger than in S. kraussiana, provided the microsporangia produce approximately equal numbers of spores in the two species. Selagnella rupestris, according to Miss Lyon, produces strobili or cones on the new vegetative shoots in late summer and autumn. Only megaspores develop that season and in these the gametophytes reach the stage bearing archegonia. In the spring the cones resume their special growth and the first microspores appear. Thus each cone has a basal zone of megasporangia, approximately six months old, and above it a narrow region of microsporangia. The number of microsporangia appears to be strictly limited, usually 8-12. Thenceforth so long as the cone continues to grow during the remainder of that season megasporangia only are developed. Here then sex determination goes parallel with the seasons. And it is interesting to note that male and female producing spores are developed in much the same way as the alternate zones of sporophylls and foliage leaves in some Lycopods.

These examples show that sex determination goes on without any reference to a reduction division or to the segregation of sex-determining bodies. Either directly or indirectly the control of sexuality may be dependent on the seasonal environment in exactly the same way as foliage leaves and scale leaves are determined in harmony with seasonal conditions on a woody twig.

SEX CONSTANCY.

In some organisms, it does not seem possible to change the sex by any known manipulation when once determined. So long as the individual continues, either directly or through vegetative propagation the sex remains the same. This has been found to be the case in the gametophytes of Marchantia for example. In these gametophytes the haploid number of chromosomes is present and they are always strictly male or female. In related Bryophytes the gametophytes, also with the haploid number of chromosomes, are hermaphrodite. Therefore the haploid and diploid, or the x and 2x, condition of chromosomes has nothing to do primarily with the determination of the sexual condition. And because the sexual condition cannot be changed means no more in the given case than that certain leaves have lost the power of reproduction while others have not. There is no structural difference in the hereditary apparatus so far as our cytological knowledge goes but only a difference of conditions. The latency of the opposite hereditary tendency is to all appearances complete.

In some ferns the gametophytes, normally hermaphrodite, can be kept as males or females by a proper control of the environment. In Equisetum arvense, the gametophytes are unisexual, the male gametophytes are the smaller while the larger females are also more branched. There is thus a normal sexual dimorphism of the vegetative body. The thalli are influenced to a certain extent by external conditions and unfavorable conditions of nutrition tend to increase the proportion of males. But what is still more important, it has been demonstrated that Equisetum thalli which have developed ovaries, namely developed as females, can by insufficient nutrition be forced to produce spermaries. It is evident, therefore, that the thalli have not developed unisexually, as male or female, through some inherent difference in their constitution nor through the loss of male or female sex determining characters, but rather that one set of tendencies has become latent while the opposite set is active. The latency is however not permanent but can be overcome by a proper environment.

E′. and E′. Marchal have shown that in certain mosses, Barbula unguiculata. Bryum argentium, and Ceratodon purpureus, the gametophytes are strictly male and female and are produced in equal numbers from the spores of one sporangium. Now these mosses may regenerate secondary protonemata from fragments of the gametophyte, stem, scale or rhizoid, and in every case the sex character is faithfully continued. The sex could not be changed by varying the conditions of environment. By regenerating parts of the sporophyte which has the diploid number of chromosomes the Marchals obtained protonemata which are hermaphrodite rather than unisexual as those produced from the spores or gametophytes. The great majority, however, showed only male characters and a few developed only female characters. But the one sex was only latent as was shown by the possibility of obtaining hermaphrodite individuals again from these diploid, unisexual forms.

Now it is evident that two interpretations may be made of these phenomena. First, the spore gametophytes which were apparently unisexual contained the characters of both sexes, one set being latent; second, the hereditary characters of one sex only were present. The Marchals adhere to the second hypothesis. Were this the condition of things generally, one might agree with the conclusion, but since we have exactly the opposite condition in the Pteridophytes the hypothesis is probably incorrect even for the cases where it seems to fit. And certainly the production of some unisexual individuals among the abnormal gametophytes developed from the sporophyte, notwithstanding the fact that both sex tendencies were present and should have produced hermaphrodites, clearly points to the simpler explanation, namely, that the unisexual condition in both cases was brought about in the same way. To my mind the experiments indicate just the opposite from the conclusions drawn. If all the diploid individuals had been hermaphrodite the case would have been somewhat stronger. Even then the hypothesis would not necessarily follow that male and female hereditary characters were separated by the reduction division. For reduction might be merely the cause of the latency of one tendency or the other in chromosomes possessing both qualities.

As stated, in the homosporous pteridophytes the haploid gametophytes are mostly hermaphrodite, so it is certain that no sexual tendencies are segregated in reduction. Now is it not self-evident that in haploid hermaphrodite gametophytes at least so far as the evidence goes at present, both maternal and paternal sets of chromosomes have similar hereditary characters? Are not sexual peculiarities for the most part simply modifications in development of the general hereditary characters of the body which may produce a male-like, a female like, or a neuter-like type of structure depending on certain conditions of internal or external environment. Even Wilson, who has probably gone farthest in finding a specific difference between male and female insects, says that male and female are but relative terms. One need only recall the influence of emasculation on some of the higher animals to be convinced how important some more or less remote influences may be in determining the development of secondary sexual characters.

There are few plants that are strictly dioecious. In the willows and mulberries for example the sporophytes are frequently bisphorangiate. In all such plants therefore the hereditary characters are present which are able to produce the staminate or the carpellate condition or both on the same individual.

In most of the monœcious and diecious flowers also there are some vestiges of the opposite set of organs. The gametophytes of heterosporous plants are however all strictly unisexual The nature of the spore determining the condition definitely and this unisexuality is produced entirely apart from the reduction division.

In Salix petiolaris, Chamberlain found microsporangia growing in the ovulary of the carpel. In the microsporangia borne inside of the ovularies the microspore development was sometimes normal, but was as often feeble and abortive. In ovularies which contained microsporangia, the ovules were sometimes orthotropous, and had the integument developed all around. The megaspore development was normal and embryos were not uncommon. Now this is certainly an important case, for it shows that even in the very organs differentiated to produce the one or the other set of spores, the hereditary characters are not always completely controlled. Something overcomes the dominance of the characteristic tendency and thus permits the opposite tendency, which has no phylogentic basis in the hereditary characteristics of the organ, to come to expression. But this is after all no more remarkable than many other vegetative expressions, as stamens changing to petals, leaf-blades of Botrychiums developing as sporophylls, and many other peculiar developments that might be mentioned.

One of the most interesting cases on record in the change of the sexual condition is that of the tropical papaya (Carica papaya). This is a dioecious species but it has been found that if one of the staminate and therefore unfruitful trees has its terminal bud removed it soon begins to produce carpellate fruits.

This experiment suggests that there may be many methods of manipulation, which might be employed for changing the sexual condition, that have not yet been tried on favorable subjects.

Braem reports a somewhat similar case for a worm.

Ophryotrocha puerilis is usually unisexual but occasionally hermaphrodite. Braem halved a female with ripe eggs. The head portion with 13 segments was isolated and in three weeks it had regenerated 7 segments. The ova had disappeared from the gonads and a functional spermary had developed which was producing spermatozoa. Braem thinks that the very young indifferent germ cells had developed as male cells in consequence of the amputation. There was no trace of hermaphroditism. It is certain, therefore, that the gonads changed from an egg-producing to a sperm-producing tissue.

In dioecious plants also where some of the imperfectly carpellate individuals have bisporangiate flowers, poor nutrition, induced by various causes, lessens the proportion of bisporangiate flowers. Correns found that in Satureia the production of a greater or less number of carpellate or bisporangiate flowers is dependent upon nutrition in its widest sense, notwithstanding that he believes sex is determined in Mendelian ratio.

All the known facts clearly indicate that various external and internal conditions, are able to influence the *expression* of hereditary characters, although they may not affect the *transmission* of characters. This has lately been emphasized by O. F. Cook.

Differences of heat, light, food, chemicals, and internal secretions are known to induce changes in the expression of characters. The necessary presence of the thyroid gland in man, the presence of the spermaries in the higher animals, the influence of gall producing organisms on the higher plants, the effect of scions on the character of the roots on which they are grafted, all show how expression of hereditary characters can be changed in the individual. A remarkable fact in support of the proposition that the morphological expression of sexuality is the result of a condition is presented by the known cases of sterile female birds which sometimes take on the male plumage. All these phenomena appear to indicate that sexual characters are a common inheritance, there being no female hereditary characters as such nor male characters, but general characters which may be expressed in one form or another during development from the egg on up to the death of the individual.

TIME OF DETERMINATION OF THE SEX OF THE INDIVIDUAL.

Nothing in biology is more definitely established than the fact that there is no definite or special time common to all organisms at which the sexuality of the individual is determined. It may be in the vegetative cells before the sporocytes are produced, in the development of the sporocytes themselves, in the daughter cells of the sporocytes, or at some later stage. In the case of organisms with the diploid number of chromosomes, the sex may be determined in one of the gametes before fertilization, and for the individual, therefore, at the time of fertilization, or in certain species at some subsequent time.

In speaking of the determination of sex, one must not forget that there are a number of types of sexual individuals,—namely, haploid males, females, and hermaphrodites; diploid males, females, and hermaphrodites; and of heterosporous sporophytes there are diploid microsporangiate, megasporangiate, and bisporangiate individuals. Through parthenogenesis there are possibly also haploid microsporangiate, megasporangiate, and bisporangiate individuals. In all critical discussions these different categories must be clearly distinguished before generalizations can be made.

Recently the opinion has several times been expressed that it is wrong to compare hermaphrodites which have in a given case developed but one sex with what are supposed to be true unisexual forms. But the stand does not seem to be well taken. We have all gradations between normal hermaphrodites and true unisexual gameophytes as well as between bisporanglate and monosporangiate sporophytes. Many of the discussions on sex-heredity are confused because the authors fail to recognize the logical homologies between sexual and nonsexual plants and animals. The most common mistake along this line is in regard to the haploid gametophyte generation which has no clear homolog among the animals. The same confusion exists in regard to the reduction division. Many are not able to get beyond the erroneous idea that the reduction division must in some way be a maturation division when in most plants it has nothing whatever to do with the development and ripening of gametes.

But to return to the question of sex determination; in Isoetes, according to Smith, each leaf bears but one sporangium and the sporangia are apparently all alike in the early stages. Up to the time when the archesporium is 8 to 10 cells deep in cross section there is no histological feature by which one may determine whether a given sporangium will produce microspores or megaspores. The first changes to be seen that mark the microsporangium are those which lead to the differentiation of the sporocytes. The sex of the future gametophytes is, therefore, determined in the early stages of the sporocytes if not earlier. The nature of the sporophylls of Selaginella kraussiana must be determined in the incipient stage, for the one megasporophyll always has a definite position in relation to the numerous microsporophylls.

As far back as 1881, Prantl found that if fern thalli are cultivated with aboundant nutriment, only ovaries are developed, while with poor nourishment spermaries are formed. The sex of these potentially hermaphrodite juvenile individuals is thus determined by their environment during vegetative growth. Moreover, by keeping them in suitable conditions they may be kept as male and female, the ordinary hermaphrodite tendencies never coming to expression.

Douin finds that in the unisexual liverwort, Sphaerocarpus terrestris about 75 per cent. of the spore tetrads clearly show two males and two females. There were, however, several cases clearly anomalous. One group of two tetrads had five males and three females. Another tetrad had three males and one female, and two others had one male and three females. Apparently the sex in this plant is determined at the time of the reduction division. But I do not think that the 75 per cent. is high enough to warrant a final conclusion. At least 90 per cent. of the tetrads should be taken into account before one could make any decided claims. But it may well be that the sex is determined at the first division without any definite shifting of hereditary characters. The anomalous cases can also be explained as examples of abnormal latency or activity. Probably with a large number of cultures properly controlled, one could find tetrads giving rise to all males or all females. One can simply say that in Sphaerocarpus sex determination is usually coincident with reduction. To say that it is caused by a definite segregation during reduction of male and female hereditary units is another proposition. Closely related Bryophytes are hermaphrodite after reduction. It must be clearly kept in mind that when plants finally developed a condition of complete unisexuality in the heterospores groups it was accomplished without any reference to a segregation in the reduction division. This is the one great fact that stands out most prominently. The final evolution of a definite sex determining process was accomplished independently of the reduction division and therefore independently of any known segregation of material hereditary units or determinants. Maternal and paternal chromosomes do not determine sex whatever determining factors may be present, the only visible and known difference in the male and female producing microspores and megaspores of higher plants is a difference in size of the cell together with a difference in the amount of cytoplasm and included food materials. If it can be shown that sex is determined independently of reduction in a large number of cases then it is reasonable to demand that the opposite assertion be established with indubitable proofs.

Not only does the double or single number of chromosomes appear to have nothing to do with sex determination, but according to Yamanouchi, the apogamously produced sporophyte of nephrodium, which shows constantly the x or gametophytic number, looks like the ordinary 2x or diploid sporophyte, resulting from fertilization. It is evident, therefore, that the single or double number has little influence upon the general appearance of the plant. The conclusion follows that both the maternal and paternal chromosomes have all the ordinary hereditary units of the species. And since it is known that paternal and maternal equivalents conjugate in the formation of the bivalent chromosomes, it follows that no difference how the univalents are segregated, each daughter nucleus will still have all the types of true chromosomes and so the complete inheritance of the race, including sexual tendencies.

If one thinks of organisms as continuous developments from generation to generation and each individual as a branch from the main axis of progression, then sex in most cases becomes simply an individual expression of a more general inheritance, in many cases even an alternative expression when female determining cells give rise to males or vice versa. The alternative expression is then probably of the same nature as alternative expression in the formation of leaf and flower shoots in a branching plant.

SEX PRODUCING NUCLEAR BODIES.

In a large number of insects belonging chiefly to the Hemptera and Coleoptera a definite chromosomal difference has been found between the male and female. The "accessory chromosomes" or allosomes are so distributed at the time of the reduction division that all the eggs are alike while the sperms are of two kinds. The chromosome group of one of the two types of sperms is like that of the egg, and when such a sperm fertilizes an egg a female zygote is produced. The other type of sperm has a chromosome group unlike that of the egg and produces a male zygote in fertilization. An attempt has been made to find similar peculiarities in plants but so far without success. I shall touch but briefly on the presence of these sex-determining bodies as discovered by McClung and worked out for many species by Stevens, Wilson, Montgomery, Morgan, and others. These "accessory chromosomes," "idiochromosomes," or allosomes as Montgomery calls them are said generally to arise from or to be closely connected with a chromatin nucleolus. Now in plants, at least in all cases where the objects are of such size and distinctness as to warrant definite conclusions, the chromosomes come from the chromatin network. If then the allosomes are a type of body related to the nucleolus, we may regard their presence as influencing nutritive functions and in some such way controlling sex. If the allosomes are not derived from the chromatin network they need not be considered as special bearers of hereditary characters. They may be put in the same category as nucleoli, centrosomes, plastids, etc. Their presence may have an influence on the chromosomes in making latent or setting free certain hereditary peculiarities which control sexual development. We can, with all the evidence so far brought to light, still say that maleness or femaleness is a condition and not a simple character. Nevertheless the presence of such bodies is an exceedingly interesting biological fact.

According to Wilson the known cases of sexual differences of chromosome groups, where allosomes or "idiochromosomes" are present, fall into five classes as follows:

1. "Both sexes with the same number of chromosomes, a pair of equal idiochromosomes present in both. No visible difference between the two classes of spermatozoa or between the male and female somatic groups."

2. "Both sexes and both classes of spermatozoa with the same number of chromosomes; the male with a pair of unequal idiochromosomes, half the spermatozoa receiving the large one and half the small one."

3. "The female chromosome group with one more chromosome than the male. The male with an unpaired idiochromosome and an odd spermatogonial number, half the spermatozoa receiving the idiochromosome and half being without it."

4. "Female group (by inference only) with two more chromosomes than the male. In the male a pair of unequal idiochromosomes, half the spermatozoa receiving both these idiochromosomes, and hence two more than the other half."

5. "Female group with three more chromosomes than the male. Half the spermatozoa receiving three more chromosomes than the other half."

Wilson is very careful to say that the two kinds of spermatozoa are female — and male-producing and not female — or male-determining.

The allosome appears to be one of a number of external and internal influences which accomplish sex determination, and it is probable that this influence is brought about either directly or indirectly by a stimulus on the hereditary apparatus, the result of the stimulus showing itself in large and small spores, large and small gametes, or male and female individuals.

But great caution must still be taken lest we be led away by this seemingly clear case of sex-producing bodies in the gametes of insects and other animals. The difference may after all be only a coincidence to the sex-determining factor, and this really appears to be the case according to some recent investigations by Morgan. In the phylloxerans which are gall-insects of the hickories, the fertilized eggs produce only females. This results because only functional female-producing spermatozoa are formed — the male-producing sperms degenerating. The females that result from the fertilized eggs produce subsequently both males and females parthenogenetically. Without going into the complicated history of the development of the various generations in the life cycle a few prominent facts may be pointed out. In the two species, Phylloxera fallax and P. caryaecaulis, male eggs and female eggs are determined as such before there is any loss of chromosomes. The total number of chromosomes is present, yet one egg is large and the other small. The preliminaries of sex-determination for both sexes go on in the presence of all the chromosomes. The large eggs produce females, the small males. The male animal itself is produced only after the elimination of two of the chromosomes, but the sexual female and the parthenogenetic female are both produced in the presence of all the chromosomes. It is apparent that we have here something like in the heterosporous plants. Sex is determined before the reduction division and the two sizes of eggs are significant when compared with microspores and megaspores. In Phylloxera caryaecaulis a large preponderance of male producers are developed. When it is recalled that all the descendants can be traced to a single egg fertilized by a "female-producing" sperm the results are very significant. Either external conditions determine the result or else there is a strong "prepotency" of the egg or sperm in one or the other direction. Certainly these gall-insects show that the allosomes are not sex-determining bodies per se and this is still further established by the fact that the division into male and female layers takes place one generation prior to the formation of the sexes. The evidence which Morgan thus gives from the animal side is in complete agreement with that presented by the heterosporous pteridophytes. We must at present, therefore, regard the allosomes as sex-indicating rather than sex-determining or sex-producing bodies.

SPECIAL VIEWS REGARDING SEX-INHERITANCE.

Guyer reports that pheasant hybrids are almost all males and suggests that their sex is due to incompatibility of the germ plasms. The known hybrids resulting from a crossing of guinea fowls and ordinary chickens are also all males. He says that in the case of hybrids and particularly those from widely separated parents, there would in all probability be more or less default in the metabolic processes because of the incompatibilities which must necessarily exist between two germ-plasms so dissimilar.

Kauffman studied the water molds, Saprolegniaceae, with especial reference to the variations of the sexual organs. He holds that sexuality can be controlled by external conditions.

Maud and Raymond Pearl made a statistical study based on 200,000 births in Buenos Aires. They show that there is a markedly greater preponderance of male to female births in children born of parents of different races. This seems to be in agreement with the results obtained from hybrid pheasants.

Among botanists, Strasburger, Correns, and Noll believe that the egg tends to produce females. If this were really the case, the reduction division could have nothing to do directly with sex-determination in the heterosporous plants, since no allosomes are known to be present and the eggs are vegetative descendants of spores produced through reduction. But on the other hand, they think that the reduction division in the microsporocyte separates male tendencies of unequal vigor so that in dioecious plants two microspores of a tetrad will give rise to male gametophytes with sperms which in fertilizing the egg are prepotent over the female tendency and so will produce staminate plants; the other two microspores will give rise to gametophytes whose sperms are not able to overcome the female tendency of the egg and hence will produce carpellate plants.

Correns supports his hypothesis by results obtained through studies of Bryonia dioica and other plants. He believes that the egg always carries the same sex tendency, namely to produce females are more properly speaking carpellate plants, while the sperms are of two kinds, half bearing the female and half the male (staminate) tendency. The male tendency dominates over the female. The females are therefore, homozygous (female + female) with respect to sex; the male are heterozygous (female + male) with respect to sex. In other words, the female is a homozygous recessive while the male is a heterozygous dominant. But if the observations on bees are correct, then the egg must have the male tendency; for all parthenogenetic developments among the common honey bees result in males.

According to Castle, the female is the male condition plus something else, i. e. a distinct unit character Mendelian in heredity. Maleness is not, then, the Mendelian allelomorph to femaleness, but a differential factor between male and female is allelomorphic to absence of that factor. Presence of the factor then means femaleness, absence of it means maleness. The differential factor is supposed to be inherited as a Mendelian character dominant over its absence. But it must be remembered that both sexes develop peculiarities absent in the other and the male has usually more than the female. The sex determination simply causes one or the other set of peculiarities to appear.

Castle concludes among other things that sex is not directly controlled by the environment but is determined by internal (gametic) factors. But this does not harmonize with the facts presented by the homosporous and heterosporous pteridophyte gametophytes. Castle's further statement that the determination of sex depends upon the presence in the zygote of a factor or factors which are inherited in accordance with Mendel's law cannot hold for the heterosporous pteridophytes, for the zygote produces a bisporangiate plant and the sex of the gametophyte is determined independently of the reduction division not in a Mendelian ratio but in some species in the proportion of 5,000 males to one female.

According to Wilson, the eggs are all alike, while the spermatozoa are of two sorts half bearing the same character as the eggs and half being without it. But Bateson and his associates find that in the moth Abraxas grossulariata and in a canary bird studied by them, the eggs are dimorphic in sex tendency whereas the spermatozoa are all alike.

The apparently antagonistic results brought to light are really only antagonistic when viewed from the standpoint of the several contradictory hypotheses of sex-determination. If we take a reasonable view of sexual inheritance, regarding it as a common inheritance of the race which may express itself in one way or the other, as ordinary vegetative characters, the peculiarities presented will be readily explained on the same basis as the various vegetative polymorphisms to be found in the higher plants, the play of hereditary factors and the result of hereditary expression being much greater than what is shown by Mendelian inheritance.

GENERAL CONCLUSIONS.

The principles maintained in the foregoing discussion are either based on or lead to the following general conclusions and hypotheses:

1. Every cell of an organism contains all the general hereditary characters or units of the entire individual body.

2. Only a part of these characters come to expression at any given stage of development.

3. Some hereditary characters are common to all the organs or parts of the hereditary apparatus, others to individual chromosomes.

4. Peculiarities of form and function come to expression by the combined activity of groups of cells as well as by the

activity of chromosome groups, of individual chromosomes, or of smaller heredity-bearing units.

5. Hereditary tendencies may be dominant or recessive in respect to each other; they may be dormant or active through the influence of environment; or they may work together or influence one another in such a way that a strange or new structure appears.

6. Sexuality expressed as maleness or femaleness, whether in gametes, sexual organs or individuals is a condition and not a character, and the development of a cell as an egg or a sperm does not destroy its power later, parthenogetically, to produce the opposite sex.

7. Fertilization was primarily not a stimulus to further growth; conjugation was primarily not a mode of reproduction, nor was sexuality primarily developed as a means to variability.

8. Sex may be determined sometime before reduction and thus independently of any process going on during either a vegetative or reduction karyokinesis; it may be determined during the reduction division; it may be determined during the fertilization stage; or finally it may be determined after vegetative growth has begun.

9. In some cases, when the sex is once determined it cannot be changed in the vegetative body nor in any negative spore or propagative bud; in other cases, it may be changed in the vegetative body after being developed as male or female.

10. The sexual ratio is not Mendelian in the gametophyte and apparently not in the sporophyte.

11. The most prominent fact in the differentiation and evolution of unisexual gametophytes in the higher plants is that although the entire mechanism of reduction was well developed, nevertheless the separation of the sexes was accomplished entirely independently of reduction by a differentiation of large, female-determining, and minute, male-determining spores.

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THE FAUNA OF THE MAXVILLE LIMESTONE

BY

WILLIAM CLIFFORD MORSE

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ILLUSTRATIONS.

THE

FAUNA OF THE MAXVILLE LIMESTONE.

WILLIAM CLIFFORD MORSE,
Ohio State University.

INTRODUCTION.

The present paper represents the final results of a study of the Maxville limestone begun in 1906, the historic, stratigraphic, and economic portions of which are soon to appear as Bulletin 13 of the Geological Survey of Ohio. In that publication it was shown that the region of outcrop of the limestone is naturally divisible into three parts, a Northern Area, a Central Area, and a Southern Area, and that in the stratum itself, in many places, may be recognized three divisions, a lower zone, a middle (shale-nodular) zone, and an upper zone. The Northern Area extends from a point near Zanesville on the north to one near Logan on the south, and contains the best exposures of the limestone. The Southern Area reaches from Hamden on the north to the Kentucky side of the Ohio River on the south, and has but a few widely separated exposures. The Central Area lies between the other two and so far as known contains no exposures. The limestone of the lower zone is an impure one, nearly destitute of regular bedding planes, poor in fossils, and about twenty-five feet in thickness. The middle zone is about three feet thick, and consists of alternating nodular-like layers of limestone and thin intervals of shale, both of which are fossiliferous. In the upper zone, the maximum thickness of which is twenty-two feet, the fossils are common, the limestone purer, and the medium layers are separated by shaly partings in such a manner that the stratification is the conspicuous feature.

Twenty-four species of fossils from the Maxville limestone have been described and illustrated by Whitfield. The present study has resulted in the discovery of twelve additional species which are new to the stratum. Pursuant to the original idea of making the report as complete as possible, these thirty-six species are described and illustrated in the following pages, and with the exception of those after Whitfield the illustrations are either camera lucida drawings or actual photographs by the author.

The bibliography of each species has been made as complete as possible simply for convenience, and in questions of synonomy the arrangement in Weller's Bibliographic Index of North American Carboniferous Invertebrates has been followed. The horizon and locality from which the described specimens came have also been added to the bibliography so that a glance would suffice to show both their geologic range and geographic distribution.

Although sections have been made at practically all of the places mentioned in the following "Table of Distribution" and each one carefully located in Bulletin 13, it will probably be more convenient for some readers if the location of each be again briefly described. With the exception of the Harper Shaft, which is near Olive Furnace in the Southern Area, all of the localities are in the Northern Area. Of those along Jonathan Creek, the Bridge Gully, Cuts No. 2 to No. 6, and the Mouth of Hough Hollow are between Mt. Perry and Fultonham, the Mouth of Buckeye Fork and the North Bank are just below Fultonham, and Gladstone Mill is at White Cottage. The Kroft Residence, the Kroft Bridge, and the Thompson Residence are located along the lower portion of Kents Run within a mile of White Cottage. West Jockey Hollow crosses the "State Road" at a point about three and a half miles east of Rushville and the Folk Quarry is located on the Zanesville and Maysville Pike a like distance east of the same village. The Stimmel Residence is about a mile north of Maxville and Smith Chapel about two miles south-east of Logan.

Table of

	Species.	Upper Zone.																							
		Jonathan Creek.											Kents Run.				Rush Creek.		Little Monday Creek.	Three Mile Run.	Jonath				
		Bridge Gully.	Cut No 2.	Cut No. 3.	Cut No. 4.	Cut No. 5.	Cut No. 6. Upper end.	Cut No. 6. Middle.	Mouth of Hough Hollow.	Mouth of Buckeye Fork.	North Bank.	Gladstone Mills.	Kroft Residence.	Kroft Bridge.	Thompson Residence.	Below Thompson Residence.	West Jockey Hollow.	Polk Quarry.	Stimmel Residence.	Smith Chapel.	Bridge Gully.	Cut No. 2.	Cut No. 3.	Cut No. 4.	Cut No. 5.
1.	Zaphrentis cliffordana									X		X													
2.	Pentremites elegans									X															
3.	Cyathocrinus maxvillensis									X															
4.	Septopora rectistyla																								
5.	Fenestella serratula																								
6.	Rhombopora armata																								
7.	Derbya crassa									X		?			?	X									
8.	Productus pileiformis									X		X			X	X									
9.	Productus cestriensis											X			X	X				X					X
10.	Martinia contracta									X		X			X	X									
11.	Spirifer keokuk									?		X			X										
12.	Dielasma turgida											X			X	X									X
13.	Seminula subquadrata											X			X										X
14.	Eumetria marcyi																								
15.	Cleiothyris hirsuta																								
16.	Schizodus chesterensis															?									
17.	Pinna maxvillensis														X										
18.	Allorisma andrewsi											X			X										
19.	Allorisma maxvillensis															X									X
20.	Cypricardella oblonga																								
21.	Dentalium illinoiense																								
22.	Straparollus similis									X		X				?				X					X
23.	Holopea newtonensis																								
24.	Bulimorphia melanoides											?				X									X
25.	Bulimorphia canaliculata																								
26.	Sphærodoma subcorpulenta															X									
27.	Naticopsis ziczac															X									X
28.	Bellerophon alternodosus																								
29.	Bellerophon sublævis										X	X		X	X	X				X					X
30.	Orthonychia acutirostre																								
31.	Strophostylus carleyana																								
32.	Murchisonia vermicula																								
33.	Endolobus spectabilis																								
34.	Nautilus pauper									?						?									
35.	Orthoceras randolphense																								
36.	Orthoceras okawense?																								

stribution.

Shale-Nodular Zone.												Lower Zone																				
reek.				Kents Run.				Rush Creek.		Little Mon-Day Creek.	Three Mile Run.	Jonathan Creek.											Kents Run.				Rush Creek.		Little Mon-Day Creek.	Three Mile Run.		
Mouth of Hough Hollow.	Mouth of Buckeye Fork.	North Bank.	Glad-stone Mills.	Kroft Residence.	Kroft Bridge.	Thompson Residence.	Below Thompson Residence	West Jockey Hollow.	Folk Quarry.	Stimmel Residence.	Smith Chapel.	Bridge Gully.	Cut No. 2.	Cut No. 3.	Cut No. 4.	Cut No. 5.	Cut No. 6. Upper end.	Cut No. 6. Middle.	Mouth of Hough Hollow.	Mouth of Buckeye Fork.	North Bank.	Gladstone Mills.	Kroft Residence.	Kroft Bridge.	Thompson Residence.	Below Thompson Residence	West Jockey Hollow.	Folk Quarry.	Stimmel Residence.	Smith Chapel.	Cut No.6 (Middle of) Lower and Shale-nodular zones.	Harper Shaft.
												X		X																		
					X																											X
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DESCRIPTION OF SPECIES.

PHYLUM CŒLENTERATA.

CLASS ANTHOZOA.

ZAPHRENTIS CLIFFORDANA—Milne-Edwards and Haime.

1851. *Zaphrentis cliffordana.* Milne-Edwards and Haime, Monog. des Polyp. Foss., p. 329, pl. 3, fig. 5.
Carboniferous: Buttonmould Knobs, Mammoth Cave, and Grayson County, Kentucky.

1860. *Zaphrentis cliffordana.* Milne-Edwards, Hist. Nat. Corr., Vol. III, p. 337.
Carboniferous: Kentucky.

1890. *Zaphrentis cliffordana.* Worthen, Geol. Surv. Ill., Vol. VIII, p. 75, pl. 10, figs. 1, 1a, 1b.
Kinderhook group: Monroe County, Illinois.

1891. *Zaphrentis cliffordana.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 576, pl. 13, figs. 1-3.
Maxville limestone: Maxville and Newtonville, Ohio.

1895. *Zaphrentis cliffordana.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 465, pl. 9, figs. 1-3.
Maxville limestone: Maxville and Newtonville, Ohio

1909. *Zaphrentis cliffordana.* Grabau and Shimer, N. A. Index Foss., p. 58.
Lower Carbonic.

FIG. 1.—*Zaphrentis cliffordana.*
a.—View of a specimen showing the interior of the calyx.
b.—Lateral view of another specimen showing the curvature of the cone.
c.—Transverse section of a specimen just beneath the calyx, enlarged. (After Whitfield.)

Description.— Corallum a small, curved, tapering cone with a deep calyx. Epitheca thin, and generally shows the edges of the septa. Primary septa thirty to thirty-six in number, and of nearly equal strength. Secondary septa rudimentary, equal in number to the primary. Fossula on the side of least curvature. Disseppiments not so distinctly developed as the primary septa.

Length 17 to 33 mm. Greatest diameter 15 mm.

This coral is characterized by its small size, curved cone, thin epitheca, which exposes the septa, and in cross section by the equal development of the primary septa.

Horizon and locality.—Maxville limestone.

Upper zone: Mouth of Buckeye Fork, Fultonham; Gladstone Mills, White Cottage.

Lower zone: Bridge Gully, Cut No. 3, Mt. Perry-Fultonham.

PHYLUM ECHINODERMATA.

CLASS BLASTOIDEA.

PENTREMITES ELEGANS—Lyon.

1858. *Pentremites elegans.* Lyon, Trans. St. Louis Acad. Sci., Vol. I, p. 632, pl. 20, figs. 4a-c.
Millstone grit: Near Grayson Springs and Litchfield, Kentucky.

1891. *Pentremites elegans.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 577, pl. 13, fig. 4.
Maxville limestone: Newtonville, Ohio.

1895. *Pentremites elegans.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 466, pl. 9, fig. 4.
Maxville limestone: Newtonville, Ohio.

1909. *Pentremites elegans.* Wood, U. S. Nat. Mus., Bull. 64, p. 14, pl. 2, figs. 10-12.

Description. — "Body small, broadly subpyriform, the length equal to about once and a half the height, but somewhat variable with age; the greatest width being at the base of the ambulacral areas, or considerable below the middle of the height, the outline of the lower portion being nearly straight lines, or a little concave between the base of the ambulacral areas and the lower extremities of the basal plates, while above the form is generally rounding or convex. In a basal view the form is pentangular, and viewed from above somewhat pentalobate; the ambulacral areas being slightly sulcated. Basal plates small, extending to rather less than half the height of the body below the base of the areas, and in their lower half are somewhat more attenuate than above, the cicatrix for the attachment of the column being very small. Forked plates elongated, and the sinus very broad and deep; the length of the plates being equal to more than once and a half their greatest width, and their summits slightly truncated for the reception of the small pointed inter-

FIG. 2.—*Pentremites elegans.* Lateral view. (After Whitfield.)

ambulacral plates, which are in length about equal to one-fourth of the entire length of the areas. Ambulacral areas proportionally wide, distinctly depressed along their middle and composed, in the specimen figured, of about twenty-six pairs of transverse poral-plates, from ten to eleven of which occupy the space of an eighth of an inch in length, in the lower and middle portions, but become shorter above. Summit openings rather large, surface smooth [Whitfield, 1893]."

Horizon and locality. — Maxville limestone.
Upper zone: Mouth of Buckeye Fork, Fultonham.

CLASS CRINOIDEA.

CYATHOCRINUS MAXVILLENSIS—Whitfield.

1882. *Cyathocrinus inequidactylus.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 219, (Not *C. inequidactylus* McCoy, 1844).
Maxville limestone: Newtonville, Ohio.

1891. *Cyathocrinus maxvillensis.* Whitfield, Ann. N. Y. Acad. Sci., Vol V, p. 577, pl. 13, figs. 5-8.
Maxville limestone: Newtonville, Ohio.

1895. *Cyathocrinus Maxvillensis.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 465, pl. 9, figs. 5-8.
Maxville limestone: Newtonville, Ohio.

Description. — "Body of rather small size. Calyx deep cyathiform, being nearly hemispherical in one example, and somewhat broad abconical in another, and composed of smooth plates, which have only the general convexity of the body, or very slightly tuberose. Basal plates minute to moderate size, higher than wide. Subradials large; height and width nearly equal; two of them heptagonal and the others hexagonal, the lower sides barely diverging from a straight line. First radials wider than high, and about two-thirds as high as the subradials.

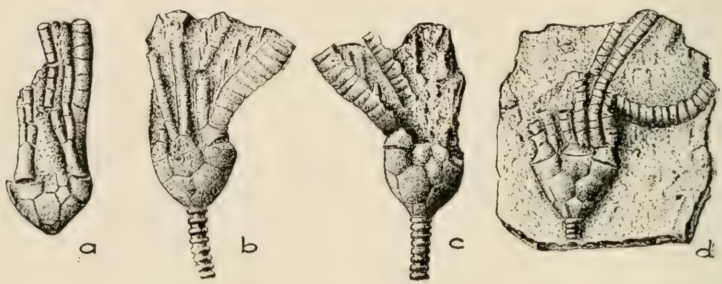


Fig. 3. — *Cyathocrinus maxvillensis.*
a. — View of the anal side of a specimen showing the long second radials, enlarged to two diameters.
b and c. — Anterior and posterior views of another specimen showing the large outer arm.
d. — Anterior view of a third specimen. (After Whitfield.)

Anals visible, three in number; the first elongate pentagonal, nearly twice as high as wide, and situated a little obliquely on the right side of the area; the other two are small and pentagonal. Second radials, or first arm plates, smaller than the first radials and narrowing upward, wedge-formed above, and each supporting two arms. On the posterio-lateral rays they are long and cylindrical, with the arms slender. On the anterior ray, it is short and supports two slender arms; while on the anterio-lateral rays they support a slender arm similar to those of the other rays on the anterior side, and on the outer side an arm several times larger and stronger than the others, and composed of larger and stronger plates.

"Plates of the arms short and unequal-sided, and giving origin to jointed tentaculæ from the longer side of each plate, which is upon the alternate sides of the arm, or on the same side from every second plate. Surface of the plates smooth. Length of the arms and subsequent bifurcation not known. Column small, round, and composed of unequal-sized plates alternating with each other.

"The slender arms are preserved on two individuals to the length of about one inch, and the strong anterio-lateral arm on one, to more than an inch; but no evidence of bifurcation appears.

"The inequality of the anterio-lateral arms will be the distinctive feature of the species, as the form of the calyx is similar to many other species of the group [Whitfield, 1895]."

Horizon and locality. — Maxville limestone.
Upper zone: Mouth of Buckeye Fork, Fultonham.

PHYLUM MOLLUSCOIDEA.

CLASS BRYOZOA.

SEPTOPORA RECTISTYLA—Whitfield.

1882. *Synocladia rectistyla.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 220.
Maxville limestone: Newtonville, Ohio.
1891. *Synocladia rectistyla.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 579, pl. 13, figs. 9, 10.
Maxville limestone: Newtonville, Ohio.
1895. *Synocladia rectistyla.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 467, pl. 9, figs. 9, 10.
Maxville limestone: Newtonville, Ohio.

Description. — Zoarium a spreading, funnel-shaped frond with a rooted base. Branches slender, straight, from 0.35 mm. to 0.40 mm. in diameter, and with bifurcations at frequent intervals. About 10 branches to each cm. Branches more or less carinate, with distant, stout, laterally compressed spines, and with a row of large apertures on either side of the carina. Dissepiments nearly as large as the branches, in some cases bent upward in the center, in others directed obliquely upward from both sides of a branch, and in still others directed transversely, and bear one to three apertures. Fenestrules more or

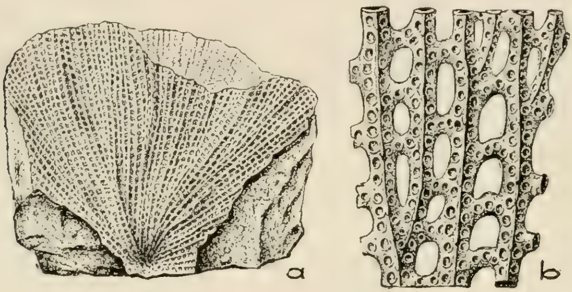


FIG. 4.—*Septopora rectistyla.*
a.—Inside of a frond, natural size.
b.—Enlarged portion showing the apertures. (After Whitfield.)

less variable and bordered, laterally, by apertures which, as a rule, are three in number. The latter are less than their own diameter apart and have a prominent peristome.

Reverse side not known.

Horizon and locality.—Maxville limestone.
Shale-nodular zone: Kroft Bridge, White Cottage.
Undetermined zone: Harper Shaft, Olive Furnace.

FENESTELLA SERRATULA—Ulrich.

1890. *Fenestella serratula.* Ulrich, Geol. Surv., Ill., Vol. VIII, p. 544, pl. 50, figs. 5-5c.
Keokuk group: Nauvoo, Illinois.
Warsaw beds: Monroe County and Warsaw, Illinois.
St. Louis limestone: Caldwell, Lyon, and Crittendon Counties, Kentucky.

1894. *Fenestella serratula.* Keyes, Mo. Geol. Surv., Vol. V, p. 23.
Keokuk limestone: Keokuk, Iowa.

1906. *Fenestella serratula.* Cumings, Ind. Dept. Geol. Nat. Res., 30th Ann. Rept., p. 1280, pl. 30, figs. 2-2c, 3-3a.
Salem limestone: Bedford, Indiana.

Description. — "Zoarium a foliar expansion, from 3 to 5 cms. in diameter. Branches rigid, small, 0.25 mm. wide, twenty-five or twenty-six in 1 cm., with a comparatively strong mesial carina, carrying small nodes, which give it on a side view the serrated appearance that has suggested the name. Nodes and zoecia twenty-four to twenty-six in 5 mm., and three to each fenestrule. Apertures very small, 0.07 mm. in diameter with a prominent peristome when perfect. Dissepiments thin, not more than half as wide as the branches, depressed and carinate on the obverse side. Fenestrules narrow elliptical, seventeen to nine-

Fig. 5. — *Fenestella serratula.* A branch enlarged twenty diameters to show the apertures and the nodes on the mesial carina.

teen in one cm. Reverse of branches granulo-striate or nearly smooth (?) with an occasional long, barbed, spine-like appendage [Ulrich, 1890]."

The Maxville forms are like the Chester specimens in that they lack the granules on the longitudinal striæ of the obverse side. More strictly speaking, the obverse side instead of having striæ is marked with very fine longitudinal plications, which bifurcate and diverge toward the top.

Horizon and locality. — Maxville limestone.
Shale-nodular zone: Kroft Bridge, White Cottage.
Undetermined zone: Harper Shaft, Olive Furnace.

RHOMBOPORA ARMATA—Ulrich.

1884. *Rhombopora armata.* Ulrich, Jour, Cinn. Soc. Nat. Hist., Vol. VII, p. 31, pl. 1, figs. 5, 5a.
Kaskaskia group: Tateville, Kentucky.

Description. — Zoarium slender, ramose, solid. Zoecia with deep, narrow, rhombic vestibules, arranged regularly in a quincuncial manner, thus forming vertically, transversely, and obliquely intersecting series. The oblique series slightly more evident. Apertures subcircular and comparatively large. The peripheries of the vestibules form rounded ridge-like thickenings,

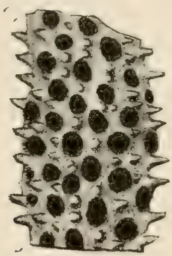


FIG. 6. — *Rhombopora armata.* Zoarium magnified twenty times to show the apertures and spines.

and at the intersections of the oblique ones of these are located one or two prominent spines.

Zoarium 1 mm. in diameter; and with eleven to thirteen zoecia to one circumference.

This species can be readily recognized by its slender cylindrical zoarium with rhombic vestibules and prominent spines.

Horizon and locality. — Maxville limestone.
Undetermined zone: Harper Shaft, Olive Furnace.

CLASS BRACHIOPODA.

DERBYA CRASSA—Meek and Hayden.

1853. *Orthis umbraculum?* Hall, Stansbury Explo. and Survey Gt. Salt Lake, p. 412, pl. 3, fig. 6.
Carboniferous: Missouri River.

1852. *Orthis umbraculum?* Owen, Geol. Rept. Wis., Iowa, and Minn., tab. 5, fig. 11.
Carboniferous: Missouri River.

1852. *Orthis arachnoidea.* Roemer, Kreid. von Texas, p. 89, tab. 1, figs. 9 a, b.
Carboniferous: San Saba Valley, Texas.

1858. *Orthisina crassa.* Meek and Hayden, Proc. Acad. Nat. Sci. Phil., p. 261.
Coal Measures: Leavenworth, Kansas.

1858. *Orthis crenistria.* Marcou, Geol. North America, p. 49.
Mountain limestone: Pecos Village, New Mexico.

1859. *Orthisina crassa.* Meek and Hayden, Proc. Acad. Nat. Sci. Phil., p. 26.
Coal Measures: Leavenworth, Kansas.

1859. *Orthisina umbraculum?* Meek and Hayden, Proc. Acad. Nat. Sci. Phil., p. 26.
Upper Coal Measures: Fort Riley and Cottonwood Creek, Kansas

1860. *Orthis lasallensis.* McChesney, Desc. New Pal. Foss., p. 32.
Upper Coal Measures: Lasalle, Illinois.

1860. *Orthis richmonda.* McChesney, Desc. New Pal. Foss., p. 32.
Coal Measures: N. W. Richmond, Missouri.

1860. *Orthis pratteni.* McChesney, Desc. New Pal. Foss., p. 33.
Coal Measures: Charbonier, Missouri.

1861. *Streptorhynchus umbraculum.* Newberry, Ives' Colo. Expl. Exped., p. 125.
Upper Carboniferous (Cherty limestone): Various.

1864. *Hemipronites crassus.* Meek and Hayden, Smithsonian Cont. Knowledge, Vol. XIV, No. 172, p. 26, pl. 1, figs. 7a-d.
Coal Measures: Leavenworth City, Kansas.

1865. *Orthis lasallensis.* McChesney, Ill. New Spec. Foss., p. 1, figs. 5a-c.

1865. *Orthis lasallensis.* McChesney, Ill. New Spec. Foss., pl. 1, figs. 6a, b.

1868. *Hemipronites lasallensis.* McChesney, Trans, Chicago Acad. Sci., Vol. I, p. 28, pl. 1, figs. 5a-c.
Coal Measures: N. W. Richmond, Missouri.

1868. *Hemipronites lasallensis.* McChesney, Trans. Chicago Acad. Sci., Vol. I, p. 28, pl. 1, figs. 6a, b.
Upper Coal Measures: Lasalle, Illinois.

1872. *Hemipronites crassus.* Meek, U. S. Geol. Surv. Nebr., p. 174, pl. 5, figs. 10a-c; pl. 8, fig. 1.
Coal Measures: Nebraska, Kansas, Iowa, Missouri, Illinois.
Chester limestone: West Virginia.

1873. *Hemipronites crassus.* Meek and Worthen, Geol. Surv. Ill., Vol. V, p. 570, pl. 25, fig. 12.
Upper Coal Measures: Lasalle, Illinois.

1876. *Hemipronites crenistria.* White, Powell's Rep. Geol. Unita Mts., pp. 90, 91.
Lower and Upper Aubrey group: Utah.

1877. *Hemipronites crenistria.* White, U. S. Geog. Surv. W. 100 Merid., Vol. IV, p. 124, pl. 10, fig. 9a.
Carboniferous: Utah, Nevada.

1883. *Streptorhynchus Richmondi.* Hall, Rep. N. Y. State Geol. for 1882, pl. (10) 40, figs. 10, 11.
Coal Measures: Iowa.

1884. *Hemipronites crassus.* White, Ind. Geol. Nat. Hist., 13th Rep. pt. II, p. 129, pl. 26, figs. 4-11.
Coal Measures: Indiana.

1887. *Hemipronites crassus.* Herrick, Bull. Sci. Lab. Denison Univ., Vol. II, p. 50, pl. 2, fig. 19.
Coal Measures: Flint Ridge, Ohio.

1888. *Streptorhynchus crenistria.* Keyes, Proc. Acad. Nat. Sci. Phil., p. 229.
Lower Coal Measures: Des Moines, Iowa.

1891. *Streptorhynchus crassum.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 580, pl. 13, figs. 11, 12.
Maxville limestone: Ohio.

1892. *Derbya crassa.* Hall and Clarke, Int. to Study of Brach., pt. I, pl. 17, figs. 1-4, 9.
Upper Coal Measures: Missouri, Iowa.

1892. *Derbya crassa.* Hall and Clarke, Pal. N. Y., Vol. VIII, pt. I, pl. 10, figs. 10, 11; pl. 11A, figs. 28-33; pl. 11B, figs. 23, 24; pl. 20, figs. 12, 13.
Upper Coal Measures: Missouri, Iowa.

1894. *Streptorhynchus crenistria.* Keyes, Mo. Geol. Surv., Vol. V, p. 67, pl. 38, figs. 8a-h.
Coal Measures: Missouri.

1895. *Streptorhynchus crassum.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 468, pl. 9, figs. 11, 12.
Maxville Limestone: Ohio.

1897. *Derbya crassa.* Smith, Proc. Am. Phil. Soc., Vol. XXXV, p. 28.
Coal Measures: Indian Territory, Arkansas.

1900. *Derbya crassa.* Beede, Univ. Geol. Surv. Kansas, Vol. VI, p. 62, pl. 8, figs. 11, 11b.
Upper and Lower Coal Measures: Fort Scott, Kansas City, Lawrence, Topeka, Kansas.

1903. *Derbya crassa.* Girty, U. S. Geol. Surv., Prof. Paper 16, p. 347.
Hermosa formation: San Juan region, Ouray, Colorado.
Weber limestone and Maroon formation: Crested Butte district, Colorado.
Weber formation: Leadville district, Colorado.

1904. *Derbya crassa.* Girty, U. S. Geol. Surv., Prof. Paper 21, p. 52, pl. 11, fig. 3.
Naco limestone: Bisbee quadrangle, Arizona.

1909. *Orthothetes (Derbya) crassus.* Grabau and Shimer, N. A. Index Foss., p. 231, fig. 282 a-d.
Upper Carbonic: North America.

Description. — "Shell very variable in size and form, but usually more or less plano-convex as seen in profile, somewhat semi-oval in outline, but usually a little too long from beak to base to be strictly so considered. Ventral valve more or less flattened, a little prominent on the umbo, but usually becoming slightly concave toward the front of the shell; cardinal area of

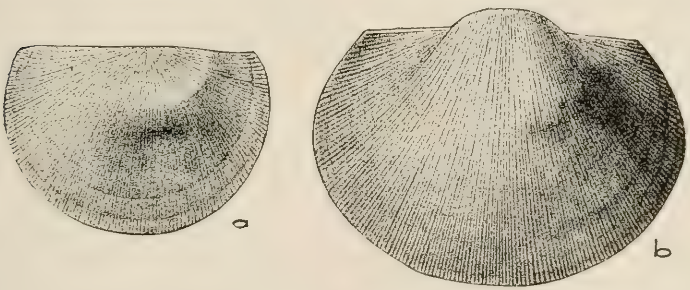


Fig. 7. — *Derbya crassa.*
a and b. — Impression of a ventral and dorsal valve. (After Whitfield.) Shell decidedly variable, but the ventral valve of many specimens is very flat except for the beak which rises abruptly and which is commonly distorted.

moderate height with a covered deltidium; beak more or less distorted. Dorsal valve convex, often quite rotund, but usually depressed convex, with a slightly prominent umbo. Surface of the shell marked by radiating striæ of considerable strength, which are sometimes sharply elevated and uniform, but on other specimens may be distinctly alternating in strength or arranged in fascicles; these are crossed by fine concentric striæ which give a finely crenulated surface when viewed through a lens. Coarser concentric undulations of growth also mark the shell at irregular distances [Whitfield, 1895]."

Length 30-35 mm.; width 35-40 mm.

As pointed out by Whitfield this shell is decidedly variable. However, the ventral valves of most specimens may be characterized by their flattened appearance and the somewhat sudden prominence and distortion of the beak. At the extreme margin, the valve is bent upwards.

Horizon and locality. — Maxville limestone.

Upper zone: Mouth of Buckeye Fork, Fultonham; Gladstone Mills?, Thompson Residence?, Below Thompson Residence, White Cottage.

Lower zone: Bridge Gully, Mt. Perry-Fultonham.

Undetermined zone: Harper Shaft, Olive Furnace.

PRODUCTUS PILEIFORMIS—McChesney.

1859. *Productus pileiformis.* McChesney, Desc. New Paleozoic Foss., p. 40.
Kaskaskia limestone: Chester, Illinois.

1891. *Productus pileiformis.* Whitfield, Ann. N. Y. Acad. Sci., Vol V, p. 582, pl. 13, figs. 13, 14.
Maxville limestone: Ohio.

1895. *Productus pileiformis.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 470, pl. 9, figs. 13, 14.
Maxville limestone: Ohio.

1909. *Productus pileiformis.* Girty, U. S. Geol. Surv., Bull. 377, p. 26, pl. 2, fig. 7.
Caney shale: McAlester quadrangle, Oklahoma.

1911. *Productus pileiformis.* Girty, U. S. Geol. Surv., Bull. 439, p. 44, pl. 4, figs. 1, 2.
Moorefield shale: Batesville quadrangle, Marshall quadrangle, Arkansas.

Description. — Shell larger than medium, fragile, decidedly concavo-convex with a reflected margin.

Pedicle valve strongly curved in the posterior region and decidedly recurved at the anterior margin. Valve pointed at the beak and gradually increases in size to near the margin where it rapidly expands into a trumpet-shaped opening. Hinge line straight, of medium length, with medium sized auricular extremities. Surface marked by fine radiating plications, which increase in number by bifurcation or insertion, and many of which decrease in number by coalescence at a point just posterior to the expansion of the anterior margin. Auricular margins

FIG. 8.—*Productus pileiformis.*

a.—A view of a pedicle valve, the anterior margin of which is more or less broken.

b.—A view of the internal portion of the umbonal half of a brachial valve and the external portion of the anterior half of the pedicle valve.

c.—Profile view of a specimen (with a broken beak) showing the trumpet-like expansion of the anterior margin of the shell.

marked by prominent concentric wrinkles which disappear at the side of the shell so that the umbonal region is free from them or so that the latter region is marked by only faint representations of them.

Brachial valve slightly concave in the umbonal region, suddenly reflected at the anterior margin to conform to the pedicle valve, into which it is deeply withdrawn. Interior (?) surface marked by fine radiating plications which are crossed by prominent concentric wrinkles in both the auricular and umbonal regions.

Length 43 mm.; width 30 mm.; hinge line 16-20 mm.

The shell is characterized by its fragile nature, fine plications, and trumpet-shaped aperture. The umbonal half of the pedicle valve is, in most specimens, broken away, leaving the interior surface of the umbonal half of the brachial valve and the outer surface of the anterior half of the pedicle valve exposed, *seemingly* as one valve (Fig. 8b).

The specimen that Whitfield figured was undoubtedly an imperfect one. The shell must have been so broken that the ventral view showed the umbonal half of the brachial valve and the anterior half of the pedicle valve. And, furthermore, the expanded, anterior margin was evidently broken away. As a result of this imperfection, the pedicle valves of the Maxville specimens resemble Hall's figures of *P. tenuicostus* (Geol. Surv. Iowa, Vol. I, pl. 24, fig. 2 a-c), whereas the brachial valves agree with Whitfield's figures. The shell differs, though, from *P. tenuicostus* in that the beak of the pedicle valve is more pointed, in that the transverse section is rounded instead of subquadrate, and in that the umbonal half of the brachial valve is slightly concave rather than flat. The hinge line of *P. pilciformis,* also, varies from 16 to 20 mm. whereas the one of the only specimen used by Hall is 23 mm.

Horizon and locality.—Maxville limestone.

Upper zone: Mouth of Buckeye Fork, Fultonham; Gladstone Mills, Thompson Residence (aa), below Thompson Residence, White Cottage.

Lower zone: Cut No. 4, Mt. Perry-Fultonham; Folk Quarry, Rushville.

PRODUCTUS CESTRIENSIS—Worthen.

1855. *Productus elegans.* Norwood and Pratten, Jour. Acad. Nat. Sci. Phil. (2), Vol. III, p. 3, pl. 1, figs. 7a-c. (Not *P. elegans* McCoy).

Mountain limestone: Chester and Kaskaskia, Illinois; near Hat Island, Missouri.

1860. *Productus cestriensis.* Worthen, Trans. St. Louis Acad. Sci., Vol. I, p. 570.
Chester limestone: Chester, Illinois.
1877. *Productus elegans.* Hall and Whitfield, U. S. Geol. Expl. 40 Par., Vol. IV, p. 268, pl. 5, figs. 3, 4.
Lower Carboniferous limestone: Utah.
1891. *Productus elegans.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 581, pl. 13, figs. 15, 16.
Maxville limestone: Ohio.
1894. *Productus cestriensis.* Keyes. Mo. Geol. Surv., Vol. V, p. 44.
Kaskaskia limestone: Ste. Mary, Missouri.
1895. *Productus elegans.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 469, pl. 9, figs. 15, 16.
Maxville limestone: Ohio.
1897. *Productus cestriensis.* Weller, Trans. N. Y. Acad. Sci., Vol. XVI, p. 256, pl. 19, figs. 7-9.
Batesville sandstone: Batesville, Arkansas.
1911. *Diaphragmus elegans.* Girty, U. S. Geol. Surv., Bull. 439, p. 51, pl. 4, figs. 4, 5.
Moorefield shale: Batesville quadrangle, Arkansas

Description. — Shell of medium size, highly curved. Hinge line straight and short.

Pedicle valve strongly curved, gradually increases in breadth from the beak toward the anterior end where it is slightly expanded in the older forms. Auricular depressions at the extremities of the hinge line very small. In many specimens a shallow, ill-defined sinus extends from near the beak to the anterior end. Surface marked with numerous, medium-sized, radiating plications which bear a number of spine bases. Plications crossed by concentric wrinkles in the posterior region.

Brachial valve with central portion nearly flat or concave and with anterior half bending abruptly forward and fitting in the opposite valve so as to greatly restrict the viseral cavity. Surface ornamented with medium-sized, radiating plications which are less distinct on the flattened portion and which, in this area, are crossed by concentric wrinkles.

Length 16 mm.; width 16 mm.

This species is characterized by the highly curved pedicle valve and by the withdrawal of the brachial valve far within the pedicle valve, as shown in Fig. 9 c and e.

This contact causes a plane of weakness along which the

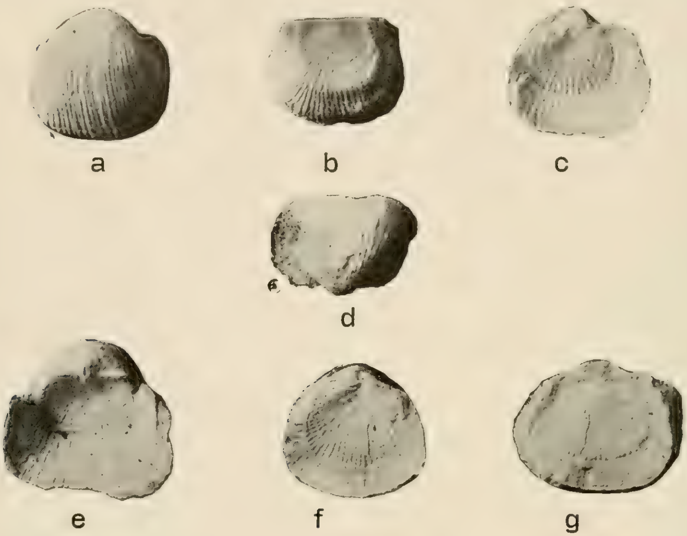


FIG. 9.—*Productus cestriensis.*

a.—A view of a pedicle valve, a portion of the margin of which has been broken away.

b.—An internal view of a brachial valve, showing the abrupt, forward bend of this valve.

c.—A dorsal view, showing the concave structure of the brachial valve.

d.—A view of a pedicle valve showing the beak and concentric wrinkles.

e.—A dorsal view showing especially the concavity of the brachial valve.

f and g.—Portions of the same specimen, which have separated along the plane of weakness caused by the abrupt forward bend of the anterior half from the flat posterior half of the brachial valve.

shells of many specimens break (Fig. 9 f and g). Its smaller size and coarser plications readily separate it from *P. pileiformis,* the other Maxville species.

This shell is one of the four abundant forms found in the Maxville limestone. It occurs in association with *Seminula subquadrata* and like it in great numbers in the shale nodular zone and very commonly in the shaly partings of the upper zone.

Horizon and locality. — Maxville limestone.

Upper zone: Gladstone Mills, Thompson Residence, below Thompson Residence, White Cottage; Smith Chapel, Logan.

Shale-nodular zone: Cut No. 5, Upper end of Cut No. 6, Middle of Cut No. 6, Mouth of Hough Hollow, Mt. Perry-Fultonham; Kroft Residence, Kroft Bridge, White Cottage; Stimmel Residence, Maxville; Smith Chapel, Logan.

Lower zone: Bridge Gully, Cut No. 3, Cut No. 4, Cut No. 5, Mt. Perry-Fultonham; West Jockey Hollow, Rushville.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham; Harper Shaft, Olive Furnace.

MARTINI · CONTRACTA—Meek and Worthen.

1861. *Spirifera glabra* var. *contracta.* Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 143.
Chester limestone: Pope County and Chester, Illinois.

1866. *Spirifer glaber* var. *contracta.* Meek and Worthen, Geol. Surv. Ill., Vol. II, p. 298, pl. 23, figs. 5a, b.
Chester group: Pope County and Chester, Illinois.

1874. *Spirifer (Martinia) glaber* var. *contracta.* White, Prelim. Rept. Inv. Foss., p. 20.
Carboniferous (Coal Measures): Camp Cottonwood, Nevada.

1877. *Spirifer (Martinia) glaber* var. *cantracta.* White, U. S. Geol. Surv. W. 100 Merid., Vol. IV, p. 136, pl. 10, figs. 2a-c.
Carboniferous: Camp Cottonwood, Nevada.

1888. *Spirifer glaber.* Herrick, Bull. Denison Univ., Vol. IV, pl. 11, fig. 15.
Chester limestone: Ohio.

1891. *Spirifera (Martinia) contractus.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 583, pl. 12, figs. 17-19.
Maxville limestone: Ohio.

1894. *Spirifera contracta.* Keyes, Mo. Geol. Surv., Vol. V, p. 83.
Kaskaskia limestone: Chester, Illinois.

1895. *Spirifera (Martinia) contracta.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 471, pl. 9, figs. 17-19.
Maxville limestone: Ohio.

1909. *Martinia glabra* var. *contracta.* Grabau and Shimer, N. A. Index Foss., p. 341.
Chester: Illinois, Ohio and Nevada.

Description. — Shell of medium and of larger than medium size, fairly robust, broadly ovate in general outline.

Ventral valve robust, with incurved beak. Hinge line short, equal to half the width of the shell. Area small, divided by a rather large triangular pedicle opening. Median sinus shallow, narrow, and indistinct on the beak, but gradually increasing in width toward the anterior end where it is somewhat extended into the fold of the opposite valve.

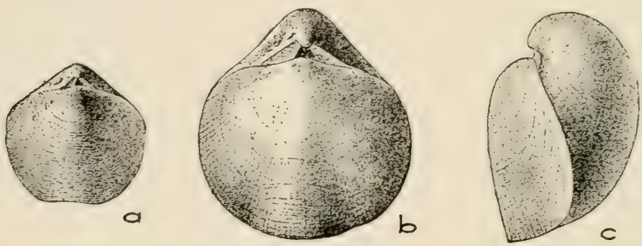


Fig. 10. — *Martinia contracta.*

a. — Dorsal view of the type specimen from the Chester limestone of Illinois.

b and c. — Dorsal and profile views of a Maxville specimen. (After Whitfield.)

Brachial valve less convex and nearly circular in outline, with minute beak. Median fold developed only in the anterior half toward which margin it increases in size.

Surface marked by very minute radiating plications, which alternate in size and which are crossed by still finer concentric lines.

Length 14-35 mm.; width 14-40 mm.

The shell is characterized by its robust form and by the minute radiating plications and the finer concentric lines. Fragments of the smaller shells may be readily separated from *Seminula subquadrata* and *Dielasma turgida* by the absence of the round foramen and from the latter also by the absence of the punctate surface.

Horizon and locality. — Maxville limestone.

Upper zone: Mouth of Buckeye Fork, Fultonham; Gladstone Mills, Thompson Residence, Below Thompson Residence, White Cottage.

SPIRIFER KEOKUK—Hall.

1852. *Spirifer attenuatus.* Owen, Geol. Rep. Wis., Iowa, and Minn., tab. 5, fig. 5, tab. 3 A, fig. 18.
Lower Carboniferous limestone: Skunk River, Iowa.
Carboniferous limestone: Keokuk Rapids of the Mississippi.

1858. *Spirifer keokuk.* Hall, Geol. Iowa, Vol. I, pt. II, p. 642, pl. 20, figs. 3 a-d, 2d.
Keokuk limestone: Keokuk, Iowa; Nauvoo and Warsaw, Illinois.

1858. *Spirifer keokuk* var. Hall, Geol. Iowa, Vol. I, pt. II, p. 676, pl. 24, figs. 4 a-d.
St. Louis limestone: Mouth of Lizard Creek, Iowa.

1876. *Spirifer keokuk* (?) Meek, Bull. U. S. Geol. and Geog. Surv. Terr., Vol. II, p. 355, pl. 1, figs. 3, 3a.
Carboniferous: Kootenay Range of Rocky Mountain.

1883. *Spirifera keokuk.* Hall, Rep. N. Y. State Geol. for 1882, pl. (30) 55, figs. 21-24.
Keokuk and St. Louis limestone: Keokuk, Lizard Creek, and Marion County, Iowa.

1888. *Spirifer keokuk.* Herrick, Bull. Denison Univ., Vol. IV, p. 114.
Waverly group: Rushville and Loudonville, Ohio.

1888. *Spirifer increbescens.* Herrick, Bull. Denison Univ., Vol. IV, pl. 11, figs. 14, 23.
Chester limestone: Ohio.
Limestone fragments in Coal Measures: Licking County, Ohio.

1891. *Spirifer Rockymontana?* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 584, pl. 13, fig. 20.
Maxville limestone: Newtonville, Ohio.

1894. *Spirifer keokuk.* Hall and Clarke, Int. Study of Brach., pt. 2, pl. 27, figs. 14, 15.
Keokuk group: Keokuk, Iowa.

1894. *Spirifera keokuk.* Keyes, Mo. Geol. Surv., Vol. V, p. 81, pl. 40, fig. 2.
Keokuk limestone: Wayland, Missouri; Keokuk, Iowa.

1895. *Spirifera Rockymontana?* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 471, pl. 9, fig. 20.
Maxville limestone: Newtonville, Ohio.

1895. *Spirifer keokuk.* Hall and Clarke, Pal. N. Y., Vol. VIII, pt. 2, pl. 30, figs. 21-24.
Keokuk group: Keokuk, Lizard Creek and Marion County, Iowa.

1895. *Spirifer keokuk* var. ? Hall and Clarke, Pal. N. Y., Vol. VIII, pt. II, pl. 37, figs. 13-15.
St. Louis group: Southern Indiana?

1897. *Spirifer keokuk.* Weller, Trans. N. Y. Acad. Sci., Vol. XVI, p. 257, pl. 19, figs. 10-12.
Batesville sandstone: Batesville, Arkansas.

1909. *Spirifer keokuk.* Grabau and Shimer, N. A. Index Foss., p. 333, fig. 425 a, b.
Keokuk: Ohio, Illinois, Iowa, Utah.

"*Spirifera Rockymontana?*

Plate IX, fig. 20.

"*Spirifera Rockymontana* Marcou, Geol. N. Amer., p. 50, pl. 7, fig. 4, Feb. 1858.

"*Spirifera keokuk* Hall, Geol. Rept. Iowa, Vol. I, pt. 2, p. 642, pl. 20, fig. 3, Sept. 1858.

"*Spirifera keokuk* Var. Hall. Ibid., p. 672, pl. 24, fig. 4.

"*Spirifera opima* Hall, Ibid., p. 711, pl. 28, fig. 1.

"Several specimens of a *Spirifera*, of the form referred to *S. keokuk* var. Prof. Hall, have been obtained from Newtonville, Ohio, which are so entirely similar to those from the St. Louis and Chester limestones of Iowa, as to be absolutely indistinguishable; the form of the shell, the form and number of the plications, and the minute surface structure being exactly as in those.

"The form of the shell will vary from longer than wide to much wider than long, dependent on the extension of the hinge line. In profile the shell is extremely ventricose, with a strongly enrolled beak; a moderate cardinal area, vertically striated; a well-marked mesial fold and sinus; from seven to ten simple, rounded, or sub-angular plications on each side, and from four to six bifurcating or dividing plications on the fold and sinus.

The plications and intervening spaces, when the surface is well preserved, are marked by fine longitudinal lines, showing even on partially exfoliated specimens, and are also crossed by still finer transverse striæ which undulate in crossing the plications, and on perfectly preserved surfaces appear to be minutely setose on their edges.

"The species is extremely variable in its general outline, as exhibited among the collections from all of the many localities from which I have examined specimens, especially in the extension of the hinge-line, and the proportional width of the shell below, and also in the prominence of the mesial fold; but the form of the plications and the character of those marking the fold and sinus are usually the same in all; while the most constant and persistent character, and one I have been able to

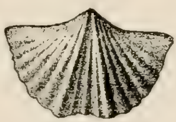


FIG. 11.—*Spirifer keokuk.* Pedicle valve. (After Whitfield.) The form of this species varies greatly in the Maxville limestone.

detect on specimens from almost every locality noticed, consists of the minute structure of the surface. I have lately examined a large number of examples from the limestones and sandstones of the Coal Measures of New Mexico, which correspond exactly with those figured by Prof. Marcou under the name *S. Rockymontana*, and find them showing all the variations in form noticed among the Keokuk, St. Louis, Chester and Coal Measure limestones of Ohio and the West, and am thoroughly convinced they cannot be separated, even as local varieties, with any degree of safety or satisfaction [Whitfield, 1895]."

In the above bibliography Weller's arrangement has been followed, except for the listing of Herrick's *S. increbescens*, which is undoubtedly the same as the other Maxville *Spirifers*. Had the writer been bolder and followed his own inclinations, he would have adopted Whitfield's and added *S. increbescens* to the latter's list.

Hall's inability to separate *S. keokuk* var. (St. Louis limestone, 1858) from *S. keokuk* (Keokuk limestone, 1858) seems especially significant. *S. keokuk* appears to represent one extreme, the short hinge line, and *S. increbescens* (Kaskaskia limestone, 1858) the other extreme, the long hinge line, of an otherwise very similar series of specimens. Between the two is *S. keokuk* var. with specimens exhibiting both long and short hinge lines. The ones with the long hinge lines might as well have been selected as the type in this case and the name *S. increbescens* var. applied rather than *S. keokuk* var. To be sure, it is not difficult to identify specimens of one extreme as *S. keokuk* and those of the other as *S. increbescens*, but what is to be done with the intermediate forms which fall as readily under one species as the other?

Just why *Spirifer opimus* (Coal Measures of Ohio, Maryland and Iowa, 1858) should have been originaly referred to *S. rockymontani* (Moutain limestone of New Mexico, 1858) rather than to *S. keokuk*, which it more closely resembles, is not clear. *S. opimus* is undoubtedly an offspring of one of the Mississippian forms, and more probably one from the adjacent Mississippian series rather than one from the western Mississippian.

If any specific division is to be made in the above forms it would seem to fall between *S. rocky-montani* (1858) on the one hand and *S. keokuk* (1858), *S. keokuk* var. (1858), *S. increbescens* (1858), and *S. opimus* (1858) on the other. This, of course, would give specific rank to the first and second and make all of the rest synonyms of the second. Should no division be deemed advisable then all of Hall's species become synonyms of *Spirifer rockymontanus* Marcou (1858).

In the lower half of the Maxville limestone are found specimens of *Spirifer* which resemble very closely the figures of *S. rockymontanus* Marcou (especially 4 c-e) in two respects: first, the plications are small and sharply angular; and second, the plications, in their growth toward the anterior end, bend decidedly toward the lateral margins. However, the mesial fold is sometimes much more abrupt with a suppression of all of its plications except two and in this respect the specimens resemble *S. keokuk*. In the upper half another small form is found which resembles *S. keokuk* somewhat more closely than it does *S. rockymontanus*. In this same division and especially in the Olive Furnace Shaft occur still other forms which are larger and coarser and which can with equal propriety be referred to either *S. keokuk* or *S. increbescens*.

In the Maxville limestone, therefore, the separation of *S. keokuk* and *S. increbescens* is attended with a great deal of difficulty if not impracticable. The same trouble is experienced in the attempt to refer some specimens to *S. rockymontanus* (1858) on the one hand and to *S. keokuk* (1858) on the other. That this should be the case is not at all surprising when the principles of evolution are taken into consideration; and when this is done one species will probably be the result.

Horizon and locality.—Maxville limestone.

Upper zone: Mouth of Buckeye Fork, Fultonham; Gladstone Mills, Thompson Residence, White Cottage.

Lower zone: Cut No. 4, Mt. Perry-Fultonham.

Undetermined zone: Harper Shaft, Olive Furnace.

DIPLASMA TURGIDA—Hall.

1856. *Terebratula turgida.* Hall, Trans. Albany Inst., Vol. IV, p. 6.
St. Louis limestone: Alton, Illinois; Bloomington and Spergen Hill, Indiana.

1882. *Terebratula turgida.* Whitfield, Bull. Am. Mus. Nat. Hist., Vol. I, p. 54, pl. 6, figs. 53-58.
St. Louis group: Indiana, Iowa, Illinois and Missouri.

1883. *Terebratula turgida.* Hall, Ind. Dept. Geol. Nat. Hist., 12th Rept., p. 336, pl. 29, figs. 53-58.
St. Louis group: Alton, Illinois; Bloomington, Lanesville and Spergen Hill, Indiana.

1891. *Terebratula turgida.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 586, pl. 13, figs. 21, 22.
Maxville limestone: Maxville and Newtonville, Ohio.

1894. *Dielasma turgida.* Hall and Clarke, Int. to Study of Brach., pt 2, pl. 53, figs. 10-12.
Chester limestone: Spencer County, Indiana.
St. Louis group: Washington County, Indiana.

1895. *Dielasma turgida.* Hall and Clarke, Pal. N. Y., Vol. VIII, pt. 2, pl. 81, figs. 1-8
Chester limestone: Spencer County, Indiana.
St. Louis group: Washington County, Indiana.

1895. *Terebratula turgida.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 473, pl. 9, figs. 21, 22.
Maxville limestone: Maxville and Newtonville, Ohio.

1906. *Dielasma turgidum.* Beede, Ind. Dept. Geol. Nat. Res., 30th Ann. Rep. p. 1309, pl. 22, figs. 53-58; pl. 19, figs. 5-5a.
Salem limestone: Indiana, Illinois and Missouri.

1909. *Dielasma turgidium.* Grabau and Shimer, N. A. Index Foss., p. 302, fig. 376 d-f.
Warsaw and St. Louis: Ohio, Kentucky, Indiana, Illinois, Missouri, Iowa.

Description.—Shell small, egg-shape in general outline, elongate, nearly as thick as broad with anterior end truncated and slightly emarginated.

FIG. 12.—*Dielasma turgida.*
a and b.—Dorsal and profile views of the same specimen. (After Whitfield.)

Pedicle valve convex, with a rather deep median sinus in the anterior half. Beak incurved, obliquely truncate, with a round foramen.

Brachial valve convex with two small grooves in the anterior portion of the valve of some specimens.

Shell structure finely punctate, and surface ornamented with faint lines of growth.

Length 7-11 mm.; width 5-10 mm.

This species is characterized by its punctate structure, thick shell, and obliquely truncated beak.

Horizon and locality. — Maxville limestone.

Upper zone: Gladstone Mills, Thompson Residence, Below Thompson Residence, White Cottage.

Shale-nodular zone: Cut No. 5, Mouth of Hough Hollow, Mt. Perry-Fultonham; Kroft Bridge, White Cottage; Stimmel Residence, Maxville; Smith Chapel, Logan.

Lower zone: Cut No. 2, Cut No. 3, Cut No. 4?, Cut No. 5, Mt. Perry-Fultonham.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham.

SEMINULA SUBQUADRATA—Hall.

1858. *Athyris subquadrata.* Hall, Geol. Surv. Iowa, Vol. I, pt. II, p. 703, pl. 27, figs. 2 a-d; p. 708, fig. 118.
Kaskaskia limestone: Chester, Illinois; Crittenden County, Kentucky.

1877. *Athyris subquadrata* ? Hall and Whitfield, U. S. Geol Expl. 40 Par., Vol. IV, p. 271, pl. 5, figs. 19, 20.
Wasatch limestone: Utah.

1886. *Athyris subquadrata.* Heilprin, 2d Geol. Surv. Penn., Ann. Rep. for 1885, p. 453, p. 440, fig. 2.
Mill Creek limestone, Upper Coal Measures: Wilkesbarre, Pennsylvania.

1886. *Athyris subquadrata.* Heilprin, Proc. and Coll. Wyo. Hist. and Geol. Soc., Vol II, pt. II, p. 269, fig. 2.
Mill Creek limestone, Upper Coal Measures: Wilkesbarre, Pennsylvania.

1891. *Athyris subquadrata.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 585, pl. 14, figs. 1-3.
Maxville limestone: Newtonville and Maxville, Ohio.

1894. *Seminula subquadrata.* Hall and Clarke, Int. to Study of Brach., pt. II, pl. 35, figs. 13, 15.
Chester limestone: Crittenden County, Kentucky.
St. Louis limestone: Pella, Iowa.

1894. *Athyris subquadrata.* Keyes, Mo. Geol. Surv., Vol. V, p. 92.
Kaskaskia limestone: Ste. Mary, Missouri.

1895. *Seminula subquadrata.* Hall and Clarke, Pal. N. Y., Vol. VIII, pt. II, pl. 47, figs. 7-9, 15, 16; pl. 84, figs. 30, 31.
Kaskaskia limestone: Chester, Illinois; Crittenden County, Kentucky.
St. Louis limestone: Pella, Iowa; Spergen Hill, Indiana.

1895. *Athyris subquadrata.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 472, pl. 10, figs. 1-3.
Maxville limestone: Newtonville and Maxville, Ohio.

1897. *Athyris subquadrata.* Weller, Trans. N. Y. Acad. Sci., Vol. XVI, p. 258, pl. 19, fig. 16.
Batesville sandstone: Batesville, Arkansas.

1903. *Seminula subquadrata.* Girty, U. S. Geol. Surv., Prof. Paper 16, p. 296, pl. 1, fig. 5.
Leadville limestone: Leadville district, Colorado.
Millsap limestone: Castle Rock quadrangle, Colorado.

1909. *Seminula subquadrata.* Grabau and Shimer, N. A. Index Foss., Vol. I, p. 354.
Kaskaskia: Ohio, Kentucky, Illinois, Utah.

Description. — Shell of medium size or smaller, subquadrate in outline, wider than long in most specimens; the widest portion being anterior of the middle. The bunching of the concentric

FIG. 13. — *Seminula subquadrata.*
a and b. — Dorsal and anterior views of the same specimen.
c. — Dorsal view of another individual. (After Whitfield.)

lines of growth at the anterior end often gives a thickened appearance to the shell.

Pedicle valve ventricose at the posterior end, with extended and incurved beak, the extremity of which is truncated thus forming a round foramen. Mesial sinus increasing in depth and breadth toward the anterior end, and culminating in a lingual extension, limited on either side by a lateral fold.

Brachial valve most rotund on the umbo, with beak incurved beneath the one on the other valve. Mesial fold prominent, rapidly increases in size toward the anterior end, due to the sudden development, on either side, of a sinus which corresponds to the two lateral folds of the opposite valve. A lateral fold on both sides of the valve and beyond each lateral sinus. The median fold with this lateral fold on either side gives a strong trilobate effect to this valve.

Surface marked by concentric lines of growth which are, in most specimens, crowded toward the anterior end.

Length 16 mm.; width 18 mm.

The shell is characterized by the rounded foramen; the trilobate, brachial valve; and the crowding of the concentric, growth lines toward the anterior margin, thus producing a thickened shell.

This species is one of the four most abundant forms in the Maxville limestone. It occurs in great numbers in the shale-nodular zone and rather abundantly in the shaly partings of the upper half of the stratum. It separates quite readily from the shales, and its greater abundance in these is due to the greater destruction of life during these intervals caused, perhaps, by the clay impurities.

Horizon and locality. — Maxville limestone.

Upper zone: Gladstone Mills, Thompson Residence, White Cottage.

Shale-nodular zone: Cut No. 5, Upper end of Cut No. 6, Middle of Cut No. 6, Mouth of Hough Hollow, Mt. Perry-Fultonham; Kroft Residence, Kroft Bridge, White Cottage; Stimmel Residence, Maxville; Smith Chapel, Logan.

Lower zone: Bridge Gully, Cut No. 3, Cut No. 4, Mt. Perry-Fultonham.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham; Harper Shaft (?), Olive Furnace.

EUMETRIA MARCYI—Shumard.

1852. *Terebratula serpentaria* ? Owen, Geol. Rep. Wis., Iowa and Minn., tab. 3 A, fig. 13, (Not deKoninck).
Carboniferous: Skunk River, Iowa.

1854. *Terebratula marcyi.* Shumard, Marcy's Rep. U. S. Expl. Red River of Louisiana, p. 177, pl. 1, figs. 4a, b.
Carboniferous: Washington and Crawford counties, Arkansas.

1856. *Retzia Verneuliana.* Hall, Trans. Albany Inst., Vol. IV, p. 9.
St. Louis limestone: Bloomington and Spergen Hill, Indiana.

1858. *Retzia verneuliana.* Hall, Geol. Iowa, Vol. I, pt. II, p. 657, pl. 23, figs. 1 a-d.
Warsaw limestone: Spergen Hill and Bloomington, Indiana.

1858. *Retzia vera.* Hall, Geol. Iowa, Vol. I, pt. II, p. 704, pl. 27, fig. 3a.
Kaskaskia limestone: Chester, Illinois.

1858. *Retzia vera* var. *costata.* Hall, Geol. Iowa, Vol. I, pt. II, p. 704, pl. 27, figs. 3b, c.
Kaskaskia limestone: Chester, Illinois.

1882. *Eumetria Verneuilana.* Whitfield, Bull. Am. Mus. Nat. Hist. Vol. I, p. 50, pl. 6, figs. 28-30.
St. Louis group: Spergen Hill, Paynter's Hill and Bloomington, Indiana: Alton, Illinois.

1883. *Eumetria verneuiliana.* Hall, Ind. Dept. Geol. Nat. Hist., 12th Rep., p. 335, pl. 29, figs. 28-30.
St. Louis group: Spergen Hill, Lanesville and Bloomington, Indiana.

1884. *Retzia Verneuiliana.* Walcott, U. S. Geol. Surv., Mon. VIII, p. 220, pl. 7, figs. 5, 5a.
Lower Carboniferous: Little Belt Mountains, Montana.

1894. *Eumetria Verneuiliana.* Hall and Clarke, Int. to Study of Brach., pt. II, pl. 37, figs. 1-4, 6, 10.
St. Louis group: Spergen Hill, Indiana.

1894. *Retzia verneuiliana.* Keyes, Mo. Geol. Surv., Vol. V, p. 95.
St. Louis limestone: St. Louis, Missouri.

1894. *Eumetria vera* var. *costata.* Hall and Clarke, Int. to Study of Brach., pt. II, pl. 37, figs. 5, 11.
Chester limestone: Chester, Illinois; Crittenden County, Kentucky.

1894. *Eumetria vera.* Hall and Clarke, Int. to Study of Brach., pt. II, pl. 37, figs. 8, 12.
Chester limestone: Crittenden County, Kentucky.

1894. *Retzia vera.* Keyes, Mo, Geol. Surv., Vol. V, p. 95.
Kaskaskia limestone: St. Mary, Missouri.

1895. *Eumetria vera* var. *costata*. Hall and Clarke, Pal. N. Y., Vol. VIII, pt. II, pl. 51, figs. 27-33.
Chester limestone: Crittenden County, Kentucky; Chester, Illinois.

1895. *Eumetria vera*. Hall and Clarke, Pal. N. Y., Vol. VIII, pt. II, pl. 51, figs. 36, 37.
Chester group: Crittenden County, Kentucky.

1895. *Eumetria Verneuiliana*. Hall and Clarke, Pal. N. Y., Vol. VIII, pt. II, p. 117, figs. 104, 105, pl. 51, figs. 13-26, 34, 35, pl. 83, figs. 26, 27.
St. Louis group: Spergen Hill, Indiana; Green County, Missouri.

1897. *Eumetria verneuilana*. Weller, Trans. N. Y. Acad. Sci., Vol. XVI, p. 259.
Batesville sandstone: Batesville, Arkansas.

1899. *Eumetria verneuiliana*. Girty, U. S. Geol. Surv., Mon. 32, pt. II, p. 560, pl. 68, figs. 12a-12b.
Madison limestone: Yellowstone National Park.

1903. *Eumetria marcyi*? Girty, U. S. Geol. Surv., Prof. Paper 16, p. 303
Ouray limestone: San Juan region, Colorado.

1904. *Eumetria marcyi*. Girty, U. S. Geol. Surv., Prof. Paper 21, p. 49, pl. 10, figs. 15-17.
Mississippian (Escabrosa limestone): Bisbee quadrangle, Arizona.

1906. *Eumetria marcyi*. Beede, Ind. Dept. Geol. Nat. Res., 30th Ann. Rep., p. 1319, pl. 22, figs. 28-30.
Salem limestone: Spergen Hill, etc., Indiana.

1909. *Eumetria marcyi*. Grabau and Shimer, N. A. Index Foss., p. 346, fig. 444 d, e.
St. Louis and Kaskaskia: Tennessee, Missouri, Arkansas, Indiana, Iowa, Illinois.

1911. *Eumetria marcyi*. Girty, U. S. Geol. Surv., Bull. 439, p. 77, pl. 8, fig. 10.
Moorefield shale: Batesville quadrangle, Arizona.

Description.—Shell very variable, ranging from smaller than medium to medium size, longitudinally ovate, almost equally biconvex.

Pedicle valve most convex in the umbonal region. Beak large, elevated, incurved, truncated by a nearly vertical plane, which produces a large rounded foramen.

Brachial valve more circular in outline with a small incurved beak.

Surface marked by numerous rounded, radiating plications which vary in size with the size of the shell.

Length 9-19 mm.; width 7-17 mm.

FIG. 14.—*Eumetria marcyi.* A dorsal view of a completely compressed and flattened specimen, which was drawn by the aid of a camera lucida and which is, therefore, much broader than a normal specimen

This shell is readily distinguished by its ovate outline, biconvexity, and rounded, radiating plications.

Horizon and locality.—Maxville limestone. Undetermined zone: Harper Shaft, Olive Furnace.

CLEIOTHYRIS HIRSUTA—Hall.

1856. *Spirigera hirsuta.* Hall, Trans. Albany Inst., Vol. IV, p. 8.
St. Louis limestone: Spergen Hill and Bloomington, Indiana; Alton, Illinois.

1882. *Athyris hirsuta.* Whitfield, Bull. Am. Mus. Nat. Hist., Vol. I, p. 49, pl. 6, figs. 18-21.
St. Louis group: Spergen Hill, Paynter's Hill and Bloomington, Indiana; Alton, Illinois.

1883. *Athyris hirsuta.* Hall, Ind. Geol. Nat. Hist., 12th Rep., p. 328, pl. 29, figs. 18-21.
St. Louis group: Alton, Illinois; Spergen Hill, Lanesville and Bloomington, Indiana.

1884. *Athyris hirsuta.* Walcott, Pal. Eureka Dist., p. 222, pl. 18, fig. 5.
Lower Carboniferous: Nevada.

1895. *Cliothyris hirsuta.* Hall and Clarke, Pal. N. Y., Vol. VIII, pt. II, pl. 46, figs. 25-28.
St. Louis limestone: Bloomington, Indiana.

1906. *Cleiothyris hirsuta.* Beede, Ind. Dept. Geol. Nat. Res., 30th Ann. Rep., p. 1320, pl. 22, figs. 18-21, pl. 19, figs. 1-1 a.
Spergen Hill, etc., Indiana.

1909. *Cliothyris hirsuta.* Grabau and Shimer, N. A. Index Foss., p. 354, fig. 464.

St. Louis and Kaskaskia: Kentucky, Indiana, Illinois, Montana.

Description. — Shell small, biconvex, sub-circular to obovate in general outline.

Pedicle valve most convex in the umbonal region. Beak small, incurved over the one of the opposite valve, and obliquely truncated. Foramen small. Sinus absent, generally not represented even by a slight depression at the anterior end.

Brachial valve uniformly convex except at the posterio-lateral angles where it is slightly flattened. Fold absent. Beak small, inconspicuous.

Surface marked by concentric, imbricating lamellæ which give rise to successive rows of minute, flat spines.

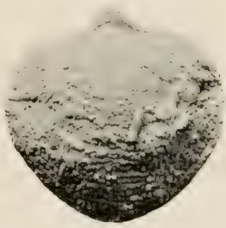


Fig. 15. — *Cleiothyris hirsuta.* A dorsal view showing some of the flat spines which have escaped removal, enlarged three diameters.

Length and width of average-sized individuals 10 mm.; a larger crushed specimen reached 14 mm. in length and width.

In the Maxville specimens the posterior margin is more nearly straight than it is in the ones figured by Whitfield, so that the greatest width of the shell is nearer the posterior end. The spines are more or less removed leaving commonly only the concentric lines.

The species is readily recognized by the concentric rows of flat spines.

Horizon and locality. — Maxville limestone.
Undetermined zone: Harper Shaft, Olive Furnace.

PHYLUM MOLLUSCA.

CLASS PELECYPODA.

SCHIZODUS CHESTERENSIS—Meek and Worthen.

1860. *Schizodus Chesterensis.* Meek and Worthen, Proc. Acad. Nat. Sci., Phil., p. 457.
Upper Chester limestone: Chester, Illinois.

1866. *Schizodus chesterensis.* Meek and Worthen, Geol. Surv. Ill., Vol. II, p. 301, pl. 23, figs. 6a, b.
Chester group: Chester, Illinois.

1891. *Schizodus Chesterensis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 587, pl. 14, fig. 4.
Maxville limestone: Maxville, Ohio.

1895. *Schizodus Chesterensis.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 474, pl. 10, fig. 4.
Maxville limestone: Maxville, Ohio.

Description. — "Shell of medium size, transversely subovate, with moderately convex valves and large, strong, incurved, and projecting beaks. Anterior end forming one-third the length of the shell, inflated, and rapidly sloping from the beaks to the longest point, which is near the middle of the height, and rounding backward below; posterior end elongated

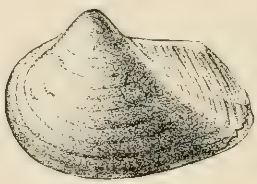


Fig. 16. — *Schizodus chesterensis.* A view of the left valve. (After Whitfield.)

and narrowed, obtusely pointed at the extremity; basal margin irregularly convex, most strongly arcuate opposite the beaks; posterio-cardinal margin sloping somewhat rapidly from the beaks backward, and the cardinal slope rather abrupt. Surface of the shell smooth, except for the fine lines of growth [Whitfield, 1895]."

A few broken internal molds have been referred to this species.

Horizon and locality. — Maxville limestone.
Upper zone: Below Thompson Residence (?), White Cottage.

PINNA MAXVILLENSIS—Whitfield.

1882. *Pinna Maxvillensis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 221.
Maxville limestone: Maxville, Ohio.
1891. *Pinna Maxvillensis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 586, pl. 14, fig. 5.
Maxville limestone: Maxville, Ohio.
1895. *Pinna Maxvillensis.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 474, pl. 10, fig. 5.
Maxville limestone: Maxville, Ohio.

Description.—"Shell of about medium size, very acutely triangular in outline, with highly convex valves; the length along the hinge equal to nearly three times the greatest width. Hinge line straight, not quite as long as the shell below; anterior end acute; basal margin very slightly arcuate, and the posterior extremity rather broadly rounded; the point of greatest length

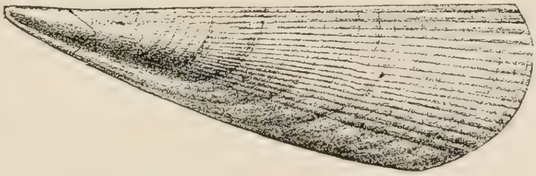


FIG. 17. — *Pinna maxvillensis.* A view of a left valve. (After Whitfield.)

being at about one-third of the width below the hinge-line. Surface of shell, except for a short distance within the basal margin, marked by moderately strong, simple radiating plications, about eighteen in number, as counted at the posterior end of the specimen figured, but increasing in number with icreased growth; the additions being near the hinge. There are also numerous strong concentric lines of growth parallel to the margin, often forming undulations of the surface [Whitfield, 1895]."

Length 70 mm.

This species is readily distinguished by its triangular outline and radiating plications.

Horizon and locality. — Maxville limestone.

Upper zone: Thompson Residence, White Cottage.

Shale-nodular zone: Kroft Bridge, White Cottage.

ALLORISMA ANDREWSI—Whitfield.

1882. *Allorisma Andrewsi.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 222.
Maxville limestone: Newtonville, Ohio.

1888. *Allorisma Andrewsi.* Herrick, Bull. Denison Univ., Vol. IV, pl. 11, fig. 12.
Chester limestone: Ohio.

1891. *Allorisma Andrewsi.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 588, pl. 14, fig. 6.
Maxville limestone: Newtonville, Ohio.

1895. *Allorisma Andrewsi.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 473, pl. 10, fig. 6.
Maxville limestone: Newtonville, Ohio.

Description. — Shell of medium size or larger, transverse outline obovate, longitudinal outline subrectangular. Valves ventricose, most so along a line extending diagonally from the

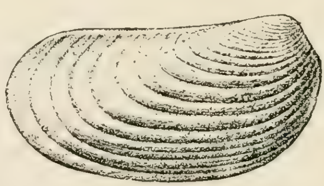


FIG. 18. — *Allorisma andrewsi.* A view of the right valve. (After Whitfield.)

beak to the posterio-ventral angle, and with a slightly concave line parallel with and dorsal to the former. Ventral margin convexly curved and parallel with the dorsal margin. Posterior margin broadly rounded. Anterior margin more abruptly rounded so that the greatest length of the shell is a little nearer to the ventral than it is to the dorsal margin. Beaks medium, projecting above the hinge line, incurved, and directed anteriorly. Surface covered with rather broad concentric ridges, which near the dorsal margin appear to be in pairs, due to interpolation.

Length 38-50 mm.; height 15-22 mm.; width 12-14 mm.

The species is characterized by its medium or larger size and by the broad, concentric ridges.

Horizon and locality. — Maxville limestone.

Upper zone: Gladstone Mills, Thompson Residence, White Cottage.

Shale-nodular zone: Stimmel Residence, Maxville.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham.

ALLORISMA MAXVILLENSIS—Whitfield.

1882. *Allorisma Maxvillensis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 222.
Maxville limestone: Newtonville, Ohio.

1891. *Allorisma Maxvillensis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 588, pl. 14, figs. 7, 8.
Maxville limestone: Newtonville, Ohio.

1895. *Allorisma Maxvillensis.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 475, pl. 10, figs. 7, 8.
Maxville limestone: Newtonville, Ohio.

Description. — "Shell small, the specimen used being a little less than one inch in length and the height less than half the length. Form of the shell transversely elongate, and cylindrically oval, the cardinal and basal margins parallel and very slightly curved, and the extremities very nearly equally rounded; beaks small, inrolled, barely projecting above the cardinal line, and situated at about one-fourth of the entire length from the anterior end. Body of shell very evenly and highly rounded from the cardinal to the basal margins, and almost as convex posteriorly as in front. Umbonal ridge scarcely perceptible, and the umbonal slope convex; escutcheon and lunule not defined; anterior slope abruptly rounded. Surface of the shell marked by faint concentric undulations of unequal strength, but most strongly marked on the posterior end and on the umbonal slope [Whitfield, 1895]."

Length 22 mm.; height 11 mm.

The shell is readily distinguished from the other species of *Allorisma* by its smaller size and more transversely cylindrical outline.

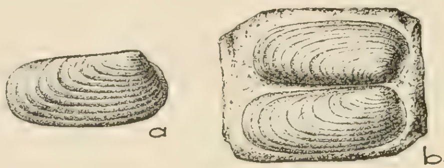


FIG. 19.—*Allorisma maxvillensis.*
a.—A view of the right valve of a specimen.
b.—A view of both valves of an individual. (After Whitfield.)

Horizon and locality. Maxville limestone.

Upper zone: Below Thompson Residence, White Cottage.

Shale-nodular zone: Cut No. 5, Upper end Cut No. 6, Mt. Perry-Fultonham; Stimmel Residence, Maxville.

Lower zone: Cut No. 4, Mt. Perry-Fultonham.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham; Harper Shaft (?), Olive Furnace.

CYPRICARDELLA OBLONGA—Hall.

1856. *Cypricardella oblonga.* Hall, Trans. Albany Inst., Vol. IV, p. 18. St. Louis limestone: Spergen Hill and Bloomington, Indiana.

1882. *Microdon* (*Cypricardella*) *oblonga.* Whitfield, Bull. Am. Mus. Nat. Hist., Vol. I, p. 65, pl. 7, figs. 30-34.
St. Louis group: Spergen Hill and Bloomington, Indiana.

1883. *Cypricardella oblonga.* Hall, Ind. Geol. and Nat. Hist., 12th Rep., p. 340, pl. 30, figs. 30-34.
St. Louis group: Spergen Hill, Lanesville, and Bloomington, Indiana.

1906. *Microdon oblonga.* Beede, Ind. Dept. Geol. Nat. Res., 30th Rep., p. 1330, pl. 23, figs. 30-36.
Salem limestone: Spergen Hill and Bloomington, Indiana.

1909. *Cypricardella oblonga.* Grabau and Shimer, N. A. Index Foss., p. 535, fig. 728.
St. Louis: Indiana.
Ste. Genevieve: Kentucky.

Description. — "Shell oblong, sub-quadrangular anterior end, narrow, rounded; posterior end broader, flattened, and almost vertically truncate; cardinal margin nearly straight and horizontal behind, declining in front; base nearly parallel to the hinge-line; beaks small, somewhat prominent, gibbous below; posterior umbonal slope gibbous or sub-angular, and extending

FIG. 20. — *Cypricardella oblonga.* A view of a right valve, enlarged four times.

obliquely downward and backward to the base of the truncation; lunule small, ovate, deep in the center; escutcheon linear distinct.

"Length, .09 to .30; width, .06 to .20 of an inch [Hall, 1883]."

Horizon and locality. — Maxville limestone.
Lower zone: Cut No. 4, Mt. Perry-Fultonham.

CLASS SCAPHOPODA.

DENTALIUM ILLINOIENSE—Worthen.

1883. *Dentalium Illinoiense.* Worthen, Geol. Surv. Ill., Vol. VII, p. 325.
Chester limestone: Chester, Illinois.
1890. *Dentalium illinoiense.* Worthen, Geol. Surv. Ill., Vol. VIII, p. 145, pl. 23, fig. 1.
Chester limestone: Chester, Illinois.

Description. — "Shell above a medium size, long, straight, cylindrical, slightly tapering, scarcely inflated at the aperture. Surface apparently smooth originally, but slightly roughened by weathering in the specimen under examination.

"Length, 5 7/8 inches; width near the aperture, 7/16 inch [Worthen, 1890]."

FIG. 21.—*Dentalium illinoiense.* An imperfect specimen.

Horizon and locality.—Maxville limestone. Lower zone: Cut No. 4, Mt. Perry-Fultonham.

CLASS GASTROPODA.

STRAPAROLLUS SIMILIS—Meek and Worthen.

1861. *Straparollus similis.* Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 145.
St. Louis limestone: Waterloo, Illinois.

1866. *Straparollus similis.* Meek and Worthen, Geol. Surv. Ill., Vol. II, p. 285, pl. 19, figs. 4a, b.
St. Louis group: Waterloo, Illinois.

1891. *Straparollus similis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 589, pl. 14, figs. 9-11.
Maxville limestone: Newtonville and near Maxville, Ohio.

1895. *Straparollus similis.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 476, pl. 10, figs. 9-11.
Maxville limestone: Newtonville and near Maxville, Ohio.

1897. *Straparollus similis* (?) Weller, Trans. N. Y. Acad. Sci., Vol. XVI, p. 270.
Batesville sandstone: Batesville, Arkansas.

1909. *Euomphalus similis.* Grabau and Shimer, N. A. Index Foss., pp. 659, 660, fig. 909.

St. Louis: Illinois; Maxville, Ohio; Batesville, Arkansas.

Description. — Shell varies from smaller than medium to medium size, subdiscoidal or with a slightly elevated spire, and with a broad umbilicus. Whorls about four in number and gradually increasing in size. Whorls flattened on the upper surface with a sharp keel on the peripheral angle, abruptly descending from the keel to the median periphery and then gently rounded to the median basal line, and rounded from the latter line to the suture. A sharp angular keel occurs on the median basal line of at least the body whorl. Surface of the shell covered with closely crowded transverse striæ.

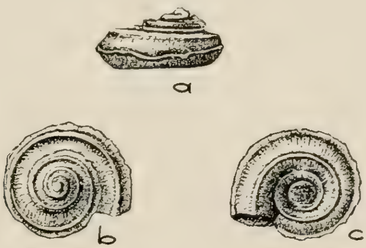


Fig. 22. — *Straparollus similis.*

a, b, and c. — Lateral, apical, and basal views of an individual. (After Whitfield.)

Diameter 14 to 25 mm.

The shell is readily distinguished by its subdiscoidal outline, large umbilicus, flattened upper surface of the whorls, the keels of the upper and lower surfaces, and the crowded transverse striæ.

Most of the specimens have a horizontal lateral extension, which is given off from the median peripheral line of the last or body whorl. This extension always adheres more or less to the matrix and seems to be due to vertical crushing.

It is one of the four most abundant forms of the Maxville limestone, and is found in great numbers in the shale-nodular zone.

Horizon and locality. — Maxville limestone.

Upper zone: Mouth of Buckeye Fork, Fultonham; Gladstone Mills, Below Thompson Residence?, White Cottage; Smith Chapel, Logan.

Shale-nodular zone: Cut No. 5, Mouth of Hough Hollow, Mt. Perry-Fultonham; Kroft Residence, Kroft Bridge, White Cottage; Stimmel Residence, Maxville; Smith Chapel, Logan.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham.

HOLOPEA NEWTONENSIS—Whitfield.

1882. *Holopea Newtonensis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 224.
Maxville limestone: Newtonville, Ohio.

1891. *Holopea Newtonensis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 591, pl. 14, fig. 12.
Maxville limestone: Newtonville, Ohio.

1895. *Holopea Newtonensis.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 477, pl. 10, fig. 12.
Maxville limestone: Newtonville, Ohio.

Description. — "Shell of medium size, ovate in outline and ventricose, with a moderately elevated spire and extremely ven-

FIG. 23. — *Holopea newtonensis.* Lateral view. (After Whitfield.)

tricose volutions, which increase very rapidly in bulk from the apex. Volutions three and half to four in number, with strongly rounded surfaces and moderate sutures. Apical angle about seventy degrees. Aperture broad ovate, modified on the inner side by the preceding volution, pointed at the upper end and broadly rounded at the base. Surface of the shell smooth and substance very thin [Whitfield, 1895]."

Length 30 mm.; diameter 20 mm.

The shell is characterized by its medium size and ventricose volutions.

Horizon and locality. — Maxville limestone. Shale-nodular zone: Kroft Bridge, White Cottage.

BULIMORPHA MELANOIDES—Whitfield.

1882. *Polyphemopsis melanoides.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 225.
Maxville limestone: Newtonville, Ohio.

1891. *Polyphemopsis melanoides.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 592, pl. 14, fig. 13.
Maxville limestone: Newtonville, Ohio.

1895. *Polyphemopsis melanoides.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 478, pl. 10, fig. 13.
Maxville limestone: Newtonville, Ohio.

Description. — Shell below medium size, elongate, similar to a slender cone in outline. Spire elevated and pointed at the apex. Whorls gradually increase in size, about five and half

FIG. 24. — *Bulimorpha melanoides.* Lateral view. (After Whitfield.)

in number, moderately and evenly convex, with distinct sutures. Aperture ovate, rounded below, acute above. Columella indistinct.

Surface seems to be smooth in most specimens. One individual shows transverse growth lines parallel with the margin of the outer lip.

Length 26 mm.; width 12 mm.

The shell is hard to characterize except the agreement of the general outline with that of the figure.

Horizon and locality. — Maxville limestone.

Upper zone: Gladstone Mills (?), Below Thompson Residence, White Cottage.

Shale-nodular zone: Cut No. 5, Mt. Perry-Fultonham; Kroft Bridge, White Cottage; Stimmel Residence, Maxville.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham.

BULIMORPHA CANALICULATA—Hall.

1856. *Bulimella canaliculata.* Hall, Trans. Albany Inst., Vol. IV, p. 29
St. Louis limestone: Spergen Hill, Indiana.

1882. *Bulimorpha canaliculata.* Whitfield, Bull. Am. Mus. Nat. Hist., Vol. I, p. 74, pl. 8, fig. 41.
St. Louis group: Spergen Hill, Indiana.

1883. *Bulimorpha canaliculata.* Hall, Ind. Geol. and Nat. Hist., 12th Rep., p. 367, pl. 31, fig. 41.
St. Louis group: Spergen Hill and Lanesville, Indiana.

1889. *Bulimorpha canaliculata.* Keyes, Proc. Acad. Nat. Sci. Phil., p. 300.

1906. *Bulimorpha canaliculata.* Cumings, Ind. Dept. Geol. Nat. Res., 30th Ann. Rept., p. 1343, pl. 25, fig. 41.
Salem limestone: Spergen Hill, Indiana.

Description. — "Shell sub-fusiform, somewhat elongate; spire short, scarcely equaling the length of the last volution;

FIG. 25. — *Bulimorpha canaliculata.* A view of an imperfect specimen referred to this species, enlarged four times.

volutions about five, upper ones scarcely convex, rapidly diminishing to the apex; last volution longer than the spire above, slightly ventricose; suture canaliculate, the groove margined by a slight sharp carination at the upper edge of the volution; aperture sub-ovate; surface smooth, or marked with fine lines of growth, which are abruptly bent backward at the carination on the upper edge of the volution, which marks the notch in the upper angle of the aperture.

Length, .18 of an inch [Hall, 1883]."

Horizon and locality. — Maxville limestone.
Lower zone: Cut No. 4, Mt. Perry-Fultonham.

SPHAERODOMA SUBCORPULENTA—Whitfield

1882. *Macrocheilus subcorpulentus.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 224.
Maxville limestone: Newtonville, Ohio.
1889. *Sphærodoma subcorpulenta.* Keyes, Proc. Acad. Nat. Sci. Phil., p. 306.
1891. *Macrocheilus subcorpulentus.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 591, pl. 14, fig. 14.
Maxville limestone: Newtonville, Ohio.
1895. *Macrocheilus subcorpulentus.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 478, pl. 10, fig. 14.
Maxville limestone: Newtonville, Ohio.

Description. — Shell small, cone-shaped, with rounded base. Whorls three or three and a half in number, convex, and rapidly increase in size so that the body whorl is much larger than the

FIG. 26. — *Sphærodoma subcorpulenta.* A view of a specimen showing the aperture. (After Whitfield.)

rest of the shell. Sutures distinct, but not deeply grooved. Aperture ovate, acute above and rounded below. Columella not prominently developed. Surface of the shell seemingly smooth.

Length 11-14 mm.; width 5-8 mm.

The shell is characterized by its small size and rapidly enlarging whorls.

Horizon and locality. — Maxville limestone.

Upper zone: Below Thompson Residence, White Cottage.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham.

NATICOPSIS ZICZAC—Whitfield.

1882. *Naticopsis ziczac.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 223.
Maxville limestone: Newtonville, Ohio.

1891. *Naticopsis ziczac.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 590, pl. 14, figs. 15, 16.
Maxville limestone: Newtonville, Ohio.

1895. *Naticopsis ziczac.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 477, pl. 10, figs. 15, 16.
Maxville limestone: Maxville, Ohio.

1909. *Naticopsis ziczac.* Grabau and Shimer, N. A. Index Foss., p. 673, fig. 933.
Maxville: Ohio.

Description. — Shell less than medium size with depressed spire. Whorls ventricose, about two and a half in number, rapidly increase in size. Aperture large, equal to about half the size of the whole shell, rounded. Suture prominent, subquadrate

FIG. 27. — *Naticopsis ziczac.*
a and b. — Natural size and enlarged views of an individual. (After Whitfield.)

in cross section. Surface of the whorls of the spire crossed by transverse striæ, which are bent backward. Surface of the body whorl also ornamented with transverse striæ which bend backward in the sutural third of the whorl, then by acute bends zigzag across the median peripheral third, and on the basal third bend abruptly forward.

Length 15 mm.; diameter 20 mm.

The shell is readily identified by its depressed spire, large aperture, and the zigzag striæ of the median portion of the body whorl.

Horizon and locality. — Maxville limestone.

Upper zone: Below Thompson Residence, White Cottage.

Shale-nodular zone: Cut No. 5, Upper end Cut No. 6, Mt. Perry-Fultonham; Kroft Bridge, White Cottage.

Lower zone: Bridge Gully, Mt. Perry-Fultonham.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham.

BELLEROPHON ALTERNODOSUS—Whitfield.

1882. *Bellerophon alternodosus.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 225.
Maxville limestone: Newtonville, Ohio.

1891. *Bellerophon alternodosus.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 593, pl. 14, figs. 17-19.
Maxville limestone: Newtonville, Ohio.

1895. *Bellerophon alternodosus.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 479, pl. 10, figs. 17-19.
Maxville limestone: Newtonville, Ohio.

Description. — "Shell of about a medium size, and somewhat subglobose in general form, with an appearance of being

FIG. 28. — *Bellerophon alternodosus.*
a, b, and c. — Apertural, dorsal, and profile views of the same specimen. (After Whitfield.)

slightly flattened on the dorsum in immature specimens; while on the adult forms, the dorsum is marked on the outer half of the body-volution by a double series of rounded nodes, those on one side of the center alternating with those of the other side, and the inner margins of the two series interlocking with each other. Aperture broadly elliptical, strongly modified by the projection of the preceding volution, on the inner margin. Auriculations largely developed and slightly reflected. Axis very distinctly perforate. Inner lip somewhat callous on the protruding inner volution. Surface of the shell, so far as can be ascertained, marked only by lines of growth, beyond the nodes mentioned [Whitfield, 1895]."

Horizon and locality. — Maxville limestone.
Unknown zone: White Cottage (Type specimen).

BELLEROPHON SUBLAEVIS—Hall.

1856. *Bellerophon sublævis.* Hall, Trans. Albany Inst., Vol. IV, p. 32.
St. Louis limestone: Spergen Hill and Bloomington, Indiana; Alton, Illinois.

1858. *Bellerophon sublævis.* Hall, Geol. Surv. Iowa, Vol. 1, pt. II, p. 666, pl. 23, figs. 15a-c.
Warsaw limestone: Above Alton, Illinois; Spergen Hill and Bloomington, Indiana.

1882. *Bellerophon sublævis.* White, Ind. Geol. Nat. Hist., 11th Ann. Rep., p. 359, pl. 40, figs. 5-7.
St. Louis group: Elletsville, Indiana.

1882. *Bellerophon sublævis.* Whitfield, Bull. Am. Mus. Nat. Hist., Vol. I, p. 89, pl. 8, figs. 6, 7.
St. Louis group: Spergen Hill, Bloomington, Paynter's Hill and Elletsville, Indiana; Alton, Illinois.

1883. *Bellerophon sublævis.* Hall, Ind. Geol. Nat. Hist., 12th Rep., p. 371, pl. 3, figs. 6-7.
St. Louis group: Alton, Illinois; Spergen Hill, Lanesville and Bloomington, Indiana.

1886. *Bellerophon sublævis.* Claypole, Proc. and Coll. Wyo. Hist. and Geol. Soc., Vol. II, pt. II, p. 246.
Lower Coal Measures: Wilkesbarre, Pennsylvania.

1891. *Bellerophon sublævis* ? Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 592, pl. 14, figs. 20, 21.
Maxville limestone: Newtonville and Maxville, Ohio.

1894. *Bellerophon sublævis.* Keyes, Mo. Geol. Surv., Vol. V, p. 148.
St. Louis limestone: St. Louis, Missouri.

1895. *Bellerophon sublævis* ? Whitfield, Geol. Surv. Ohio, Vol. VII, p. 479, pl. 10, figs. 20, 21.
   Maxville limestone: Newtonville and Maxville, Ohio.

1897. *Bellerophon sublævis.* Weller, Trans. N. Y. Acad. Sci., Vol. XVI, p. 269, pl. 21, fig. 10.
   Batesville sandstone: Batesville, Arkansas.

1906. *Bellerophon sublævis.* Cumings, Ind. Dept. Geol. Nat. Res., 30th Ann. Rep., p. 1360, pl. 25, figs. 6, 7.
   Salem limestone: Spergen Hill, Bloomington, Indiana; Alton, Illinois.

1909. *Bellerophon sublævis.* Grabau and Shimer, N. A. Index Foss., p. 620, fig. 832.
   St. Louis and Chester group: Indiana, Illinois, Ohio, Missouri, Arkansas.
   Lower Coal Measures: Pennsylvania.

Description. — Shell subglobose with three whorls of which the last or body whorl is moderately expanded. The inner whorl projects into and strongly modifies the aperture which is transversely kidney-shaped. Outer lip both thick and somewhat reflected at the junction with the body of the shell. Umbilicus not developed. Anterior portion of body whorl keeled in the best preserved specimens.

Fig. 29. — *Bellerophon sublævis.*
a and b. — Back and profile views of the same specimen from which the shell is mostly removed. (After Whitfield.)

Surface of nearly all of the Maxville specimens not preserved. However, one or two show the surface to be crossed by fine transverse striæ, which bend abruptly backward over the keel as described by Hall (1858).

Greatest diameter 15-26 mm.

The shell is characterized by its subglobose outline and its manner of preservation. Practically all of the specimens are granular, calcite casts and when broken from the limestone matrix the internal molds are sprinkled with a thin coat of these crystals. These molds as a rule do not show the keel.

This is one of the four most common species of the Maxville limestone. It has a rather great vertical range and at certain horizons is found in large numbers.

Horizon and locality. — Maxville limestone.

Upper zone: North Bank of Jonathan Creek, Fultonham; Gladstone Mills, Kroft Bridge, Thompson Residence, Below Thompson Residence, White Cottage; Smith Chapel, Logan.

Shale-nodular zone: Cut No. 5, Upper end of Cut No. 6, Mouth of Hough Hollow, Mt. Perry-Fultonham; Kroft Residence, Kroft Bridge, White Cottage; Stimmel Residence, Maxville; Smith Chapel, Logan.

Lower zone: Cut No. 4, Cut No. 5, Mt. Perry-Fultonham.

Undetermined zone: Middle of Cut No. 6, Mt. Perry-Fultonham.

ORTHONYCHIA ACUTIROSTRE—Hall.

1856. *Capulus acutirostris.* Hall, Trans. Albany Inst., Vol. IV, p. 31.
St. Louis limestones: Spergen Hill and Bloomington, Indiana.

1858. *Capulus acutirostris.* Hall, Geol. Iowa, Vol. I, pt. II, p. 665, pl. 23, figs. 14a, b.
Warsaw limestone: Warsaw, Illinois; Spergen Hill and Bloomington, Indiana.

1866. *Platyceras uncum.* Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 264.
Keokuk limestone: Nauvoo, Illinois.

1873. *Platyceras uncum.* Meek and Worthen, Geol. Surv. Ill., Vol. V, p. 516, pl. 17, fig. 1a, b.
Keokuk limestone: Nauvoo, Illinois.

1882. *Platyceras acutirostris.* Whitfield, Bull. Am. Mus. Nat. Hist., Vol. I, p. 67, pl. 8, figs. 13-15.
St. Louis group: Spergen Hill, Paynter's Hill, Elletsville, Bloomington and Crawfordsville, Indiana; Warsaw, Illinois; Tuscumbia, Alabama.

1883. *Platyceras acutirostris.* Hall, Ind. Geol. Nat. Hist., 12th Rep., p. 370, pl. 31, figs. 13-15.
St Louis group: Spergen Hill, Lanesville and Bloomington, Indiana.

1886. *Capulus acutirostris.* Claypole, Proc. and Coll. Wyo. Hist. and Geol. Soc., Vol. II, pt. II, p. 246.
Lower Coal Measures: Wilkesbarre, Pennsylvania.
1890. *Capulus acutirostris.* Keyes, Am. Geol., Vol. VI, p. 9.
1890. *Capulus acutirostris.* Keyes, Proc. Acad. Nat. Sci. Phil., p. 170.
Keokuk group: Warsaw and Nauvoo, Illinois.
St. Louis limestone: Spergen Hill and Bloomington, Indiana; Tuscumbia, Alabama.
1892. *Orthonychia acutirostre.* Keyes, Am. Geol., Vol. X, p. 276.
1894. *Orthonychia acutirostre.* Keyes, Mo. Geol. Surv., Vol. V, p. 190, pl. 54, figs. 2a-c.
Keokuk limestone and shale: Warsaw and Nauvoo, Illinois.
St. Louis limestone: Spergen Hill and Bloomington, Indiana; Tuscumbia, Alabama.
1897. *Capulus acutirostris.* Weller, Trans. N. Y. Acad. Sci., Vol. XVI, p. 268.
Batesville sandstone: Batesville, Arkansas.
1906. *Orthonychia acutirostre.* Cumings, Ind. Dept. Geol. Nat. Res., 30th Ann. Rep., p. 1335, pl. 23, figs. 14, pl. 25, figs. 5, 13-15.
Salem limestone: Spergen Hill, Bloomington, Indiana; Illinois; Alabama.
1909. *Orthonychia acutirostris.* Grabau and Shimer, N. A. Index. Foss., p. 688, figs. 976, 977.
Keokuk and Warsaw: Illinois, Indiana, Alabama.
St. Louis: Indiana, Illinois.
Chester: Arkansas.
Coal measures: Pennsylvania.

Description. — "Shell below medium size, rather slender, strongly arcuate, forming from one to one and one-half volu-

Fig. 30. — *Orthonychia acutirostre.* A slightly restored drawing of an individual, showing the prominent ridge on the dorsal side. Enlarged two diameters.

tions; posterior side for some distance from apertural margin nearly straight. Spire laterally more or less compressed; sometimes small and short, sometimes long, attenuate, simply incurved or enrolled. Aperture oval, or sub-circular; margin sharp, sinuous. Surface marked by somewhat imbricated lines of growth and several obscurely defined longitudinal plications, the anterior one being usually larger than the others, and often forming a prominent subangular ridge [Keyes, 1894]."

Length 12 mm.; diameter 7 mm.

The species is readily distinguished by its open coil, its suddenly expanded cone, and by its anterior ridge.

Horizon and locality. — Maxville limestone. Lower zone: Cut No. 4, Mt. Perry-Fultonham.

STROPHOSTYLUS CARLEYANA—Hall.

1856. *Natica Carlyana.* Hall, Trans. Albany Inst., Vol. IV, p. 31.
St. Louis limestone: Spergen Hill and Bloomington, Indiana; Alton, Illinois.

1882. *Naticopsis Carleyana.* Whitfield, Bull. Am. Mus. Nat. Hist., Vol. I, p. 71, pl. 8, figs. 26, 27.
St. Louis group: Spergen Hill and Bloomington, Indiana; Alton, Illinois.

1883. *Naticopsis Carleyana.* Hall, Ind. Geol. and Nat. Hist., 12th Rep., p. 369, pl. 31, figs. 26, 27.
St. Louis group: Alton, Illinois; Spergen Hill and Bloomington, Indiana.

1894. *Strophostylus ? carleyana.* Keyes, Mo. Geol. Surv., Vol. V, p. 196.
St. Louis limestone: Alton, Illinois.

1906. *Strophostylus carleyana.* Cumings, Ind. Dept. Geol. Nat. Res., 30th Ann. Rept., p. 1340, pl. 25, figs. 26, 27.
Salem limestone: Spergen Hill and Bloomington, Indiana; Alton, Illinois.

1909. *Strophostylus carleyanus.* Grabau and Shimer, N. A. Index. Foss., p. 678, fig. 949.
St. Louis limestone: Illinois and Indiana.

1911. *Strophostylus* aff. *carleyanus.* Girty, U. S. Geol. Surv., Bull. 439, p. 94, pl. 7, fig. 6.
Moorefield shale: Batesville quadrangle, Arkansas.

Description.—"Shell sub-globose; spire short, consisting of about three volutions, which increase very rapidly, the last one extremely ventricose; suture not distinctly defined; aperture ovate, straight on the columella side; outer lip sharp; inner lip thickened; columella with distinct groove near the base of the lip for the reception of the operculum; surface marked by fine, elevated striæ corresponding to the lines of growth.

Fig. 31.—*Strophostylus carleyana.* A view of a partially exfoliated or worn specimen, referred to this species. Enlarged four times.

"Height, .10 to .30; diameter, .08 to .34 of an inch [Hall, 1883]."

Horizon and locality.—Maxville limestone.
Lower zone: Cut No. 4, Mt. Perry-Fultonham.

MURCHISONIA VERMICULA—Hall.

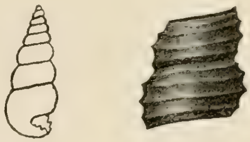
1856. *Murchisonia vermicula.* Hall, Trans. Albany Inst., Vol. IV, p. 27.
St. Louis limestone: Spergen Hill and Bloomington, Indiana.

1882. *Murchisonia vermicula.* Whitfield, Bull. Am. Mus. Nat. Hist., Vol. I, p. 87, pl. 9, fig. 11.
St. Louis group: Spergen Hill and Bloomington, Indiana.

1883. *Murchisonia vermicula.* Hall, Ind. Geol. and Nat. Hist., 12th Rep., p. 361, pl. 32, fig. 11.
St. Louis group: Spergen Hill, Lanesville and Bloomington, Indiana.

1906. *Solenospira vermicula.* Cumings, Ind. Dept. Geol. Nat. Res., 30th Ann. Rep., p. 1357, pl. 26, fig. 11.
Salem limestone: Spergen Hill, etc., Indiana.

Description.—"Shell cylindrical, abruptly tapering at the apex; volutions from six to ten, moderately convex in the middle, and scarcely diminishing for the first four or five turns above the base, but becoming more abruptly contracted above; the surface of each volution marked by two very prominent revolving striæ, having a space between them on the periphery and a single finer line below, and one above near the suture; the last volution not ventricose, and marked by a fifth revolving striation, which is a continuation of the suture line; aperture



a b

FIG. 32.—*Murchisonia vermicula.*

a.—An outline drawing of an individual which has undergone much erosion, enlarged four diameters.

b.—Two whorls of another specimen, enlarged to eight diameters in order to show the characteristic markings.

broadly oval, rounded below; columella imperforate. Shell minute.

"Length, .14 of an inch [Hall, 1883]."

Horizon and locality.—Maxville limestone. Lower zone: Cut No. 4, Mt. Perry-Fultonham.

CLASS CEPHALOPODA.

ENDOLOBUS SPECTABILIS—Meek and Worthen.

1860. *Nautilus spectabilis.* Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 469.
Chester limestone: Gravel Creek, Illinois.

1865. *Nautilus (Endolobus) peramplus.* Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 259.
Chester group: Randolph County, Illinois.

1866. *Nautilus (Endolobus) spectabilis.* Meek and Worthen, Geol. Surv. Ill., Vol. II, p. 308, pl. 25, figs. 1a, b.
Chester group: Randolph County, Illinois.

1891. *Nautilus (Temnocheilus) spectabilis.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 594, pl. 14, fig. 22.
Maxville limestone: Near Rushville, Ohio.

1894. *Nautilus spectabilis.* Keyes, Mo. Geol. Surv., Vol. V, p. 222.
Kaskaskia limestone: St. Louis County, Missouri.

1895. *Nautilus (Temnocheilus) spectabilis.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 480, pl. 10, fig. 22.
Maxville limestone: Near Rushville, Ohio.

Description. — "Shell of medium to large size, composed of several volutions, which increase rapidly in size, and are (transversely) elliptical in a transverse section; the diameter from side to side being about one-third greater than the dorso-ventral diameter at the same point; the lateral edges being obtusely angular, and the dorsal [ventral] portion of the sec-

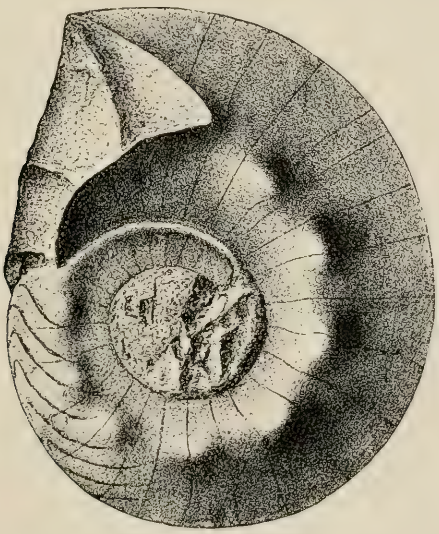


FIG. 33. — *Endolobus spectabilis.* Lateral view. (After Whitfield.)

tion larger and more convex than the inner part, strongly convex and subangular on the back. Inner surface of the volution strongly impressed by the one preceding, which it embraces to near the point of greatest diameter. Umbilicus very broad and deep, exposing each of the inner volutions to just beyond the point of greatest transverse diameter, the umbilical surface of the volutions being moderately convex but quite abrupt. The sides of the volutions are marked by a series of nodes of considerable strength and size, arranged at regularly increasing distances, and occurring, as nearly as can be determined from the example on hand, at about every second septum. The nodes are situated on the crest of the side, and are obtusely rounded and prominent. Septa moderately distant and but slightly bent downward on the dorsum [venter?]. On a specimen measuring about three inches in its greatest diameter, the whole of which is septate, they are arranged at about one-third of an inch apart; near the outer extremity of the last volution. Siphuncle not observed, and the depth of the septa not ascertained. The surface of a portion of the specimen bears marks of a series of strong varices of growth, which have crossed the dorsum [venter?] and show a strong retral sinus or notch in the margin of the lip at this point. The varices are seen in the inner portion of the last volution and appear to have been arranged at distances nearly corresponding to the septa at the same place. No other markings of the surface are retained [Whitfield, 1895]."

As Whitfield points out, this species closely resembles the illustrations and description of the one originally named *Nautilus forbesianus* by McChesney. Apparently the only difference is the location of the line of lateral nodes. In the species *spectabilis* the line is so located that the greater portion of the volution lies on the peripheral side while in *forbesianus* the larger part occurs on the inner side. Why two species so nearly alike that they can scarcely be separated specifically, should subsequently be referred to two distinct genera (*Endolobus spectabilis* and *Temnocheilus forbesianus*) is rather hard to understand.

Horizon and locality. — Maxville limestone.
Unknown zone: Rushville (Andrew's collection).

NAUTILUS PAUPER—Whitfield.

1882. *Nautilus pauper.* Whitfield, Ann. N. Y. Acad. Sci., Vol. II, p. 226.
Maxville limestone: Near Rushville, Ohio.

1891. *Nautilus pauper.* Whitfield, Ann. N. Y. Acad. Sci., Vol. V, p. 595, pl. 14, fig. 23.
Maxville limestone: Near Rushville, Ohio.

1895. *Nautilus pauper.* Whitfield, Geol. Surv. Ohio, Vol. VII, p. 481, pl. 10, fig. 23.
Maxville limestone: Near Rushville, Ohio.

Description. — "Shell somewhat below the medium size, and consisting of about two and a half volutions, which increase rather rapidly in size, and are so coiled as to expose almost the entire diameter of the inner coils in the umbilical cavity; the outer one embracing only the dorsal [ventral] surface of the inner volution. Volutions quadrangular in form , with lateral diameter only about two-thirds as great as the dorso-ventral

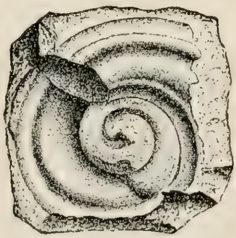


FIG. 34. — *Nautilus pauper.* A view of the outer chamber and the impression of the inner coils. (After Whitfield.)

diameter, while the dorsal and ventral surfaces are nearly vertical [perpendicular] to the plane of the sides, so far as can be determined from the specimen on hand; or possibly the dorsal [ventral?] surface may be slightly rounded. The sides of the shell are marked by a faint, narrow, revolving sulcus bordering the margin of the umbilicus, and by a correspondingly faint ridge close to the dorsal margin; while a much stronger rounded ridge occurs on the surface at about one-third of the width of the volution from the dorsal [ventral?] border. Internal features of the shell not known.

"A single individual only of the species has been observed, and is altogether too imperfect to reveal all the features. It consists of the non-septate portion of the shell, in the condition of an internal cast, with the impression of one side of the entire shell; but gives no indications of the septa themselves. The only features indicating its cephalopodous nature, upon which one can rely, are its symmetrical form and the evidence of a similar ornamentation on the opposite sides; otherwise it might have been supposed to represent a form of *Euomphalus* [Whitfield, 1895]."

Horizon and locality. — Maxville limestone.

Upper zone: Mouth of Buckeye Fork (?), Fultonham; Below Thompson Residence (?), White Cottage.

Lower zone: Cut No. 4, Mt. Perry-Fultonham.

ORTHOCERAS RANDOLPHENSE—Worthen.

1861. *Orthoceras annulo-costatum.* Meek and Worthen, Proc. Acad. Nat. Sci. Phil., p. 147, (Not *O. annulato-costatum* Boll, 1857).
Chester limestone: Chester, Illinois.

1866. *Orthoceras annulato-costatum.* Meek and Worthen, Geol. Surv. Ill., Vol. II, p. 304, pl. 24, figs. 3a, b.
Chester group: Chester, Illinois.

1882. *Orthoceras Randolphensis.* Worthen, Ill. State Mus. Nat. Hist., Bull. No. 1, p. 38.
Chester group.

1884. *Orthoceras Randolphensis* ? Walcott, U. S. Geol. Surv., Mon. VIII, p. 265, pl. 18, fig. 17.
Lower Carboniferous: Eureka District, Nevada.

Description. — "Shell attaining a medium size, and having the form of an elongated, moderately compressed cone, the sides of which converge towards the apex at an angle of about 14°. Section elliptical, the greater transverse diameter being to the smaller as 100 to 80. Surface ornamented with slightly oblique, annular costæ, which are less than the depressions between, and rather sharply elevated on the smaller half of the shell, but become gradually obsolete towards the aperture, where they are not more widely separated than near the smaller end. Traces of fine transverse striæ are also seen on well preserved specimens; both between and upon the costæ. (Septa and siphuncle unknown). The largest specimen we have seen is about five inches in length (both extremities being incomplete) and 1.83 inches in its greatest diameter at the larger end, while its greater diameter at the smaller end is near 0.70 inch."

"............Prof. Swallow has described, from the same horizon as this, a similar species under the name *O. chesterensis* (Trans. St. Louis Acad. Sci., Vol. II, p. 98, 1862), but our shell differs in having fewer and more distant costæ, there being generally about four of them in a space equalling the transverse diameter, while *O. chesterensis* has eight in the same space. [Meek and Worthen, 1866]."

FIG. 35. — *Orthoceras randolphense.* A view of an imperfect specimen.

Horizon and locality. — Maxville limestone.
Shale-nodular zone: Kroft Bridge, White Cottage.

ORTHOCERAS OKAWENSE?—Worthen.

1883. *Orthoceras Okawensis.* Worthen, Geol. Surv. Ill., Vol. VII, p. 324.
Chester limestone: Okaw Bluffs near Red Bud, Randolph County, Illinois.

1890. *Orthoceras okawense.* Worthen, Geol. Surv. Ill., Vol. VIII, p. 149, pl. 26, fig. 3.
Chester limestone: Near Red Bud, Randolph County, Illinois.

Description. — "Shell elongate, slender, very gradually tapering to the apex; septa concave, about four of them in the space of one diameter. Siphuncle sub-central; surface markings unknown.

"This shell has a general resemblance to *O. rushense,* Mc-

Fig. 36. — *Orthoceras okawense*? A view of a fragment of a shell referred to this species.

Chesney of the upper Coal Measures, but differs from it in the position of the siphuncle which in our species is decidedly subcentral [Worthen, 1890]."

Horizon and locality. — Maxville limestone.
Shale-nodular zone: Kroft Bridge, White Cottage.

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Names in *italic* are synonyms.

Proceedings

of the

Ohio State Academy of Science

VOLUME V, PART 8

Annual Report

Twentieth Meeting

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Selby, A. D., *Botany*....................Experiment Station, Wooster
Shade, Ernest F., *Physiography, Botany, Physics*....................Medina
Shatzer, C. G....................Wittenberg College, Springfield
Shaw, N. E., *Entomology*....................O. S. U., Columbus
Shilliday, C. L., *Zoology*....................Athens
Sim, Robert J....................Jefferson
Smead, Anna, *Biology*....................624 Nestle St., Toledo
Smith, A. L....................Valley Crossing
Smith, Ethel M....................Rome
Smith, G. D., *Botany, Zoology*....................Richmond, Ky.
Smith, J. Warren, *Meteorology*....................Weather Bureau, Columbus
Snearline, A. L., *Botany and Geology*....................Akron
Snyder, F. D., *Zoology, Ethnology*....................Ashtabula
Stair, L. D....................Federal Furnace Co., S. Chicago, Ill.
Stauffer, Clinton R., *Geology*....................Adelbert College, Cleveland
Sterki, Victor, *Conchology, Botany*....................New Philadelphia
Stickney, M. E., *Botany*....................Granville
Stockberger, W. W., *Botany*.......Dept. Agriculture, Washington, D. C.
Stover, W. Garfield, *Botany*....................Stillwater, Okla.
Stout, W. E., *Chemistry, Geology*.........217 E. Mithoff Ave., Columbus
Surface, F. M., *Zoology, Botany*....................Lexington, Ky.
Sweezey, Otto H....................Twelfth Ave., Honolulu, Hawaii
Todd, Joseph H., *Geology, Archaeology*........Christmas Knoll, Wooster
True, H. L....................McConnelsville
Tyler, F. J., *Botany*....................Perry, Lake County
Waite, F. C....................Western Reserve University, Cleveland
Walton, L. B., *Biology*....................Gambier
Webb, R. J., *Botany*....................Garrettsville
Webster, F. M., *Entomology*.....U. S. Dept. Agricul., Washington, D. C.
Werthner, William B., *Botany*....................Steele High School, Dayton
Westgate, Lewis G., *Geology*....................Delaware
Wieman, Harry L., *Biology*....................Univ. of Cincinnati, Cincinnati
Williams, Stephen R., *Biology*....................Miami University, Oxford
Williamson, E. B., *Ichthyology, Ornithology*....................Bluffton, Ind.
Wilson, Stella S., *Geography, Geology*........97 N. 20th St., Columbus
Wineland, L. A., *Chemistry*....................Westerville
Wittenmyer, J. G., *Zoology*....................Peebles

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* Subject to ratification of the Society at the annual meeting, 1911.

WRIGHT, G. FREDERICK, *Geology*.................................Oberlin
YORK, HARLAN H., *Botany*........................Providence, R. I.
YOUNG, R. A., *Botany*...
..............Div. Seed and Plant Introduction, Washington, D. C.

Report of the Twentieth Annual Meeting

of the

Ohio State Academy of Science

ANNUAL MEETING

The twentieth annual meeting of the Academy was held at Buchtel College, Akron, Ohio, on November 24, 25 and 26, the President, Professor W. F. Mercer, presiding. On Thursday evening an informal reception was given to the members of the Academy by President and Mrs. A. B. Church. Acquaintances were renewed and a most enjoyable period spent by those fortunate enough to arrive Thursday evening.

The meeting was called to order on Friday morning at 9:00 in the Knight Chemical Laboratory after a preliminary session of various committees. President Church in behalf of the college extended a cordial greeting to all members of the Academy, and reviewed the scientific progress of which he had been observant in Ohio.

The regular business meeting followed, the president after a few brief remarks appointing a committee on membership and a committee on resolutions. The report of the Secretary was presented and accepted. This was followed by a report of the Treasurer, Prof. J. S. Hine, which after being referred to an auditing committee was accepted. The report of the Treasurer is as follows:

REPORT OF THE TREASURER FOR THE YEAR 1910.

For the year since our last annual meeting the receipts, including balance from last year; have amounted to $329.37, and the expenditures to $264.94, leaving a cash balance of $64.43.

RECEIPTS.

Balance from last year	$ 56 37	
Interest on endowment	2 00	
Membership dues	271 00	
Total		$329 37

DISBURSEMENTS.

190 subscriptions to The Ohio Naturalist	$142 50	
Printing annual report and price lists	66 25	
Miscellaneous expenses	56 19	
Balance due December 1, 1910	64 43	
Total		329 37

Respectfully submitted,

JAS. S. HINE, *Treasurer.*

The report of the Librarian, Prof. W. C. Mills, is as follows:

As Librarian of the Ohio State Academy of Science, I take pleasure in presenting my report upon the receipts from the sale of publications of the Academy and the expense of sending out the publications.

Cash on hand November 26, 1909	$ 1 42	
Sale of publications	26 88	
Total		$ 28 30

EXPENDITURES FROM NOVEMBER 26, 1909, TO NOVEMBER 25, 1910.

Letter postage	$ 1 42
Sending out Special Paper No. 16	6 00
Sending out Annual Report	6 00
Express	1 00
Stationery	1 25
Sending out publications during the year	1 66

	$ 17 33
Balance on hand	$ 10 97

Respectfully submitted,

WM. C. MILLS, *Librarian.*

Under the reports of Standing Committees, Prof. Lazenby, a trustee of the Emerson McMillin Research Fund, noted the continued interest of Mr. McMillin in the cause of science, through the gift of $250 toward the promotion of scientific investigation in Ohio. The detailed report follows:

FINANCIAL STATEMENT OF THE EMERSON McMILLIN RESEARCH FUND, OHIO ACADEMY OF SCIENCE, 1909-1910.

RECEIPTS.

Cash on hand November 1, 1909	$371 44	
Check, Emerson McMillin, November, 1909	250 00	
Total		$621 44

EXPENDITURES.

Dec. 13, 1909—G. E. Coghill, balance of grant of $50.00	$ 6 50	
Jan. 20, 1910—A. Dachnowski, expense in research	15 25	
Mar. 2, 1910—A. Dachnowski, expense in research	17 00	
Mar. 10, 1910—F. J. Heer, printing 500 copies Schaffner's fern list	47 50	
May 23, 1910—A. Dachnowski, expense in research	18 95	
June 20, 1910—Freda Detmers, expense in research	50 00	
Total		$155 20

Leaving balance in bank November 20, 1910, $466.24. Of this balance there has been appropriated but not yet expended $150.00, leaving an unappropriated balance of $316.24.

WILLIAM R. LAZENBY,
EDWARD L. RICE,
FRANK CARNEY,
Board of Trustees.

The Publication Committee reported progress.

Under Special Committees, Professor Herbert Osborn, chairman of the Committee on the Natural History Survey, stated that conditions in the present legislature seemed adverse toward accomplishing the desired legislation. After some discussion the former committee was discharged, and a new committee consisting of Professors Carney, Osborn and Waite was appointed.

The report of the Committee on Conservation of the Natural Resources of Ohio was accepted and the committee discharged.

Under new business, Prof. Waite made the following motion, which was carried: "The Ohio Academy of Science extends to the American Association for the Advancement of Science and the affiliated societies, a cordial invitation to meet within the State of Ohio in the near future, and promises cooperation toward the success of such a meeting."

After the election of a Nominating Committee, consisting of Professors Carney, Osborn and Rice, the business meeting was adjourned until Friday at 4:30 p. m., while the Society proceeded with the reading of papers, adjourning at 12:00 m. for luncheon.

The afternoon session opened with the address of the President of the Academy, Prof. W. F. Mercer, a most interesting paper in which the Circulation of the Blood was considered in a historical way as well as the relation of the Circulation to Health and Disease. This was followed by the reading of the papers.

At 4:50 p. m. occurred the adjourned session of the Business Meeting. The report of the Nominating Committee was received and the following officers elected for the ensuing year:

OFFICERS OF THE OHIO ACADEMY OF SCIENCE FOR 1910-11.

President—Professor L. G. Westgate, Delaware, Ohio.
Vice-Presidents—Zoology: Professor Charles Brookover, Akron, Ohio
Botany: Professor Malcolm E. Stickney, Granville, Ohio.
Geology: Professor George D. Hubbard, Oberlin, Ohio.
Secretary—Professor L. B. Walton, Gambier, Ohio.
Treasurer—Professor James S. Hine, Columbus, Ohio.
Librarian—Professor William C. Mills, Columbus, Ohio.
Trustee—Professor Frank Carney, Granville, Ohio (3 years).

Publication Committee—Professor E. L. Rice, Delaware, Ohio (3 years).
Executive Committee—Professor M. F. Guyer, Cincinnati, Ohio;
Professor E. L. Moseley, Sandusky, Ohio.

The following members were elected upon the recommendation of the Nominating Committee:

NEW MEMBERS ELECTED AT THE AKRON MEETING, 1910.

Fischer, Martin H., Experimental Medicine..Univ. of Cincinnati, Cincinnati
Himebaugh, Oscar, Botany, Geology..................................Akron, Ohio
Knower, H. M., Biology............Univ. of Cincinnati, Cincinnati, Ohio
Livingston, A. E., Zoology..................................Athens, Ohio
Mark, (Miss) Clara Gould, Geology, Botany..Mt. Holyoke College, S. Hadley, Mass.
Rush, R. C., Conchology..................................Hudson, Ohio
Schilliday, C. L., Zoology..................................Athens, Ohio
Snearline, A. L., Botany, Geology..................................Akron, Ohio

The names of members proposed by the Executive Committee and provisionally placed on the list of membership were also ratified.

The Committee on Resolutions presented the following:

The Ohio Academy of Science, desiring to express its sense of loss in the death of its late member, Professor W. G. Tight, has prepared the following brief memorial:

Professor Tight, although not a charter member, joined the Academy during the first year of its existence, and was elected its Secretary at the second annual meeting in 1892. In this position he faithfully served the Academy for two years, and was chosen and served as President for the year 1898.

Few members were more active or more enthusiastic in the work of the Academy during its early history than Professor Tight. From the first meeting in 1891 until he left the State ten years later he never failed to attend and always had something in the way of the results of research to present.

His energy and his unfailing devotion to science, together with a pleasing address and genial temperament, won the respect and esteem of his fellow members. His removal from the State to enter upon a larger field of labor was a decided loss to the Academy, and the news of his death brought a pang of regret to many of his old associates. Of him it may well be said his life was a record of useful service.

Be It Resolved, That we express our great appreciation of the continued interest of Mr. Emerson McMillin, whose substantial contributions have done and are doing so much to advance the scientific work of the Ohio State Academy of Science; and that we extend to him our sincere thanks.

Be It Further Resolved, That we extend our hearty thanks to the President, Trustees, and Faculty of Buchtel College, to Professor Brookover and the other members of the Local Committee, and to the Manufacturers of Akron, who have co-operated so happily in arranging for the entertainment of the visiting members and for the general success of the Twentieth Meeting of the Academy.

Edward L. Rice,
William R. Lazenby,
Francis L. Landacre,
Committee.

After the formal adjournment of the meeting at 5:45 p. m. a luncheon was served by the college in the Crouse Gymnasium, followed by a social gathering of the members and friends of the Academy.

At 8:00 p. m. Mr. F. A. Seiberling, President of the Goodyear Rubber Co., addressed the Society upon "The Rubber Industry," giving a most interesting account of his recent trip up the Amazon River, together with the description of the method of obtaining and preparing the crude rubber for the market.

On Saturday morning many of the members visited the factories of the rubber companies where the various mechanical methods involved in the preparation of rubber were exhibited. A few collecting trips were made and the members of the Academy departed from Akron with the remembrance of a most enjoyable session.

The complete program was as follows:

1 Anatomy and Physiology of the Unionidae. 10 min.
V. Sterki

2 The Olfactory Nerve of *Ameiurus* and *Lepidosteus*.

(Lantern slides.) 8 min. Charles Brookover

3 Further Notes on the Skull of *Eumyces*. (Lantern Slides.) 8 min. E. L. Rice

4 Diseases of Peat Soils. 10 min. Alfred Dachnowski

5 Notes on Ohio Trees. 3 min. W. R. Lazenby

6 Effect of Lack of Light on Amphibian larvæ. 7 min. A. M. Banta

7 Delaware Bird Records. 3 min. E. L. Rice

8 Catalogue of Ohio Vascular Plants. 3 min. J. H. Schaffner

9 Remarks on the Genus *Scaphoideus* with a Revised Key to the American Species. 7 min. Herbert Osborn

10 A Revision of the Genus *Symbiotes* with a Description of New Species. 5 min. L. B. Walton

11 A Revision of the Species of *Anasa* and *Cimolus* found in the U. S. 8 min. J. C. Hambleton

12 Preliminary Report on the *Agaricaceae* of Ohio. 12 min. W. G. Stover

13 The Occurrence of Apple Blotch in *Phyllosticta solitaria* E. and E. in Ohio. 6 min. W. O. Gloyer

14 The Known *Polyporaceae* of Ohio. 5 min. Lee Overholtz

15 Notes on Some Common Spiders found at Cedar Point. 8 min. W. M. Barrows

16 Producing Rubber from Milk Weed. 5 min. Chas. Fox

17 Notes on a Collection of *Boletaceae*. 5 min. Bruce Bink

18 Notes on Some Recent Collections of Hemiptera. 5 min. Herbert Osborn

19 Collecting Land and Fresh Water Mollusca. 7 min. V. Sterki

20 A Case of Bisymmetrical Cervical Fistulae in Man. 4 min. L. B. Walton

21 A Report on the Mammals of Ohio. 5 min. J. S. Hine

22 The Blister Rust of White Pine in Ohio. 3 min. A. D. Selby

23 On the Nature of the Reaction of Embryos of Amphibia to Hydrochloric Acid. 5 min. G. E. Coghill

24 The Development of Transportation in Ohio. 10 min. Frank Carney

25 The Mississippian Pennsylvanian Unconformity and the Sharon Conglomerate in Northern Ohio. 10 min. G. F. Lamb

26 Some Large Masses of Rock in the Drift. 7 min. G. D. Hubbard

27 The Olfactory Nerve in *Chrysemys marginata.* 5 min. Albert Meyers (Introduced by Charles Brookover)

28 The Placodal Ganglia of *Lepidosteus.* 7 min. F. L. Landacre

29 Leaf Markings of Certain Ohio Plants. 7 min. J. H. Schaffner

30 Descriptions of 11 New Fossil Fishes of the Corniferous Limestone. 10 min. Herman Hertzer

31 The Succession of Vegetation Groups of Ohio Lakes and Ponds. 5 min. Alfred Dachnowski

32 A Disease of *Pinus strobus* due to *Cenangium abietis.* 7 min. Bruce Fink

33 Keeping Quality of Apples. 7 min. W. R. Lazenby

34 New and Rare Ohio Plants Added to the State Herbarium in 1910. 5 min. J. H. Schaffner

35 Physical and Chemical Substratum Factors of Cranberry Island. 3 min. Alfred Dachnowski

36 Observations on *Protosiphon botryoides* (Kutz.) (Lantern slides.) 5 min. M. E. Stickney

37 The Classification of the Fresh Water *Oligochaeta* with Tables of Genera, Species, etc. 5 min. L. B. Walton

38 *Demonstration of Color Photography by the Lantern.* Paul Biefield

L. B. Walton, Secretary.

Gambier, Ohio, August 1, 1911.

PRESIDENT'S ADDRESS

By W. F. Mercer.

In presenting this paper I wish to deviate from the accepted form of papers and present the subject upon somewhat of a peculiar basis. In the first part of the paper I will trace the history of a great discovery, bringing out the methods of research necessary for such a discovery and in the second part of the paper I will try to show how a great fact in biological science may be made of practical benefit to humanity in the preservation of health and strength, that is, increasing our "health bank account" and to show how it would have been impossible to do this without the correct view brought out in the historical review. Many times too little attention is paid to the history in a science. The young mind takes the facts and knows nothing of the long struggle that was made to arrive at them. Many times the methods of research are brought out in the tracing of the history of a discovery better than in any other way. Beside that, the mind appreciates more the things that cost something in time and strength on the part of some one.

In studying the history of the discovery of the circulation of blood the mind is naturally turned to William Harvey but such a discovery can not be associated with the name of any one man. While the demonstration of the facts was left for Harvey in 1626, other men had been working on the question for more than 2000 years. The general structure of the heart; the working of the valves; the circulation of the blood through the lungs; the relation of the arteries and the veins to the heart; the valves in the veins; were all known before Harvey's time. One might ask what was left for him to discover? Without doubt Harvey was the first to describe the circulation in its completeness. It will be noted later in this paper how much they knew of the structure of the organs of circulation and how little they understood their workings and what it all meant, but of course all of these discussions had their bearing and in the total makeup they must all have had their influence.

In the time of Homer the blood was known to circulate but the crudeness and the indefiniteness of the knowledge of the Greeks was very evident. To them the blood was contained in certain vessels and the body was permeated with another set of vessels which they called arteries because they carried air. They also knew that the heart was a hollow, muscular organ. The notion of the Greeks was not to be wondered at for their great respect for the dead rendered human dissection impossible. The little anatomical knowledge of the times had to be gained from the rapid observation of the parts of animals offered for sacrifice. Even Aristotle, whose anatomical knowledge was far in advance of the more ancient Greeks, made very little addition to the knowledge of the vascular system.

A great change was destined to be made soon, for Alexander was to conquer Egypt in the third century B. C., establish the Macedonian kings, and build the city of Alexandria with its great university, museums, and library. This was to be the center of learning of all kinds and especially the sciences, above all the study of medicine. Herophilus and Erasistratus were among the noted names from the medical school at Alexandria. In this school human dissection was common, so common that even the kings were known to attend the lectures and the demonstrations in the dissecting rooms. The foundation for the real knowledge of the circulation was laid here.

Herophilus demonstrated the relation of the beat of the heart to that of the arteries and that the beat of the heart was the cause of the beat of the arteries but he considered the arteries to carry only air. He compared the walls of the arteries with those of the veins and described the connection of the heart with the lungs calling the vessel leading from the right ventricle to the lungs the ARTERIAL VEIN and the one leading from the lungs to the left side of the heart the Venous Artery.

Science is indebted to Erasistratus for the discovery of the valves in the heart and their function in the circulation. It is also supposed that he saw the lacteals, which are a part of the lymphatic circulation. There is no doubt that the Greeks recognized two kinds of vessels but the fact that they considered the arteries to contain only air shows that they knew nothing of their true function. This can be accounted for from the fact that after death the arteries contain no blood as a usual thing, and from the supposition that these arteries had their origin in the trachea, hence the name "tracheal artery." Erasistratus traced the air from the trachea through the arteries to all parts of the body. During the next four hundred years human dissection, even in the Alexandrian school, gradually fell into disuse, but in the later part of this era there arose a man that was destined to become so world renowned that his word was not disputed in any particular for the next succeeding thirteen hundred years. Galen was born in 130 A. D., went to Alexandria at sixteen years of age and was practicing medicine at the age of twenty. He spent many years at different times in his life in Egypt studying anatomy. His dissections were limited to work upon the lower animals, but by ligating an artery in two places and opening it between the ligatures he showed that they contained blood, not air. This shows the great advantage of vivisection. The importance of this experiment can not be over-estimated for with the belief that the arteries carried air the true circulation could never have been discovered.

Galen did not believe with Erasistratus that the air entered the body but that it was rejected at once after it had served its function, which was to cool the body. He believed also that the right ventricle was in communication with the left by means of holes through the septum. Of course Galen never saw these holes, but his belief in the theory of the vital blood and the coarse blood was so strong, as it was for many years afterwards, that he had to see them in theory at least. The vital blood of the left ventricle had to be mixed with the coarser blood of the right ventricle, and the only way it could be done was for a part of the blood to pass through the septum and the remainder to pass to the lungs through the pulmonary artery. This is only an illustration of what happened many times in Galen's time and for many years afterwards and often happens even today, viz: that men have to account for certain things and to do this they must have a theory and they then have to see things to bear out the theory. But considering the fact that for sixteen centuries from the Alexanderian museum to the establishment of the school at Salermo in 1221 A. D., the human body had never been dissected, it is no wonder that we see evidences of the grossest ignorance of anatomy. The difficulties that stood in the way of dissection can be appreciated from the fact that Mundini, the professor of anatomy at Bolona during the latter part of the thirteenth century and the beginning of the fourteenth, dissected only three bodies in eleven years. The bettering of these conditions can be noticed from the work of DeCarpi, professor of anatomy in the same school a century later in that he dissected over a hundred bodies; and yet DeCarpi had such respect for Galen and his doctrines that he said there must be holes in the septum, but in discussing it he says they are seen with difficulty in man.

Michael Servetus, a Spaniard, published his Christianismi Restitutio in 1553 which was a short time after DeCarpi's works appeared. Servetus was a unique character in history. He studied for a priest at Saragossa; studied law at Toulouse; became secretary to Charles the Fifth at Bolona; soon gave up his diplomatic career for theology; studied medicine at

Paris; practiced medicine for some years, writing medical books meanwhile; returning to theology again he was burned at the stake in Geneva for heresy in the same year that he published his Restitutio. While this work is a theological treatise, it is of great interest to the physiologist for in treating of the vital spirit he describes the circulation of the blood. He disagrees with Galen from start to finish. According to Servetus the blood does not pass through the septum but passes from the right to the left ventricle by the way of the lungs, through the pulmonary artery to the lungs and the pulmonary vein from the lungs. Instead of the blood becoming vitalized in the left ventricle, as Galen held, it is done in the lungs. Servetus was the first to describe the pulmonary circulation and the first to discard the idea of there being holes in the septum for the blood to pass from one ventricle to the other. In fact he says there is no blood passing in this way. The idea of Servetus that the venous blood was changed to arterial blood in the lungs was not understood nor appreciated for more than a hundred years after his death. He also states that the left ventricle is not large enough for this mixture or elaboration to take place. This fact will be noted again farther on in the paper. I will quote the passage in the Restitutio that refers to the points in question.

"For which purpose the substantial generation of the vital spirit itself is first to be understood, which is composed of and nourished by the inspired air and most subtle blood. The vital spirit has its origin in the left ventricle of the heart, the lungs aiding, to the highest degree, in its generation. The spirit is subtle, elaborated by the force of heat, of a yellowish color, with the power of fire, to the end that it may be, as it were, a bright vapor from the pure blood, containing in itself the substance of water, air, and of fire. It is generated, in fact, in the lungs, with the mixture of inspired with the elaborated, subtle blood, which the right ventricle of the heart communicates to the left. Yet this communication is made, not by the middle wall of the heart, as is commonly believed, but the subtle blood is driven, by a great plan or device, from the right ventricle of the heart, by the long passage through the lungs; is prepared in the lungs; the yellow color is made, and it is poured out from the arterial vein (vena arteriosa or pulmonary artery) into the venous artery (arteria venosa or pulmonary vein); there it is mixed in the venous artery itself with the inspired air; is purged by expiration of its fuliginous matter; and so, at length, the whole mixture is attracted by the diastole from the left ventricle of the heart, a fit stuff out of which to make vital spirit." It will be noted that Servetus here considers the relaxation of the left ventricle to be the force that pulls the blood into it. Farther he says: "The various connection and communication of the arterial vein with the venous artery teaches that the communication and preparation is made by the lungs in this manner. The remarkable size of the pulmonary artery confirms this, which would be neither made in such a way nor so large, nor would there be emitted so great a mass of blood from the heart itself into the lungs, if for the nourishment of these alone, nor would the heart serve the lungs in this manner, since especially before, in embryo, the lungs themselves are accustomed to be nourished from elsewhere, an account of these little membranes, or valves of the heart, not yet being open until the hour of birth, as Galen teaches. Therefore the blood is poured forth, and so copiously from the heart into the lungs at the hour of birth, for another use. The air also is sent from the lungs to the heart by the venous artery, not pure, but mixed with blood; therefore the mixture is made in the lungs. That yellow color is given to the blood by the lungs, not by the heart. The space in the left ventricle is not capable of holding so great and so capacious a mixture, nor is sufficient for that elaboration of color. Finally that middle wall, as it is wanting in vessels and power, is not fit for that communication and elaboration, even if some might sweat through. By the same plan by which the transfusion is made from the vena porta to the vena cava, with reference to the blood, so the transfusion from the arterial vein to the venous artery is made in the lungs, with reference to the spirit. If any one compares this with that which Galen writes, Lib. 6. et. 7. on the use of the parts, he easily perceives the truth, not observed by Galen himself. And so the vital spirit from the left ventricle of the heart is thus poured out into the arteries of the whole body."

Christianismi Restitutio is at present a very rare book. Of the 100 copies that were printed only three are known to exist at present. All of the rest are supposed to have been destroyed by fire with their author. There is some question as to the influence of this book upon the scientific world. It is strange that the great advance in the knowledge of the circulation of the blood should occur almost at the same time at Padua in the works of Vesalius and Columbus. Vesalius brought out his first work in 1543 in which he agrees with Galen that the blood passes through the septum but in the revised edition brought out in 1555 he doubts the proposition and almost states that it does not so pass. Servetus' work was in manuscript form in 1546 and it is known that several copies were sent to different parties and it would be prefectly natural that the great school of medicine at Padua would be the first to be influenced by this work although it was brought out especially as a theological work. There is nothing to be found in Servetus' work to indicate that he had the least idea of the systemic circulation and he evidently did not understand the passage of the blood through the tissue of the lungs for the capillaries were not discovered for more than a hundred years after. As has been stated above and in the quotation, it is evident that he knew that the blood passed through the lungs in passing from one side of the heart to the other but as to how it passed was entirely unknown to him.

In 1559 Matheus Realdus Columbus, six years after the death of Servetus, re-described the circulation and agrees in every respect with Servetus but says that it had never been described before, thereby claiming the discovery for himself. There can be no doubt but that Columbus had known of this new theory for Servetus is known to have sent a copy of his book to Padua where Columbus was professor of anatomy and had studied for some time with Vesalius. He may be excused for this claim under the circumstances for if he had referred to Servetus' work and agreed with him he would doubtless have suffered the same fate at the stake, for if he had recognized Servetus as a physiologist he would have been held as respecting him as a theologian. There may be, however, some question as to whether Columbus was familiar with the works of Servetus but there can be no doubt about his understanding the pulmonary circulation as well as could be understood without knowing of the capillaries.

Columbus says on the heart and arteries: "Cavities, that is, two ventricles, are present in the heart, not three as Aristotle thought. Of these one is on the right side, and the other on the left. The right is much larger than the left. The right contains the natural blood, but the left the vital blood. It is very interesting to observe that the substance of the heart surrounding the right ventricle is very thin but on the left side is very thick; and this is so arranged on the one hand to keep up the balance and on the other to prevent the vital blood which is exceedingly thin from transuding out of the heart. Between these ventricles is placed the septum through which almost all authors think there is a way open from the right to the left ventricle; and according to them the blood is in the transit rendered thin by the generation of the vital spirits in order that the passage may take place more easily. But these make a great mistake; for the blood is carried by the artery-like vein to the lungs and being there made thin is brought back thence together with air by the vein-like artery to the left ventricle of the heart. This fact no one has hitherto observed or recorded in writing; yet it may be most readily observed by anyone." He refers to the vein-like artery in the following terms: "Anatomists, not very wise, begging their pardon, in so doing, think that the use of this is to carry the changed air to the lungs which, like a fan, ventilates the heart, cooling this organ and not, as Aristotle thought, the brain. The same writers think that the lungs receive the, I know not what, smoky fumes (fumos capinosos) (for so in their ignorance of the tongues they call them) discharged from the left ventricle. About this, all one can say is that it pleases them, for they certainly seem to think that the same state of things exists in the heart as in a chimney, as if there were green logs in the heart which gave out smoke when burned, so far concerning the use of these parts according to the opinion of other anatomists. I for my part hold a quite different view, namely that this vein-like artery was made to carry blood mixed with air from the lungs to the left ventricle of the heart. And this is not only most probable, but is actually the case; for if you examine not only dead bodies but also living animals, you will find this artery in all instances filled with blood, which would by no manner of means be the case if it were constructed to carry air forsooth and vapours. Wherefore I cannot wonder enough at those anatomists who have not observed a matter so clear and of such importance, eminent though they wish to be considered by many of their fellows. But for these it is enough that Galen said so. What? To think that some folks in our time swear to the dogmas of Galen so that they dare to assert that Galen ought to be taken as gospel, and that there is nothing in his writings which is not true. It is wonderful how men are carried away by this doctrine; and the princes of anatomy offer it to the rabble. Yet no one sees how much this is to be blamed. Who indeed is there who never offends? But of this enough and more than enough." While Columbus cast away the theory of Galen that the blood passed through the septum yet he accepts the theory that the blood circulates in the veins only. "This is the use of the veins, to carry blood to all parts of the body in order to nourish them; for all the members of the body are nourished by the blood alone, therefore nature made the veins hollow for the sake of their function that like streams they might pervade the body." Although he makes great claims for his discovery he failed to appreciate the importance of it, as many did after his time.

Andreas Caesalpinus differed greatly from Columbus. Columbus lacked culture. His education was comparatively limited. Vesalius refers to him as the smatterer. The exact reverse of this was Caesalpinus. He was versed in all of the knowledge of his time. Born in 1519; we find him professor of medicine at Pisa from 1567 to 1592. He was an ardent follower of Aristotle's philosophy. He was a naturalist, for we find him teaching botany as well as medicine at Pisa. Being more of a philosopher than a naturalist he was inclined to dispute everything. He went so far as to not only dispute all that Galen said but to hold that all that Galen opposed was correct. He understood the working of the valves of the heart. "For the membranes are so placed at the orifices that they are opened when the heart is dilated and are closed when the heart is contracted." He still holds to the idea of the spirits and the two kinds of blood. He associated the pulse in the arteries with the beat of the heart and explained the working of the heart correctly in receiving and discharging the blood. He notices that the arteries expand when the heart contracts and that the valves are so placed that the blood can not get back from the arteries when the heart relaxes. "If therefore the arteries were dilated and constricted at the same time as the heart, it would follow that they would be dilated at the time when the material filling them from the heart was denied them, and constricted at a time when material was flowing into them from it. But it is manifest that this is impossible." He is the first to grasp the idea that the blood is discharged from the heart into the arteries and that the heart receives the blood from the veins, not only from the pulmonary vein but also from the venae cavae. He seems to get the idea of a connection of the arteries with the veins in some way. "The following matter seems worthy of consideration, the reason namely, why veins when ligatured swell on the far side and not on the near side of the ligature. But exactly the contrary ought to happen if the movement of the blood and the spirits took place in the direction from the viscera to all parts of the body. When a channel is interrupted, the flow beyond the interruption ceases; the swelling of the veins therefore ought to be on the near side of the ligature." The ebb and flow of the blood in the veins was a common belief by all until the time of Caesalpinus and there is no doubt that in setting forth his ideas he broke loose from the old Galenic beliefs, but knowing the temperament of the man and the spirit that prevails in all of his work, the question arises, how much of all this is due to his personal research or how much was the result of his spirit of controversy? In noting the little influence he and his ideas had on his contemporaries I am inclined to think that he knew very little about what he was writing from actual experience, but his ideas were the result of a very lucky hit in forming philosopical theories. Hieronymus Fabricius was the great contemporary of Caesalpinus and the one to add the next great step in the knowledge of the circulation of the blood.

Fabricius was born in Tuscany in 1537. During his early life he was hampered considerably by lack of means and opportunity, but we find him studying medicine at Padua under Fallopius, upon whose death he became the professor of anatomy in which capacity he remained for 40 years. He died at the age of 82 in the year 1619. He was well versed in all the knowledge of the biologic sciences of his time, writing many books on various subjects but the most important one of interest to this paper is the one on the valves of the veins, DeVenorum Osteolis "the little doors of the veins," which he published in 1574. These valves had been noticed some years before but he was the first on to carefully work them out. In his work he illustrated them with fairly good figures and gives the method of demonstrating them on the living specimen. He still held to the old theory of Galen, viz: that the blood flows out from the heart to the tissues in the veins and refers to the valves as a mere hindrance to the flow so it would not accumulate in the lower extremities to the detriment of the upper extremities. He says "little doors of the veins" is the name I give certain very thin membranes occurring in the inside of the vein and distributed at intervals over the limbs, placed sometimes one by itself, and sometimes two together. They have their mouths directed toward the roots of the veins (i. e. the heart) and in the other direction they are closed. Viewed from the outside they present an appearance not unlike the swellings which are seen in the branches and stem of a plant. In my opinion they are formed by nature in order that they may to a certain extent delay the blood and so prevent the whole of it flowing at once like a flood either to the feet, and to the hand or the fingers, and becoming collected there. For this would give rise to two evils; on the one hand the upper parts of the limbs would suffer from want of nourishment, and on the other hand the hands and the feet would be troubled with a continued swelling. In order therefore that the blood should be everywhere distributed in a certain just measure and admirable proportion for maintaining the nourishment of the several parts, these valves of the veins were formed." It will be seen that Fabricius did not grasp the true function of the valves at all. It was left for a pupil of his to clear up the points and demonstrate their use. He had many clear ideas of the process of respiration but we still hear him speak of the air reaching the heart through the vein-like artery and of the generation of the vital spirits. "If all this belongs to the innate heat of the heart which burns as with a flame, it must in any case be maintained that the whole business of maintaining and regulating that heat consists in the first place of providing material (for the flame), then for the ventilation, then of moderate refrigeration, and lastly of the discharge of the fumes; all these are supplied by respiration." It is with wonder that we sum up the works of

Fabricius for he must have known of the works of Servetus, of Caesalpinus, of Vesalius, and of Fallopius. He himself was a pupil of Fallopius who in turn was a pupil of Vesalius the greatest anatomist of his day, and if he had used his own knowledge of the valves in the veins rightly it would have overthrown the doctrine of Galen completely. He had such respect for old doctrines that his eyes were closed to "facts staring him in the face" and his ears were deaf "to voices crying out new views." "It was left for William Harvey, a pupil of his, to seize that which he had just failed to lay hold of, to weld together, as he was passing away, into one sustained and convincing argument, the several links which he and the rest had furnished, and nine years after his death to make known to the world that true view of the circulation which was the real beginning of modern physiology." (Foster.)

Harvey was born at Folkstone, England, in 1578. He was four years old when Fabricius published his work. Entering college at Cambridge in 1593, he took his arts degree in 1597 and left at once for Padua to study medicine in the greatest medical school of his day. He was made a doctor of medicine in 1602 after five years of hard work under the great master, Fabricius. We have already seen what the views of Fabricius were in regard to the circulation and respiration. Not being satisfied with the working of the old theories of Galen, Harvey at once, after returning to England, set to work to improve them. He developed his ideas in his lectures at the college of physicians in 1615. His book Exercitatio, however, did not appear until 1628. The method that prevails in all of Harvey's work is to advance from one thoroughly demonstrated point to another, not depending upon any one method of demonstration. He resorts to vivisection in many cases; not depending upon analogies or any course of reasoning to establish his points. His first work was to establish the movements of the heart itself. In doing this he found great difficulty in studying the live heart on account of its rapid movement, so much so that he nearly came to the conclusion that the heart was made for God himself to understand, not man. He used the lower forms in many cases for their hearts beat slower, and as a reward for diligent labor on many forms he discovered the true movements of the heart. He found that both ventricles beat at once and that the valves between the auricles and the ventricles were closed when the ventricles contract; that the valves at the opening of the arteries were pushed open at the same time and the blood forced into the arteries, not only the pulmonary artery but the aorta as well. It was the force of the contraction of the different parts of the heart that caused the movement of the heart, not the sucking of the blood from the relaxation of the heart as was believed by many up to his time; that the arteries swelled at one point or another on account of the pressure of the blood forced into them not that they might suck air into them. He saw how the auricles were a storehouse for the blood while the ventricles contracted; how they received the blood from the venae cavae on the one side and the pulmonary vein on the other. He had a complete understanding of the pulmonary circulation; how the pulmonary artery carried the blood to the lungs and the pulmonary vein brought the blood from the lungs to the left auricle. The old idea of Columbus and Servetus was that a part of the blood passed through the septum and the rest took the longer course through the lungs. If this was true for a part of the blood Harvey reasoned that it was true for all of it and he demonstrated it as a fact.

He speaks of this new view as one "to which some, moved either by the authority of Galen or Columbus or the reasoning of others, will not give their adhesion"; it led him to another conception which "was so new, was so novel and unheard of a character that in putting it forward he not only feared injury to himself from the envy of a few, but trembled lest he might have mankind at large for his enemies." This new view to which he refers is the application of the same principles to the greater circulation that he had already applied to the pulmonary circulation. He arrives at this conclusion from his estimate of the amount of blood in the body, and that arteries would become congested if there was no way for it to get out of the arteries; the body could not use up the blood as fast as it was made or absorbed from the viscera, therefore the blood must travel in a circle from the left side of the heart through the arteries of the tissues from the tissues to the veins through them to the right side of the heart, through the pulmonary artery to the lungs, through the pulmonary vein to the left side of the heart. In other words the blood must travel in a circle. He says: "I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be affected, and the like; and not finding it possible that this could be supplied by the juices of the ingested aliment without the veins on the one hand becoming drained, and the arteries on the other hand becoming ruptured through the excessive charge of blood, unless the blood should somehow find its way from the arteries into the veins, and so return to the right side of the heart; I began to think whether there might be a motion, as it were, in a circle. Now this I afterwards found to be true; and I finally saw that the blood, forced by the action of the left ventricle into the arteries, was distributed to the body at large, and its several parts, in the same manner as it is sent through the lungs, impelled by the right ventricle into the pulmonary artery and that it then passed through the veins and along the vena cava and so round to the left ventricle in the manner already indicated, which motion we may be allowed to call circular."

The heart is emptied when the vena cava is tied, the vena cava becomes distended when the aorta is tied, the limb becomes swollen when a tight ligature is supplied to shut off the veins, the same limb becomes pale when a tight ligature is applied to shut off the arteries, nearly all of the blood in the body can be drained away from a single opening in a vein. All of this can be easily understood in the light of

Harvey's discovery. "And now for the first time was clear the purpose of those valves in the veins, whose structure and position had been demonstrated to Harvey, by the very hands of their discoverer, his old master, Fabricius, who did not rightly understand their use, and concerning which succeeding anatomists have not added anything to our knowledge."

Harvey speaks of the spirits but casts it aside as not essential to his work. However, his discovery killed the idea of the natural spirits being carried by the veins and the vital spirits being carried by the arteries. He considers the blood the same blood all the time going in a circle meeting with change in the lungs and in the tissues of the body as it goes. His discovery leads easily to the understanding of the chemical phenomena going on in the body and the relation of the blood circulation to the nutrition in the body and the production of power for the body to carry on the processes necessary to its life. The fact that the food disappears from the alimentary canal and in some way becomes blood was known from the time men began to think of the activities in their own bodies, but how this was done was left to Harvey's time.

Gasper Aselli discovered the lacteals in 1622 in a way that some might think an accident. In working on the viscera of a dog he noticed some fine white cords in the mesentery taking them to be nerves at first, "but presently I saw that I was mistaken in this since I noticed that the nerves belonging to the intestine were distinct from these cords, and wholly unlike them. But presently recovering from his surprise he pricked one of the larger cords with a sharp scalpel and immediately a milky substance came forth. Afterwards he demonstrated this to many learned men and they were all "very much struck with the novelty of the thing." Aselli noticed valves in the lacteals and saw that they hindered the flow of the chyle, but doubtless influenced by the belief of the times that all of the food had to go to the liver for elaboration he supposed that these lacteals ended in the liver; in fact he said that he could trace them to the liver. It was left for Pecquet, a French physician, in 1651 to show that the lacteals ended in the thoracic duct which leads to the subclavian vein into which it pours its contents which has been partially absorbed from the intestine. The food thus received by the blood would at once proceed to the heart and from there be sent all over the body. If Pecquet had published his book thirty years before, his discovery would have been received as an impossibility. This simply shows what an influence the work of Harvey had upon the minds of men. Another argument was brought forward by Rudbeck in 1653 in publishing an account of another set of vessels that did not carry blood nor chyle but a clear watery fluid. These vessels are now called lymphatics. Rudbeck showed that these vessels carried their contents away from the tissues and toward the heart.

The importance of Harvey's work was not so much that the facts of the circulation of blood were made clear as it was the great field that it opened up for future discovery. The methods of experiment that Harvey used were a lesson for all future generations. After all of Harvey's study and description he never saw the connection of the arteries to the veins yet he said there must be a connection of some sort. This connection was the result of a course of reasoning with him, and it was left for Malpighi, after Harvey's death, to demonstrate the capillaries. Harvey had no microscope by which he could see them. He did all that was possible for him to do with the limited facilities at his disposal.

Many writers claim the honor for the discovery of the circulation of blood belongs to other men before his time, such as Servetus, Columbus, Caesalpinus and others. We have already discussed these men and their work and I think the place that they occupy in this history is clear. It was supposed that Sarpi made the discovery before Harvey and that Harvey copied his work, but it was found later that Sarpi had a chance to borrow a copy of Harvey's book and copied it largely for his own work. This manuscript was found after

Sarpi's death by his friends who claimed the discovery for him.

(Foster) "All such attempts to take away from Harvey what is his due are vain and useless efforts. The greatness of all great men is partly built on the worth of those who have gone before. In science no man's results are entirely his own, like other living things they come from something that lived before. Vesalius, Servetus, Fabricius, and the rest led up to Harvey; but they were not Harvey. He was himself, and his greatness is in no wise lessened by its having come through them."

In the second part of the paper I want to make Harvey's discovery apply to actual living mainly in the phase of muscular activity and show how the circulation of blood and the true notion of it, is important in every day life. To be sure men lived many years before they had the true notion of the circulation of the blood but I want to show that it is possible to live more and better by having the proper idea of the circulation of the blood.

The direct result of muscular activity, in a popular sense, is the strengthening of the muscles themselves. Many people overlook the indirect results and fail to see what bearing they have on the general health of the body; in their influence on the circulation of the blood and the lymph; the process of restion; the digestion of the food; in fact how the whole organism is tied up to these results. The popular notion is if we want strong muscles they must be exercised, if they are to be increased in size they must be exercised. This is very true but we will see later that this is a very small part as compared with the indirect results brought about by the grosser activities of the organism.

Every cell of the body must be fed. Every cell gets its food in just the same way as the amoeba, by absorption. To be sure the amoeba has the power of digestion to a limited degree because he is a generalized cell, but the bulk of his food, suspended in the water in which he lives, is absorbed into the cell substance directly. The body cells of the higher forms are specialized and cannot digest food for themselves. They are suspended in the body fluid, the lymph, in exactly the same sense as the amoeba, the difference being that these cells can not go after their food like the amoeba which may move about in the water from poorer to richer feeding grounds, but their food must be prepared and brought to them by the circulation of the fluid in which they are suspended. The blood circulates in a closed system of vessels and does not bathe the cells in general, but the lymph or body fluid has its origin mainly in the blood by dializing through the walls of the capillaries and bathes the cells of the body. The circulating media of the body carry on a double function. The distributing of the food has already been mentioned but the other side, the carrying the waste from the cells is as necessary to the life of the body as the food supply. Activity means waste in every place so every living organism is constantly producing matter that must be eliminated. The cells can not get away from it therefore it must be carried from the cells. If the cells can not get the food necessary and can not get rid of the waste matter, first they will starve and secondly they will be choked and death will be the result in either case. The body as a whole is alive or dead in proportion to the number of cells that are living or dead. The main point here is the absolute necessity for a circulatory medium and that this medium be kept in motion mainly on account of the specialized condition and the size of the human body. Small bodies like the amoeba can come in contact on all sides with the food, but with large bodies it is not so. To satisfy these conditions the blood must be put under pressure in the arteries. This pressure must be kept up and the arteries full of blood all the time. These conditions being mantained the blood will circulate to the points of least resistance. The resistance will depend upon the activity of the organ or organs in question. This will include muscular activity, glandular activity, etc. Any activity will force the blood out of an organ. In so doing the pressure is released in the organ and more blood comes to it on account of the elacticity of the arteries and the pressure in the general arterial system. Muscular activity is responsible for a large part of the reduction of pressure in the organs. The muscles of the arm for example upon contracting increase in diameter which causes pressure to be brought to bear upon the veins. There being valves in the smaller veins opening toward the heart the blood can go in but one direction, i. e., out of the organ toward the heart. A casual observation of the muscular activities of the body will show their importance and their general distribution. The digestive processes show it from beginning to end. The mastication of the food, the action of the stomach, and the action of the intestine in moving the food along, all are muscular action. The heart beat in pumping the blood into the aorta to keep up the pressure in the arterial system is muscular activity. The processes of respiration all depend upon muscular activity.

The rate of heart beat and the rate of respiration depends upon the general muscular activity, in that the greater the activity the greater the oxidation producing a greater amount of waste matter in the form of CO2. CO2 is the stimulant for the respiratory center which has control of the respiratory operations. Therefore the greater the muscular activity the greater the speed of the respiratory operation and the better the ventilation of the lungs. This means more air taken into the lungs, more oxygen absorbed into the blood, a greater amount of the life giving element with a subsequent better general health. Nature's method of bringing this about is shivering. If the temperature of the body becomes low for any cause the muscles are set into sudden contraction, which starts the circulation with the result as stated above. The heart beat depends upon the amount of heat in the blood and the lack of pressure in the aorta. Oxidation is producing heat while the CO2 is being made. The rate of heart beat is therefore increased in speed and the heart muscles themselves increased in strength to throw the blood into the aorta to keep up the pressure necessary for the distribution of the blood to the surface or to points of least resistance, which has a tendency to equalize the temperature by the loss of heat. The increased activity of the heart tends to increase the strength of the muscle fiber of the heart itself the same as the strength of any muscle is increased by exercise. Many failures of the heart to act in emergencies are accounted for from this lack of exercise. People of sedentary habits are more subject to weak hearts. A quick run for a train or any temporary sudden call for heart force is not responded to for the very reason that the heart has not been regularly exercised for strength to meet more than the regular calls of the organism. Result:—Sudden death; Cause:—heart failure. The arteries like the heart are called upon under like circumstances to stand a greater strain on account of the more forcible heart beat. They are made up of muscular tissue as well as elastic tissue. Unless they have been exercised properly they may give way or lose their elasticity from the great stretching on account of the weakness of the muscles.

Another element in the circulation of the blood and the body fluids in general is the suction force caused by the respiratory movements. These are all brought about by the activity of the muscles of the chest and the diaphragm. As the muscles contract, the chest cavity expands thereby reducing the pressure in the cavity. Since the blood is flowing toward the cavity in the veins, the lack of the pressure here will accelerate the blood in that direction. It will have a tendency also to pull the lymph in the same direction and to increase the flow of the lymph in the thoracic duct and the other lymphatic ducts that open into the veins which empty directly into the heart. The lymphatic vessels all have valves opening only toward the heart, so any movement of the lymph from any cause must be in that direction. We have already noticed that the lymph collects nearly all of the impurities and carries them to the veins near the heart. The increase in the percentage of the CO_2 in the blood stimulates the respiratory center in the medulla oblongata which will cause the muscle of the chest to act more rapidly, thereby eliminating more CO_2 and gaining more oxygen. We have already noticed that the amount of blood going to an organ depends upon the pressure of blood in that organ. The pressure of blood in the organ depends largely upon the muscular activity in the organ or in the surrounding tissues. A sudden closing of the capillaries of the peripheral organs, which would never occur if the muscles were active, will naturally have a tendency to throw the blood to the internal organs causing a congestion. If there should be any weakness in any one of them that organ would suffer more than the others. Many chronic diseases are traced to this cause, for example, Bright's disease, diabetis, etc.

The reason for many of the common rules to govern exercise can be seen from the foregoing discussion, i. e. "We should not exercise vigorously on a full stomach." Exercise reduces the pressure in the peripheral organs which will naturally take the blood away from the internal organs where it is needed just at this time. Moderate exercise is not bad, for the digestive organs are stimulated by the presence of food which causes them to be active. The simple fact that they are active in movement or in the secretion of digestive fluids will cause less pressure in the organ and more blood will set in that direction in spite of a moderate call for blood in other directions. The whole thing is relative and if the balance is in favor of any organ that organ will get the blood necessary for it to do its work.

A muscle does not tire so much from the work that it does as from the impurities that it makes by its activity. In case that products of metabolism are made faster than they are carried off by the circulation the body becomes tired in proportion as the balance is in favor of the impurities. In the case of extreme exercise the muscle tissue is actually broken down faster than it can be built up, faster than food can be brought to it and the waste taken away. Extreme fatigue is the result. The system becomes clogged temporarily, which a period of rest will relieve by the blood having time to catch up in its work in carrying away waste and bringing food to the overworked parts. Here is the line between youth and old age. In youth exercise is spontaneous, but as people increase in age they must exert a will power to continue to exercise unless their occupation requires it. Unless they force themselves to it the heart and the arteries become weak and flabby from the lack of tone which is brought about by exercise and it soon becomes impossible to perform the feats of youth. In fact they lose all interest or desire to take part in any of the plays or spontaneous exercises of youth. Many a man has found that when he was called upon for a little more force than the ordinary, either through disease or in an emergency, he is found wanting and succumbs. It is well known that a man with a strong vigorous heart in pneumonia, other things being equal, will have the best chance for recovery. In fact the large percentage of deaths from pneumonia are from this very fact, heart failure, when if the patient had taken good regular exercise during health his heart would have been in shape to have brought him through. A man may become old while he is young in years. It all depends upon the circulation of the blood and the metabolism. That is upon which side is the balance. By tone as referred to above is meant the power to resist disease or to cope with an extra call if the time ever comes when the demand is made. The main business of life is to keep this tone as high and for as long a time as possible; i. e. to push our youth as far into life as possible. People as they advance in age resort to all means possible to avoid muscular activity and often deceive themselves in thinking that fresh air is a substitute for exercise. Often a horse and carriage with a hired driver is a great misfortune, for riding gives the minimum muscular activity. People whose occupation requires exercise indoors receive great benefit in out door air even if there is no great amount of activity at that time, but it is much better to get the exercise with the fresh air. It would be interesting and profitable to follow this discussion with familiar examples of abnormal development, diseased conditions both chronic and acute, caused by the lack of exercise which results in poor circulation of the blood and the body fluid, and how the increase of the circulation to a certain part, may remedy many unsightly forms, and diseased conditions of many organs, but the limits of this paper will not permit.

To keep well means to keep the circulation of the blood and the lymph up to the highest possible point and not overdo it. To get sick is to reduce the circulation below the upkeep point. To get well after disease does get a hold is to restore the circulation and bring it up and above the mere upkeep point. Dr. Knopf would express these conditions as the body being in physiological wealth or in physiological poverty.

From this paper it will be seen that I place great stress upon the circulation of the blood in physiology. Without a true knowledge of this system modern medicine would have been out of the question. The great feats of surgery which we witness today would have been unknown without Harvey's discovery. This is only one illustration of how any science is made up. One discovery after another makes it possible for the next. Without Harvey there could have been no Claude Bernard and others who have followed after to make the science of modern medicine and hygiene.

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The Agaricaceae of Ohio

BY

WILMER GARFIELD STOVER, A. M.

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A Preliminary Report, with Keys to the Genera and Species.

Contributions from the Botanical Laboratory of Miami University, VIII.

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INTRODUCTION.

The Agaricaceae constitute a rather large family of the Basidiomycetae and are commonly known as the "gill fungi." The family is characterized by having the spores borne on club-shaped *basidia* arranged in a definite layer known as the *hymenium*, which covers a number of radiating plates, the *lamellae* or "gills", suspended from the lower surface of the *pileus*, or cap. A *stipe*, or stem, is usually present, but may be wanting.

Many of the species are edible, and some are considered a great delicacy. Others are poisonous, and may cause serious illness or even death. A few are parasitic upon certain higher plants, notably upon the roots or trunks of trees, when they may cause extensive injury to the timber. Many are beautifully colored, red, yellow, purple, brown, white, etc., or quite large, or otherwise striking in appearance. For these reasons and others these plants are interesting objects of study.

The present paper is essentially a preliminary report on the Agaricaceae of Ohio and consists of keys to the genera and species reported as occurring within the state. A glossary of descriptive terms and a bibliography of the literature pertaining to the Ohio species and other works, which will be found helpful to the student, are included.

The list of species has been made up from the works (see bibliography) of Lea, Morgan, Hard, Lloyd, Peck, Berkeley, Kellerman and Montagne. Besides the species thus published, the list has been augmented by reference to specimens in the herbarium of the New York Botanical Garden, the herbarium of the state botanist of New York, the herbarium of the Ohio State University and by the collections of the writer.

Thomas G. Lea collected in southwestern Ohio, 1834-1844, and sent his specimens to Rev. M. J. Berkeley, in England, who described a number of new species from them. Others were referred to existing species. Morgan, a number of years later

(1878-1907), collected in the same region. He greatly extended Lea's list (although he did not recognize all the species previously reported by Lea) and described a number of new species. W. S. Sullivant, an eminent bryologist of Columbus, sent a number of collections to Montagne in Paris during the early fifties, some of them with drawings by Mr. Sullivant or by Mr. Robinson who worked with him. Montagne described fifty-five new species from these specimens. It seems remarkable that none of these species have been certainly recognized since. Most of them are probably to be referred to other species, or at least are now recognized by other names.

Peck has described species based on specimens sent to him by Ohio collectors, Morgan, Lloyd, Kellerman and others. Some of Peck's New York species have also been found in Ohio. His types are all, or nearly all, preserved in the state herbarium at Albany. Hard collected in several parts of the state and published his results in a well illustrated book. Professor Atkinson, of Cornell University, also described several species from material sent to him by Kellerman and Hard.

The list at present includes approximately five hundred and forty (540) species. Some of these are of doubtful determination. In many cases the collections were not preserved, and it is impossible at this date to confirm or correct the determination. The type specimens of Montagne have not been available to the writer for study, and, except for a few species of Marasmius, Morgan's types were not preserved. Whether these will all prove to be valid species must be left for future study to determine.

Moreover, the list is not claimed to be complete. There are doubtless many species occurring in the state which have not yet been reported, for some sections have scarcely been worked over at all. Before it is possible to have a fairly complete and reasonably accurate state list, there must be a large number of specimens from different parts of the state assembled in accessible herbaria, preferably, the state herbarium. If notes on the fresh plants accompany each specimen, the collection will have much greater value.

In preparing the keys, the most apparent characters possible have been employed. The aim has been to produce accurate and usable keys, rather than to exhibit relationships of species. Some of the keys have been tested by use by mycology students at Miami University for several years and at the Ohio State University during the present year. Most of them have been revised several times as suggested by use.

The work is based largely on published descriptions, and in some cases altogether. These are sometimes so brief or so lacking in precise detail that it has been difficult to find reliable and well-marked characters upon which to separate species. This is especially true of species founded wholly upon dried specimens.

Notwithstanding such errors, misconceptions and incorrect conclusions as doubtless occur, it is believed that the paper will prove helpful to students, amateur mycologists and others in the determination of Ohio Agarics. It is offered as a summary of our present knowledge of the Ohio plants, and is to be regarded as only a preliminary study.

It is not within the scope of this paper to discuss the species in detail, so that many points of interest and of some importance must necessarily be omitted. With each species included, however, a list of references to the most available and useful works is given. One or more of these should always be consulted before reaching a decision as to the determination of any plant.

The matter of the classification and nomenclature of the Agaricaceae is still in an unsettled condition. It has seemed best in most instances to follow the arrangement given by Saccardo in his Sylloge Fungorum for two reasons: It is not the purpose to present a critical study of the nomenclature of the family, and most of the available works on this group will be found to follow a similar system.

The writer wishes here to acknowledge his many obligations to Dr. Bruce Fink under whose direction the work was undertaken. He is also indebted to Dr. W. A. Murrill for the privilege of examining specimens in the herbarium of the New York

Botanical Garden; to C. H. Peck for the determination of a number of species, and for the privilege of studying type specimens in the herbarium of the state botanist at Albany; to Mr. S. H. Burnham, his assistant; to Miss Gertrude S. Burlingham, of Brooklyn, for aid in the determination of species of Russula and Lactaria; to Mr. C. G. Lloyd for library privileges in the Lloyd Library at Cincinnati; to Mr. William Holden, librarian, for many courtesies while consulting literature; to Professor T. H. Macbride for the loan of the specimens of Marasmius in the Morgan collection, now at Iowa City, Iowa; to Mrs. Laura Vaile Morgan for the loan of Mr. Morgan's manuscript; and to others in various ways.

Columbus, Ohio, July, 1911.

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ABBREVIATIONS.

(*See bibliography for full titles.*)

A.—Atkinson: Mushrooms.

B. T.—Bulletin of the Torrey Botanical Club.

H.—Hard: The mushroom edible and otherwise.

J. M.—Journal of Mycology.

K.—Kauffman: Russulas of Michigan.

M.—Morgan: Mycologic flora of the Miami Valley.

M. B.—New York State Museum Bulletin. (See bibliography: Peck, C. H.)

Mc.—McIlvaine: One thousand American fungi.

M. S. M.—Memoir of the New York State Museum. (See bibliography: Peck, C. H.)

N. A. F.—North American Flora, Vol. 9, Part 3.

Oh. Nat.—Ohio Naturalist.

P. R.—Peck: Reports of the state botanist of New York.

S.—Saccardo: Sylloge Fungorum (volume 5, unless otherwise stated.)

St.—Stevenson: British fungi (volume 1, unless otherwise stated.)

KEY TO THE GENERA.

Spores white (sometimes yellow or ochraceous, lilac or pale pink; cinnabar-red in one species and *green* in another) **Leucosporae** (473)

Spores rosy, salmon-colored or rosy-rust-colored **Rhodosporae** (475)

Spores ochraceous, yellowish-brown or brown-rust-colored **Ochrosporae** (476)

Spores purple, purple-brown or black... **Melanosporae** (478)

LEUCOSPORAE.

A.[1] Plants corky, tough, leathery or fleshy-leathery; persistent or reviving when moistened.

B.[1] Plants corky; hymenium often porose at first, becoming lamellate; lamellae often branched and anastomosing. **Lenzites** (543)

B.[2] Plants not corky, lamellae never porose.

C.[1] Edge of lamellae split into two laminae. **Schizophyllum** (543)

C.[2] Lamellae not as above.

D.[1] Pileus differing from stipe in texture, or easily separable from it.

E.[1] Pileus gelatinous-leathery. **Heliomyces** (532)

E.[2] Pileus fleshy and tough or thin and leathery .... **Marasmius** (533)

D.[2] Stipe, if present, continuous with pileus, but may be absent.

E.[1] Lamellae obtuse and fold-like. **Trogia** (543)

E.[2] Edge of lamellae acute.

F.[1] Edge of lamellae serrate or notched. **Lentinus** (539)

F.[2] Edge normally entire... **Panus** (541)

A.[2] Plants fleshy or somewhat so; soon putrescent, not reviving when moistened.

B.[1] Stipe eccentric, lateral or wanting....**Pleurotus** (513)

B.[2] Stipe central or subcentral.

C.[1] Edge of lamellae obtuse; lamellae thick or vein-like.

D.[1] Lamellae decurrent, usually dichotomous. **Cantharellus** (531)

D.[2] Lamellae not decurrent; plants parasitic on other Hymenomycetes.....**Nyctalis** (532)

C.[2] Edge of lamellae acute.

D.[1] Universal veil membranous, usually leaving a volva at base of stipe, or more rarely breaking up into patches or scales which are evident on surface of pileus.

E.[1] Annulus present as a ring about the stipe. **Amanita** (480)

E.[2] Annulus wanting.....**Amanitopsis** (482)

D.[2] Volva wanting.

E.[1] Annulus present.

F.[1] Pileus confluent with stipe; lamellae attached ....**Armillaria** (491)

F.[2] Pileus distinct and easily separating from stipe; lamellae usually free. **Lepiota** (482)

E.[2] Annulus wanting.

F.[1] Trama floccose (of interwoven fibers).

G.[1] Lamellae waxy, not easily splitting into two layers. **Hygrophorus** (516)

G.[2] Lamellae fleshy, readily splitting into two layers.

H.[1] Stipe fleshy or fibrous elastic, confluent with pileus and of same texture.

I.[1] Lamellae sinuate. **Tricholoma** (492)

I.[2] Lamellae usually decurrent, sometimes adnate at least when young.

Clitocybe (497)

H.[2] Stipe cartilaginous, confluent with pileus but of different texture.

I.[1] Lamellae decurrent; pileus umbilicate.

Omphalia (511)

I.[2] Lamellae not truly decurrent; pileus not umbilicate or rarely so.

J.[1] Pileus typically campanulate; margin straight from the first; lamellae adnate or uncinate.

Mycena (508)

J.[2] Pileus not campanulate, usually convexo-plane; margin at first inrolled; lamellae free or obtusely attached.

Collybia (502)

F.[2] Trama vesiculose (hyphae often enlarged, in sections giving the appearance of rounded cells).

G.[1] Plants with a milky or colored juice.

Lactaria (519)

G.[2] Plants with watery juice.

Russula (525)

RHODOSPORAE.

A.[1] Stipe eccentric or wanting.

B.[1] Pileus large, usually glabrous; lamellae white or whitish.

Pleurotus (513)

B.[2] Pileus medium, downy to hairy; lamellae orange-yellow.
Claudopus (548)

A[2]. Stipe central or subcentral.

B.[1] Edge of lamellae obtuse; thick and veinlike.
Cantharellus (531)

B.[2] Edge of lamellae acute.

C.[1] Universal veil leaving a volva at base of stipe.
Volvaria (543)

C.[2] Volva wanting.

D.[1] Lamellae free; pileus easily separating from stipe...................... **Pluteus** (544)

D.[2] Lamellae normally attached (in some becoming nearly free); pileus confluent with stipe.

E.[1] Lamellae decurrent.

F.[1] Stipe fleshy-fibrous...**Clitopilus** (546)

F.[2] Stipe cartilaginous; pileus umbilicate.
Eccilia (547)

E.[2] Lamellae not decurrent.

F.[1] Lamellae sinuate; stipe fleshy-fibrous.
Entoloma (545)

F.[2] Lamellae not sinuate; stipe cartilaginous.

G.[1] Pileus campanulate; margin straight from the first...**Nolanea** (547)

G.[2] Pileus convexo-plane; margin at first inrolled ....**Leptonia** (547)

OCHROSPORAE.

A.[1] Lamellae dissolving at maturity into a gelatinous or powdery condition ....**Bolbitius** (561)

A.[2] Lamellae not dissolving.

B.[1] Lamellae readily separating from substance of pileus: margin of pileus inrolled..........**Paxillus** (560)

B.[2] Lamellae not readily separating from pileus.

C.[1] Edge of lamellae obtuse; thick and vein-like.
Cantharellus (531)

C.[2] Edge of lamellae acute.

D.[1] Arachnoid (cobwebby) veil present; often disappearing with age.....**Cortinarius** (557)

D.[2] Arachnoid veil absent.

E.[1] Stipe lateral, eccentric or wanting.
Crepidotus (556)

E.[2] Stipe central or subcentral.

F.[1] Partial veil normally leaving an annulus.
Pholiota (548)

F.[2] Annulus wanting.

G.[1] Trama vesiculose; pileus usually bright-colored, yellow, red or purple ....**Russula** (525)

G.[2] Trama floccose; pileus variously colored.

H.[1] Lamellae free.
Pluteolus (554)

H.[2] Lamellae normally attached, sometimes becoming nearly free with age.

I.[1] Stipe fleshy or fleshy-fibrous.

J.[1] Lamellae adnate or decurrent.
Flammula (553)

J.[2] Lamellae sinuate or mostly so.

K.[1] Pileus glabrous, often viscid.
Hebeloma (552)

K.[2] Pileus fibrillose, silky or scaly, dry.
Inocybe (550)

I.[2] Stipe cartilaginous.

J.[1] Lamellae adnate or adnexed.

K.[1] Pileus conical or campanulate, margin straight from the first.
Galera (555)

K.[2] Pileus convexo-plane, margin at first inrolled.
Naucoria (554)

J.[2] Lamellae decurrent.
Tubaria (556)

MELANOSPORAE.

A.[1] Spores purple or purple-brown.
B.[1] Partial veil present.
C.[1] Veil forming an annulus.
D.[1] Lamellae free; pileus easily separating from stipe .... **Agaricus** (562)
D.[2] Lamellae attached; pileus continuous with stipe.
Stropharia (564)
C.[2] Veil mostly appendiculate to margin of pileus, slight annulus rarely formed...... **Hypholoma** (565)
B.[2] Partial veil absent, or soon evanescent.
C.[1] Lamellae free from stipe......... **Pilosace** (566)
C.[2] Lamellae attached.
D.[1] Lamellae decurrent .... **Deconica***
D.[2] Lamellae not decurrent.
E.[1] Pileus conic to campanulate, margin straight from the first; stipe fragile.
Psathyra (567)
E.[2] Pileus usually becoming convex or expanded, margin at first inrolled; stipe more or less rigid .... **Psilocybe** (566)
A.[2] Spores black or blackish-brown.
B.[1] Lamellae deliquescent at maturity into an inky fluid or into fine lines.................. **Coprinus** (567)

B.[2] Lamellae not deliquescent.

C.[1] Spores globose to elliptic; lamellae not decurrent.

D.[1] Annulus present; variegated lamellae exceeding the margin .... **Anellaria** (570)

D.[2] Annulus wanting.

E.[1] Pileus striate, membranous; lamellae uniform in color....... **Psathyrella** (571)

E.[2] Pileus not striate, fleshy; lamellae variegated in color, extending beyond margin of pileus .... **Panaeolus** (570)

C.[2] Spores fusiform; lamellae decurrent; plants glutinous or viscid .... **Gomphidius***

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* No Ohio species reported.

KEY TO THE SPECIES.

AMANITA PERS.

A.[1] Volva persistent as a loose cup about base of stipe; pileus not scaly from remnants of volva.

B.[1] Pileus orange-red or yellow; lamellae yellow. S. 8; H. 40; M. 57; Mc. 12; A. 70; P. R. 33:41.
A. caesarea Scop

B.[2] Pileus white, rarely yellow or brownish, never orange-red; lamellae white.

C.[1] Stipe bulbous; margin of pileus even.

D.[1] Stipe rooting; spores elliptical. S. 14:64; H. 28; Mc. 10; P. R. 50:96.
A. magnivelaris Peck

D.[2] Stipe not rooting; spores globose or subglobose.

E.[1] Pileus dry; lamellae adnexed; volva circularly split. S. 10; H. 35; Mc. 10; St. 4.
A. mappa Fr.

E.[2] Pileus viscid or slightly so when moist; lamellae free; volva bursting at top, not circularly split.

F.[1] Lamellae broad; stipe nearly smooth. S. 9; H. 20; Mc. 7; A. 55; St. 4; P. R. 33:42.......*A. phalloides* Fr.

F.[2] Lamellae linear-lanceolate; surface of stipe torn into scales; pileus often lobed. S. 9; H. 23; Mc. 6; A. 61; St. 3..................*A. virosa* Fr.

C.[2] Stipe not bulbous; margin of pileus narrowly striate. S. 12; H. 43; Mc. 11; P. R. 33:42; A. 69.
A. spreta Peck

A.[2] Volva forming a closely fitting or adnate sheath, or concentric rings about base of stipe, or wholly friable; pileus usually with warty scales.

B.[1] Flesh becoming reddish when wounded; pileus dingy reddish to tan; volva wholly friable. S. 16; M. 58; Mc. 21; H. 38, 39; A. 71; St. 8; P. R. 33:44.
A. rubescens Fr.

B.[2] Flesh not so changing.

C.[1] Stipe stuffed or hollow.

D.[1] Pileus orange or yellow, rarely white.

E.[1] Margin of pileus widely tuberculate-striate; pileus yellow or straw-yellow. S. 13; P. R. 33:43; Mc. 18....*A. russuloides* Peck

E.[2] Margin narrowly striate or striatulate.

F.[1] Pileus more than 6 cm. broad; spores elliptical. S. 13; H. 23; M. 58; Mc. 14; A. 52; P. R. 33:43.
A. muscaria Linn.

F.[2] Pileus less than 6 cm. broad; spores globose. S. 14; H. 26; Mc. 16; A. 54; P. R. 33:44...*A. frostiana* Peck

D.[2] Pileus white to brownish, or rarely with tinge of yellow.

E.[1] Margin of pileus even; stipe rooting. S. 14:64; H. 28; Mc. 10; P. R. 50:96.
A. magnivelaris Peck

E.[2] Margin striate or striatulate; stipe not rooting.

F.[1] Pileus white; stipe bulbous; spores globose. A. 66; H. 37.
A. cothurnata Atk.

F.[2] Pileus olive-brown to livid; stipe nearly equal, spores elliptical. S. 14; M. 58; Mc. 17; St. 6......*A. pantherina* Dc.

C.[2] Stipe solid.

D.[1] Stipe deeply rooting.

E.[1] Lamellae free. S. 16:2; H. 31, 33; B. T. 27:609-10.............*A. radicata* Peck

E.[2] Lamellae adnexed. S. 15; Mc. 19; H. 28-30; A. 72...............*A. solitaria* Fr.

D.[2] Stipe not rooting; bulb massive. S. 15; H. 32, 33, 36; St. 7; Mc. 19; P. R. 33:46.
A. strobiliformis Vitt.

Doubtful Species.

A. flavo-rubens B. & M., described from specimens collected at Columbus by Sullivant, has not been since reported. As suggested by Lloyd, it is doubtless a form of A. muscaria. S. 17.

A. daucipes B. & M., also described from Sullivant's material, is placed in Amanitopsis by Saccardo, and in Lepiota by Morgan. It is probably a variety of A. solitaria. Not reported since Sullivant's time. S. 26.

A. polypyramis B. & C. is placed in Lepiota by Morgan who reports it from Preston, O. As stated by Morgan and suggested by Atkinson, it is probably a form of A. solitaria. S. 18.

Morgan regards A. radicata as a form of A. solitaria but places it in Lepiota. J. M. 13:12.

A. verna is regarded by most writers as a variety of A. phalloides. A. virosa is also so regarded by some.

AMANITOPSIS ROZ.

Volva persistent; pileus not mealy, more than 4 cm. broad.
Pileus sulcate on margin, glabrous; spores globose or subglobose. S. 21; H. 43; M. 58; Mc. 28; P. R. 33: 47; A. 74; St. 11 . . . . *A. vaginata* (Bull.) Roz.
Pileus striate only, floccose-scaly; spores elliptical. S. 23; M. 58; Mc. 31; P. R. 33:47 . . . . *A. volvata* (Peck) Sacc.
Volva breaking up into floccose scales; pileus mealy, less than 4 cm. broad. Mc. 31; A. 76; P. R. 33: 49.
A farinosa (Schw.)

LEPIOTA FR.

A.[1] Pileus viscid or glutinous.
B.[1] Pileus 3-4 cm. broad; stipe solid; lamellae broad. J. M. 12:203 . . . . *L. glischra* Morg.
B.[2] Pileus 1-3 cm. broad; stipe fistulous; lamellae narrow. J. M. 12:202 . . . . *L. candida* Morg.

A.[2] Pileus dry; not viscid.

B.[1] Plants changing color when bruised, or markedly so in drying.

C.[1] Plants becoming bluish; pileus usually less than 3 cm. broad. S. 16:9; J. M. 12:246; B. T. 26:63.
L. coerulescens Peck

C.[2] Plants not becoming bluish; pileus more than 3 cm. broad.

D.[1] Pileus 3-5 cm. broad; flesh becoming reddish when bruised, whole plant reddish when handled and finally blackish when dried; stipe not bulbous or clavate. J. M. 12:246.
L. rufescens Morg.

D.[2] Pileus 5-10 cm. or more broad; plants not becoming blackish; stipe bulbous or clavate.

E.[1] Flesh only becoming reddish when broken; pileus not umbonate; margin even. S. 29: M. 61; J. M. 13:8; St. 14; Mc. 35.
L. rhacodes Vitt.

E.[2] Whole plant becoming reddish or reddish-brown; pileus broadly umbonate; margin more or less striate. S. 43; H. 49, 50; Mc. 48; M. 62; A. 80; P. R. 35:159; J. M. 13:9 ....*L. americana* Peck

B.[2] Plants not changing color as above.

C.[1] Pileus with *erect, pointed* scales; annulus somewhat cobwebby.

D.[1] Pileus brown. S. 34; H. 55; M. 62; J. M. 12: 200, 201; A. 81, 82; Mc. 40; P. R. 35:154.
L. acutesquamosa Weinm. *L. asperula* Atk

D.[2] Pileus white. J. M. 12:202. .*L. gemmata* Morg.

C.[2] Pileus and annulus not as above.

D.[1] Pileus usually more than 8 cm. broad.

E.[1] Lamellae and spores green. S. 31; H. 50, 51: Mc. 37; A. 80; M. 61; J. M. 13:8.
L. morgani Peck

E.[2] Lamellae usually white or yellow, spores white; never green.

F.[1] Lamellae narrow, adnate; pileus granulose. S. 48; H. 52, 53; M. 63, pl. 3; J. M. 12:196... *L. granosa* Morg.

F.[2] Lamellae broad, free; surface of pileus breaking up into large scales; annulus movable.

G.[1] Pileus umbonate; stipe furfuraceous-scaly. S. 27; H. 46; M. 60; St. 13; A. 79; Mc. 35; J. M. 13:7; P. R. 35:152.......*L. procera* Scop.

G.[2] Pileus not umbonate; stipe smooth or nearly so. S. 29; M. 61; St. 14; Mc. 35; J. M. 13: 8.
L. rhacodes Vitt.

D.[2] Pileus less than 8 cm. broad.

E.[1] Pilei mostly more than 2 cm., and less than 8 cm. broad.

F.[1] Pileus glabrous.

G.[1] Flesh thick; lamellae white, soon dingy or smoky-brown; annulus movable. S. 43; H. 48, 49; M. 63; St. 21; A. 77; Mc. 44, 45; J. M. 13: 10; P. R. 35: 160.
L. naucina Fr.
L. naucinoides Peck

G.[2] Flesh thin; lamellae white.

H.[1] Pileus bright brownish red. M. 62; J. M. 12: 245; P. R. 35: 155......*L. rubrotincta* Peck

H.[2] Pileus not as above.

I.[1] Stipe mealy. S. 50; St. 25; J. M. 12: 157.
L. seminuda Lasch

I.[2] Stipe more or less fibrillose.

J.[1] Pileus buff or umber; margin even; lamellae broad. J. M. 12:248.

L. neophana Morg.

J.[2] Pileus white or rufous in the center; margin striatulate; lamellae rather narrow. S. 49; J. M. 12:157.

L. noscitata Britz.

F.[2] Pileus granulose; furfuraceous or more or less scaly.

G.[1] Pileus deeply striate, sulcate or plicate.

H.[1] Flesh thick; lamellae adnate. S. 48; H. 52, 53; J. M. 12:196; M. 63, pl. 3.

L. granosa Morg.

H.[2] Flesh thin; lamellae free or adnexed only.

I.[1] Pileus granulose; lamellae adnexed. S. 47; H. 52; J. M. 12:196; St. 23; Mc. 49; P. R. 35:161.

L. granulosa Batsch

I.[2] Pileus scaly; lamellae free.

J.[1] Lamellae subdistant; veil yellow. J. M. 13:5.

L. flavescens Morg.

J.[2] Lamellae very close.

K.[1] Annulus movable. S. 33; St. 16; Mc. 37; J. M. 13:2. M. 61

L. mastoidea Fr.

K.[2] Annulus fixed (not movable).

L.[1] Stipe enlarged above the base. S. 43; St. 22; Mc. 46; P. R. 35: 158; H. 54.

L. cepaestipes Sow.

L.[2] Stipe not so enlarged. S. 38; J. M. 12:198; St. 19; Mc. 43; P. R. 35: 157.

L. metulispora B. & Br.

G.[2] Pileus even or only striatulate.

H.[1] Flesh thick; lamellae white, soon dingy-brown; annulus movable. S. 43; H. 48, 49; St. 21; J. M. 13: 10; A. 77; Mc. 44; P. R. 35: 160.

L. naucina F.

L. naucinoides Peck

H.[2] Flesh thin.

I.[1] Pileus mealy or granulose; lamellae adnexed or reaching stipe.

J.[1] Pileus reddish-brown or reddish yellow. S. 47; H. 42; St. 23; J. M. 12: 106; P. R. 35: 161.

L. granulosa Batsch

J[2]. Pileus whitish or flesh color.

K.[1] Stipe squamulose. S. 46; St. 22; M. 63; J. M. 12: 196.
L. carcharias Pers.

K.[2] Stipe mealy. S. 50; St. 25; J. M. 12: 157.
L. seminuda Lasch

I.[2] Pileus minutely or appressed scaly; lamellae free.

J.[1] Stipe glabrous or slightly fibrillose.

K.[1] Pileus white or whitish. S. 40; M. 63, pl. 3; J. M. 12: 242.
L. miamensis Morg.

K.[2] Pileus with reddish or reddish-brown scales.

L.[1] Pileus bright brownish-red, scales persistent on margin; annulus persistent, often reddish on the margin. P. R. 35: 155; M. 62; J. M. 12: 245.
L. rubrotincta Peck

L.[2] Pileus paler, scales soon

disappearing from margin; annulus usually evanescent. S. 39; St. 20; P. R. 35:155; Mc. 42.
L. cristata A. & S.

J.[2] Stipe more or less scaly.

K.[1] Pileus pale tan to umber. J. M. 12: 198.
L. spanista Morg.

K.[2] Pileus tawny-brown or blackish-brown.

L.[1] Plants growing on wood; pileus with tawny-brown scales. S. 16: 8; J. M. 12: 201; P. R. 51; 283.
L. acerina Peck

L.[2] Plants growing on the ground; pileus with blackish-brown scales. S. 37; M. 62; J. M. 12:199; Mc. 41; P. R. 35: 156.
L. felina Pers.

E.[2] Plants very small; pilei mostly less than 2 cm. broad.

F.[1] Pileus floccose, granulose or minutely scaly.

G.[1] Pileus widely striate or plicate-sulcate.

H.[1] Lamellae rather broad, subdistant; plant whitish to rose color; annulus pale yellow. J. M. 13:6.

L. rhodopepla Morg.

H.[2] Lamellae narrow, close; plants not rose color; annulus not yellow.

I.[1] Stipe silky; spores elliptical; pileus rugulose. S. 16:15; Mc. 51; J. M. 13:2; B. T. 27:15.

L. rugulosa Peck

I.[2] Stipe not silky; spores subfusiform. S. 38; St. 19; Mc. 43; J. M. 12:198; P. R. 35:157.

L. metulispora B. & Br.

G.[2] Pileus even.

H.[1] Stipe clavate, solid; pileus with minute blackish scales. J. M. 12:248. .*L. phaeosticta* Morg.

H.[2] Stipe nearly equal, stuffed or hollow.

I.[1] Plants growing on wood; pileus with tawny-brown scales. S. 16:8; J. M. 12:201; P. R. 51:283.

L. acerina Peck

I.[2] Plants growing on the ground.

J.[1] Stipe granular-mealy; lamellae broad. S. 48; J. M. 12:158; P. R. 35:162.
L. pusillomyces Peck

J.[2] Stipe fibrillose or scaly; lamellae narrow. J. M. 12:199.
L. umbrosa Morg.

F.[2] Pileus glabrous or silky, not as above.

G.[1] Pileus rugose-plicate. S. 16:15; J. M. 13:2; Mc. 51; B. T. 27:15.
L. rugulosa Peck

G.[2] Pileus even or nearly so.

H.[1] Pileus and stipe glabrous. S. 51; J. M. 12:156; St. 25.
L. mesomorpha Bull.
L. rufipes Morg.

H.[2] Pileus silky; stipe fibrillose. S. 49; J. M. 12:157.
L. parvannulata Lasch

Notes.

L. porrigens Viv., listed by Morgan (Jour. Myc. 13:6) is probably to be considered a white form of L. procera.

L. lutea Bolt., listed by Morgan (Jour. Myc. 13:4), is usually regarded as a yellow form of L. cepaestipes.

L. rufipes Morg. Jour. Myc. 12:156, is probably not specifically distinct from L. mesomorpha Bull.

The occurrence of L. farinosa Peck in Ohio is doubtful. Peck separated it from L. cepaestipes on account of the even margin and the larger spores (Report 43, p. 35). Morgan (Jour. Myc. 13:1, 3) in reporting the former, says that the chief difference is in the color of the pileus. He gives the same spore measurements for both species.

Several writers state that L. americana is L. badhami B. & Br. of Europe.

The occurrence of L. pelidna B. & M., described from Sullivant's material, is doubtful. It is said to have a greenish-livid, rugose pileus, a solid, bulbous stipe and to grow on fallen logs. S. 67.

Fries (Hym. Eur. 31) regarded L. acutesquamosa as a variety of L. Friesii Lasch, from which it differs in having the scales of the pileus erect and the lamellae simple. In this country the plants are usually known as L. acutesquamosa. Morgan lists the species as L. aspera Pers. His plants referred to L. hemisclera B. & C. and to L. asperula Atk. were probably only forms of L. acutesquamosa.

L. glischra Morg. Jour. Myc. 12:203 is based on plants referred to L. oblita Peck in the Mycologic Flora (p. 64).

The plants referred by Morgan to L. felinoides Peck should probably be referred to L. rubrotincta .

L coerulescens Peck = L. virescens (Speg.) Morg.

L. rufescens Morg. Jour. Myc. 12:246, is based on plants which he had previously reported as L. fuscosquamea Peck (Mycologic Flora, p. 62).

L. naucinoides Peck is said by its author to differ from L. naucina Fr. principally in having the spores subelliptic, while those of the latter were said to be globose. The two species are probably not distinct, for the spores of the American plant, at least, are variable in shape.

ARMILLARIA FR.

A.[1] Lamellae adnate or subdecurrent; pileus with pointed tufts of blackish or brownish hairs, margin striate. S. 80; M. 64; H. 57; Mc. 55; A. 83............*A. mellea* Vahl

A.[2] Lamellae sinuate or adnexed; pileus without hairy scales; margin not striate.

B.[1] Stipe not bulbous; whitish pileus variegated with brown spots. S. 86; H. 59; Mc. 57; P. R. 43:41.
*A. nardosmia** Ellis

* The lamellae of A. nardosmia are described as emarginate (sinuate) but Peck says he finds the plants with lamellae adnate or subdecurrent. He regards this name as a synonym for A. rhagadiosa Fr., a European species. P. R. 43:42.

B.[2] Stipe bulbous; pileus not brown-spotted.

C.[1] Pileus white or whitish; stipe solid; bulb not marginate. S. 14:70; H. 60; Mc. 54; B. T. 24:140. *A. appendiculata* Peck

C.[2] Pileus yellow-brown or pale brick-color; stipe stuffed or hollow; bulb marginate. S. 73; St. 28; H. 59. *A. bulbigera* Alb. & Schw.

TRICHOLOMA FR.

A.[1] Pileus viscid when moist.

B.[1] Pileus white, shining when dry.

C.[1] Stipe solid, somewhat bulbous, lamellae close. S. 90; H. 600; St. 37; Mc. 63; P. R. 44:42. *T. resplendens* Fr.

C.[2] Stipe stuffed or hollow, not bulbous; lamellae subdistant. S. 90; M. 65; St. 38...*T. spermaticum* Fr.

B.[2] Pileus not white.

C.[1] Lamellae not becoming reddish or reddish-spotted.

D.[1] Lamellae sulphur-yellow. S. 87; H. 61; Mc. 61; P. R. 44:40................*T. equestre* L.

D.[2] Lamellae not yellow.

E.[1] Pileus umbonate, with blackish fibrils; lamellae subdistant. S. 88; H. 82; Mc. 63; St. 35; P. R. 44:41. *T. sejunctum* Sow.

E.[2] Pileus not as above; lamellae close.

F.[1] Pileus pale tan, not rivulose or spotted; lamellae white. S. 9:13; H. 74; Mc. 64; P. R. 44:41. *T. terriferum* Peck

F.[2] Pileus reddish-brown, becoming rivulose and spotted in drying; lamellae cinereous. S. 9:10; H. 79; P. R. 44:41. *T. maculatescens* Peck

C.[2] Lamellae becoming reddish or reddish-spotted.
D.[1] Pileus incarnate-red. S. 94; H. 70; Mc. 65; P. R. 44:42............ *T. russula* Schaeff.
D.[2] Pileus not as above.
E.[1] Stipe bulbous. S. 95.
T. muciferum B. & Mont.
E.[2] Stipe not bulbous.
F.[1] Pileus becoming rivulose and spotted; stipe solid; lamellae cinereous. S. 9:10; H. 79; P. R. 44:41.
T. maculatescens Peck
F.[2] Pileus not as above; stipe stuffed or hollow; lamellae at first whitish or yellowish. S. 91; H. 61; P. R. 44:43.
T. transmutans Peck
A.[2] Pileus not viscid.
B.[1] Lamellae sulphur-yellow. S. 112; H. 65; Mc. 74; St. 52 .... *T. sulphureum* Bull.
B.[2] Lamellae not yellow.
C.[1] Flesh becoming reddish when broken; plants with odor of soap. S. 106; H. 77; Mc. 74; St. 48.
T. saponaceum Fr.
C.[2] Flesh and odor not as above.
D.[1] Pileus scaly, fibrillose or silky or becoming so.
E.[1] Pileus some shade of brown or blackish.
F.[1] Lamellae not changing color or becoming spotted; pileus blackish-punctate; stipe stuffed or hollow. S. 107; H. 78; St. 48....... *T. cartilagineum* Fr.
F.[2] Lamellae changing color or becoming spotted.
G.[1] Lamellae whitish becoming cinereous, sub-distant; stipe white or whitish. S. 104; H. 76; M. 65; Mc. 71; P. R. 44:50.
T. terreum Schaeff.

G.[2] Lamellae becoming reddish or reddish-spotted, close; stipe not white.

H.[1] Stipe stuffed or hollow, subbulbous; pileus umbonate. S. 16:21; H. 78.
T. squarrulosum Bres.

H.[2] Stipe solid, not bulbous, pileus not umbonate. S. 101; H. 73; Mc. 73; St. 45; P. R. 44:49.
T. imbricatum Fr.

E.[2] Pileus white to pale tan.

F.[1] Lamellae becoming smoky-blue or blackish when bruised. S. 119; Mc. 72; H. 75; P. R. 44:51.
T. fumescens Peck

F.[2] Lamellae not so changing.

G.[1] Pileus silky, soon glabrous, 3-5 cm. broad; stipe rather slender, rooting, tomentose at base. S. 112; H. 70; St. 53; P. R. 44:53.
T. lascivum Fr.

G.[2] Pileus squamulose or fibrillose, usually more than 5 cm. broad; stipe stout, not tomentose.

H.[1] Pileus usually less than 10 cm. broad, fibrillose or slightly squamulose; without farinaceous taste; spores 6-8 mic. S. 99; H. 68; St. 44; Mc. 68; P. R. 44:47
T. columbetta Fr.

H.[2] Pileus usually more than 10 cm. broad, squamulose; taste farinaceous; spores larger. S. 11:9; H. 81; Mc. 68; P. R. 44:16, 47.. *T. grande* Peck

D.[2] Pileus glabrous or soon becoming so, or pruinate only.

E.[1] Lamellae violaceous or lilac; pileus of same color or with brownish tinge.

F.[1] Stipe solid, bulbous. S. 130; H. 84; A. 87; Mc. 79; M. 65; St. 61; P. R. 44:60 .... *T. personatum* Fr.

F.[2] Stipe stuffed or hollow, equal or nearly so.

G.[1] Pileus hygrophanous, brownish or brownish-violaceous; flesh whitish. S. 139; H. 62; St. 66; M. B. 131:14; P. R. 44:61..*T. sordidum* Fr.

G.[2] Pileus not hygrophanous, violaceous when young; flesh violaceous. S. 131; H. 86; St. 62; Mc. 80; M. B. 116:39 ...... *T. nudum* Bull.

E.[2] Lamellae not violaceous or lilac.

F.[1] Margin of pileus striate or rugose-sulcate.

G.[1] Pileus umbonate, pale lilac, margin striate only; stipe becoming hollow. S. 126.

T. consobrinum B. & Mont.

G.[2] Pileus not umbonate, margin rugose or sulcate; stipe solid.

H.[1] Taste mild; stipe white; pileus pruinate. S. 101; M. 65; H. 67; P. R. 44:58.

T. laterarium Peck

H.[2] Taste bitter; stipe yellowish; pileus glabrous. S. 129; St. 60; H. 70.. *T. acerbum* Bull.

F.[2] Margin of pileus even.

G.[1] Pileus sooty-black or becoming paler; stipe stuffed or hollow. S. 134; H. 69; M. 66; St. 64.

T. melaleucum Pers.

G.[2] Pileus not as above; stipe solid.

H.[1] Lamellae gray to sordid-rufescent; pileus grayish, pruinate, often spotted. S. 132; St. 63; H. 67......*T. panaeolum* Fr.

H.[2] Lamellae white or whitish, unchanging; pileus glabrous, unspotted.

I.[1] Plants cespitose, stipes rising from common fleshy mass. M. B. 105:36; H. 83. *T. unifactum* Peck

I.[2] Plants not as above.

J.[1] Stipe tomentose at the base, rooting. S. 112; H. 70; P. R. 44:53; St. 53. *T. lascivum* Fr.

J.[2] Stipe glabrous, not rooting.

K.[1] Pileus sub-umbonate usually smoky-brown, 2-5 cm. broad; taste mild. S. 128; H. 74; P. R. 44:58; Mc. 78. *T. fumidellum* Peck

K.[2] Pileus depressed, usually white, 5-10 cm. broad; taste acrid or bitter. S. 127; H. 72; P. R. 44:57; Mc. 79. *T. album* Schaeff.

NOTES.

Morgan (Myc. Flora, p. 66) reported T. cerinum Pers. for the Miami Valley, but later referred the plants to Collybia amabilipes Peck.

CLITOCYBE FR.

A.[1] Pileus viscid when moist.

B.[1] Pileus umbonate, white tinged with red; lamellae 3 mm. broad. S. 150................*C. erubescens* Mont.

B.[2] Pileus not umbonate, reddish-brown; lamellae .5 mm. broad (?). S. 196.......*C. angustilamellata* Mont.

A.[2] Pileus moist, hygrophanous or dry; not viscid.

B.[1] Whole plant deep yellow or reddish-yellow; cespitose; pileus 8-20 cm. broad. S. 162; H. 91; M. 69; A. 90; Mc. 96..........................*C. illudens* Schw.

B.[2] Plant not colored as above.

C.[1] Lamellae purplish, lilac or flesh-colored.

D.[1] Plants cespitose. S. 164; H. 102; M. 69; Mc. 89 ....*C. monadelpha* Morg.

S. 352, 587............*C. caespitosa* (Berk.)

D.[2] Plants not cespitose.

E.[1] Stipe usually 1-2 cm. thick; lamellae purplish. S. 148; H. 97; M. 67; Mc. 108.

C. ochropurpurea Berk.

E.[2] Stipe slender, usually less than 5 mm. thick; lamellae flesh-colored to violaceous. S. 197; H. 105; M. 67; A. 89; Mc. 107.

C. laccata Scop.

C.[2] Lamellae white, yellowish or cinereous.

D.[1] Pileus convexo-plane or depressed only.

E.[1] Pileus green or sordid green. S. 153; H. 90; Mc. 90; St. 74........*C. odora* Bull.

E.[2] Pileus not green.

F.[1] Pileus white or whitish to pale tan.

G.[1] Pileus more than 10 cm. broad. S. 166 ....*C. leiphaemia* Mont.

G.[2] Pileus usually less than 10 cm. broad.

H.[1] Plants growing on wood as trunks of trees. S. 184; M. 68; Mc. 94.

C. trunkicola Peck

H.[2] Plants not growing on wood.

I.[1] Pileus mostly 3 cm. or more broad; stipe 4 cm. or more high.

J.[1] Pileus subumbonate, white, or margin tinged with blue. S. 197; M. 67; Mc. 97.
C. connexa Peck

J.[2] Pileus not umbonate, whitish when young but soon brownish or grayish-brown. S. 9: 25; A. 91; H. 93.
C. multiceps Peck

I.[2] Pilei mostly less than 3 cm. across; stipe 2-3 cm. high.

J.[1] Pileus usually regular, at first silky; stipe subfistulcus, waxy; lamellae soon decurrent; plants growing among leaves. S. 157; H. 100; Mc. 92; M. 68; St. 77.
C. candicans Pers.

J.[2] Pileus usually revolute, often wavy, glabrous; stipe stuffed; lamellae adnate; plants growing in grassy grounds. S. 157; Mc. 93; H. 104; M. 68; St. 78.
C. dealbata Sowerb.

F.[2] Pileus cinereous or yellow to brown or brownish.

G.[1] Lamellae white or whitish.

H.[1] Plants cespitose.

I.[1] Stipe slender, brown or brownish; pileus becoming scaly. S. 104; H. 102; M. 69; Mc. 89; S. 587, 352.

C. monadelpha Morg.
C. caespitosa (Berk.)

I.[2] Stipe rather thick, whitish; pileus glabrous or slightly silky. S. 9:25; H. 93; A. 91; Mc. 95.

C. multiceps Peck

H.[2] Plants not cespitose.

I.[1] Lamellae close, rather narrow. S. 142; Mc. 85; M. 67; St. 70.

C. nebularis Batsch

I.[2] Lamellae subdistant, rather broad.

J.[1] Stipe tapering upward. S. 143; H. 94; Mc. 85.

C. clavipes Pers.

J.[2] Stipe nearly equal. S. 9:20; H. 88; Mc. 88.

C. media Peck

G.[2]. Lamellae yellow to ochraceous or cinereous.

H.[1] Lamellae adnate; pileus not hygrophanous.

I.[1] Plants cespitose; lamellae yellow; stipe hollow. S. 142.

C. columbana Mont.

I.[2] Plants not cespitose; lamellae pallid ochraceous; stipe solid. S. 170; H. 101; Mc. 101 . . . *C. gilva* Pers.

H.[2] Lamellae decurrent; pileus hygrophanous.

I.[1] Stipe pruinate-pulverulent above; plants with farinaceous odor. S. 185; H. 95; Mc. 109; St. 91. *C. metachroa* Fr.

I.[2] Stipe glabrous, plants without odor.

J.[1] Margin of pileus even. S. 186; Mc. 109; H. 99... *C. ditopoda* Fr.

J.[2] Margin striate when moist. S. 9:26; H. 99; P. R. 42:18. *C. subditopoda* Peck

D.[2] Pileus umbilicate to infundibuliform.

E.[1] Pileus white or whitish.

F.[1] Plants growing on wood; stipe often eccentric; pileus lobed and irregular. S. 16:24; B. T. 25:321; Oh. Nat. 10:178..........*C. eccentrica* Peck

F.[2] Plants growing among leaves or grass.

G.[1] Lamellae adnate; pileus less than 3 cm. broad. S. 157; H. 104; St. 78; Mc. 93...*C. dealbata* Sowerb.

G.[2] Lamellae soon decurrent; pileus usually 4 cm. or more broad.

H.[1] Lamellae narrow. S. 180; P. R. 54:174; H. 95. *C. adirondackensis* Peck

H.[2] Lamellae rather broad.

I.[1] Lamellae close, always white; plants growing on pine leaves. S. 155; H. 99; Mc. 91; St. 77. *C. pithyophila* Fr.

I.[2] Lamellae subdistant, becoming yellowish; plants growing on deciduous leaves. S. 155; H. 104; M. 68; Mc. 91; St. 76.
C. phyllophila Fr.

E.[2] Pileus not white when fresh; sometimes fading to whitish when old.

F.[1] Pileus hygrophanous.

G.[1] Lamellae rather distant.

H.[1] Plants usually growing on wood, as old logs; pileus dark watery-brown when moist; lamellae sordid; stipe fibrillose. S. 176; H. 105; M. 70; Mc. 104; St. 88.
C. cyathiformis Fr.

H.[2] Plants growing on the ground; pileus blackish-brown when moist; lamellae brown-cinereous; stipe glabrous. S. 177; H. 101; St. 90.
C. obbata Fr.

G.[2] Lamellae close.

H.[1] Pileus pruinate with a leaden bloom; margin even; lamellae narrow. S. 178; St. 90; M. 70 ....*C. pruinosa* Lasch

H.[2] Pileus glabrous; margin striate when moist; lamellae broad. S. 9:26; H. 99; P. R. 42:18.
C. subditopoda Peck

F.[2] Pileus moist or dry, not truly hygrophanous.

G.[1] Pileus innate-silky, umbonate when young, umbo often persisting; reddish-tan to paler. S. 165; St. 82; H. 90; M. 69; Mc. 100.

C. infundibuliform Schaeff.

G.[2] Pileus glabrous, not umbonate, yellowish-brown. S. 172; St. 86; H. 101; Mc. 103.

C. flaccida Sowerb.

Notes.

C. ohiensis Mont. Syll. Crypt. 100, S. 181, is probably C. nebularis Batsch. although the description does not quite agree in some respects.

C. reticeps Mont. Syll. Crypt. 101, S. 150, is probably C. laccata Scop.

Saccardo publishes C. subditopoda Peck as "umbonate." Peck described it as umbilicate and says he separated it from C. ditopoda Fr. on account of the paler lamellae, striate margin and longer spores. C. ditopoda, however, is not umbilicate.

C. pruinosa Lasch was first reported by Lea, but does not seem to have been found since. None of Montagne's species have been identified since their publication.

According to Bresadola C. monadelpha is the same as C. tabescens (Scop.) Bres. of Europe (Lloyd Myc. Notes 1:54).

Lentinus caespitosus Berk. and Pleurotus caespitosus B. & C. are names of the same plant. The description fits the plant now known as C. monadelpha Morg.

COLLYBIA FR.

A.[1] Pileus usually more than 1 cm. broad.

B.[1] Stipe glabrous or nearly so, except at base.

C.[1] Lamellae usually more than 4 mm. broad, distant, always white.

D.[1] Pileus glabrous, viscid when moist; stipe usually long-rooting. S. 200; H. 107-8; St. 97; A. 92; Mc. 113; P. R. 49:35, M. 70.

C. radicata Relh.

D.[2] Pileus more or less streaked with dark-colored fibrils, not viscid; stipe not long rooting. S. 203; H. 109; Mc. 114; St. 98; A. 93; P. R. 49: 35; M. 71............*C. platyphylla* Fr.

C.[2] Lamellae narrow and close or crowded.

D.[1] Whole plant purplish- or brownish-lilac. S. 236; H. 115; P. R. 49: 50..*C. myriadophylla* Peck

D.[2] Plant not as above.

E.[1] Plants usually cespitose.

F.[1] Lamellae brownish or tawny. S. 203; M. 73; P. R. 49:49; S. 214.
C. lachnophylla Berk.
C. pilularia Mont.

F.[2] Lamellae whitish or yellow.

G.[1] Stipe prominently bulbous at base. S. 240.....*C. physcopodia* Mont.

G.[2] Stipe equal or only slightly thickened at base.

H.[1] Lamellae long decurrent. S. 9: 29......*C. tagetes* B. & Mont.

H.[2] Lamellae not decurrent.

I.[1] Stipe reddish, red-brown, or brown, usually long and slender. S. 234; H. 117; St. 110; Mc. 122; P. R. 49:48....*C. acervata* Fr.

I.[2] Stipe whitish, yellowish, or rufescent. S. 234; St. 111; H. 110; Mc. 120; M. 71; P. R. 49:44.
C. dryophila Bull

E.[2] Plants commonly solitary or gregarious, occasionally somewhat cespitose.

F.[1] Pileus white, yellow, light brown or red-brown.

G.[1] Stipe white.

H.[1] Pileus fleshy, white, often with reddish spots; stipe striate. S. 207; St. 100; H. 112; Mc. 116; P. R. 49:37.

C. maculata Alb. & Schw.

H.[2] Pileus thin, white or yellow, not spotted; stipe usually not striate. S. 9:30; P. R. 49:44.

C. strictipes Peck

G.[2] Stipe some shade of yellow or brown or occasionally pallid.

H.[1] Stipe striate, usually considerably tapering upward, pileus soft to the touch. S. 209; H. 109; St. 101; M. 71; Mc. 117; P. R. 49:37.

C. butyracea Bull.

H.[2] Stipe not striate, nearly equal or slightly thickened below.

I.[1] Lamellae yellowish or reddish-yellow, becoming brownish-red in drying. S. 230; M. 72; P. R. 49:50.

C. colorea Peck

I.[2] Lamellae not becoming brownish-red.

J.[1] Pileus usually reddish-brown to tan, sometimes pallid or yellowish. S. 234; H. 110; St. 111; Mc. 120; M. 71 . . . *C. dryophila* Bull.

J.[2] Pileus yellow (see notes).

K.[1] Lamellae pallid; stipe not rooting; pileus at first conic-campanulate. S. 236; M. 71.

C. estensis Morg.

K.[2] Lamellae flesh color; stipe rooting. S. 232.

C. xanthopila Mont.

F.[2] Pileus blackish, blackish-brown or smoky-brown.

G.[1] Pileus 3-6 cm. broad, lamellae adnexed, close. S. 9:27; P. R. 49:36.

C. fuliginella Peck

G.[2] Pileus 2.5 cm. or less; lamellae adnate, subdistant.

H.[1] Plants growing on ground; lamellae not venose-connected. S. 246; H. 113; St. 116.

C. atrata Fr.

H.[2] Plants growing on wood; lamellae venose-connected. H. 116; P. R. 49:53.

C. atratoides Peck

B.[2] Stipe velvety, fibrillose, downy, furfuraceous or pulverulent.

C.[1] Stipe densely velvety.

D.[1] Pileus fleshy, viscid when moist, margin even. S. 212; H. 118; St. 102; A. 93; Mc. 118; P. R. 49:38......................*C. velutipes* Curt.

D.[2] Pileus thin, not viscid, margin more or less striate. S. 212, 213; Myc. Notes 1:42.

C. amabilipes Peck

C. tenuipes Schw.

C.[2] Stipe not velvety.

D.[1] Lamellae broad, distant; plants large.

E.[1] Pileus glabrous, viscid when moist; stipe usually long-rooting. S. 200; H. 107-8; St. 97; Mc. 113; P. R. 49-35; M. 70.

C. radicata Relh.

E.[2] Pileus more or less streaked with blackish fibers, not viscid; stipe not rooting. S. 203; H. 109; Mc. 114; St. 98; P. R. 49:35; M. 71................*C. platyphylla* Fr.

D.[2] Lamellae narrow, close.

E.[1] Pileus glabrous or not hairy or fibrillose.

F.[1] Plants commonly cespitose.

G.[1] Lamellae brownish or tawny. S. 203; M. 73; P. R. 49:49. *C. lachnophylla* Berk.

G.[2] Lamellae not as above.

H.[1] Lamellae free, soon remote from stipe; pileus reddish to red-brown, paler when dry. S. 222; St. 104; H. 114; Mc. 119; P. R. 49:47. *C. confluens* Pers.

H.[2] Lamellae adnexed or free but reaching stipe; pileus whitish to pale reddish-brown. S. 221; St. 103; M. 73; P. R. 49:43. *C. hariolorum* DC.

F.[2] Plants solitary or gregarious, occasionally subcespitose.

G.[1] Pileus sooty-brown; stipe more or less fibrillose. S. 9:27; P. R. 49:36.........*C. fuliginella* Peck

G.[2] Pileus white to red-brown; stipe white-downy or tomentose. S. 221; St. 103; P. R. 49:43. *C. hariolorum* DC.

E.[2] Pileus hairy or tomentose.

F.[1] Lamellae adnexed or becoming free, subdistant; plants not cespitose. S. 216; St. 103; M. 72; P. R. 49:42. *C. stipitaria* Fr.

F.[2] Lamellae free, close; plants mostly cespitose. S. 216; H. 112; M. 72; P. R. 49:42. . . . .*C. zonata* Peck

A.[2] Pileus 1 cm. or less broad.

B.[1] Pileus and stipe fibrillose or tomentose. S. 216; St. 103; M. 72; P. R. 49:42. . . . .*C. stipitaria* Fr.

B.[2] Pileus and stipe not as above.

C.[1] Sipe arising from a sclerotioid tuber. S. 224; St. 106; P. R. 49:41; M. 73; Oh. Nat. 11:247.
C. tuberosa Bull.

C.[2] Stipe with long, fibrillose, rooting base; no tuber present. S. 224; St. 105; P. R. 49:41.
C. cirrata Schum.

NOTES.

C. pilularia, C. xanthopila, C. physcopodia and C. tagetes were described from specimens sent to Montagne by Sullivant and have not been recognized since.

Morgan's description of C. estensis is rather meager. It is probably a form of C. dryophila or perhaps is identical with C. strictipes.

The plants referred by Hard (p. 108) to C. ingrata Schum. should probably be considered a form of C. confluens. According to Berkeley (Outlines of British Fungology, p. 117), the principal difference between the two species is that in the former the lamellae more nearly approach the stipe.

Some writers believe that C. tenuipes and C. amabilipes are identical. Schweinitz described the former as having a stipe 15-30 cm. long, pileus depressed and subumbonate, plants growing among decaying leaves. The Ohio plants grow on decayed wood, the pileus is convex-expanded, and the stipe is variable in length, but seldom more than 8-10 cm. long. Peck's description of C. amabilipes fits our plants more closely, and unless we assume that Schweinitz had very exceptional specimens, they should be known by Peck's name. Lloyd says the pileus is slightly viscid, but we have never found it so. (Myc. Notes 1: 109.)

MYCENA FR.

A.[1] Whole plant, especially stipe, with dark red juice. S. 291; St. 141; H. 122; A. 98; Mc. 130; M. 75.
M. haematopoda Pers.

A.[2] Plants without red juice.

B.[1] Whole plant bright orange red, or fading to yellow; pileus viscid. S. 9: 38; H. 127; M. 74.
M. leaiana Berk.

B.[2] Plant not orange-red or bright yellow.

C.[1] Stipe inserted. S. 302; St. 149; H. 125.
M. corticola Schum.

C.[2] Stipe not inserted.

D.[1] Lamellae violaceous, edge blackish denticulate; pileus livid-purple to paler; stipe concolorous. S. 251; St. 121; Berk. Out. 121.
M. pelianthina Fr.

D.[2] Edge of lamellae not darker than the rest of their surface, not denticulate.

E.[1] Base of stipe with blue fibrils; pileus often blue or bluish. S. 16: 29; P. R. 51: 284; Oh. Nat. 11: 350...*M. cyaneobasis* Peck

E.[2] Pileus and stipe not as above.

F.[1] Neither stipe nor pileus viscid.

G.[1] Pilei mostly 2.5 cm. or more broad.

H.[1] Plants pinkish-purple or lilac, or becoming paler; with odor of radishes. S. 256; St. 125; H. 128; A. 95; M. 74.
M. pura Pers.

H.[2] Pileus usually some shade of gray, yellow or brown; sometimes whitish.

I.[1] Stipe firm, rigid, pileus not hygrophanous.

J.[1] Lamellae adnate-uncinate, flesh-colored or whitish; pileus striate, usually some shade of gray or brown; stipe not striate. S. 268; H. 120; St. 130; A. 94; Mc. 127; M. 74.

M. galericulata Scop.

J.[2] Lamellae adnexed, white or whitish; pileus striatulate only, paler than the above; stipe striatulate. S. 267; St. 128; H. 120; Mc. 126.

M. prolifera Fr.

I.[2] Stipe more or less fragile; pileus hygrophanous.

J.[1] Pileus cinereous or some shade of brown, broadly umbonate; lamellae adnate. S. 277; St. 134; H. 123.

M. alcalina Fr.

J.[2] Pileus gray when moist to tin-colored when dry, not umbonate; lamellae adnate-uncinate. S. 280; St. 137; H. 124.

M. stannea Fr.

G.[2] Pilei mostly less than 2.5 cm. broad.

H.[1] Stipe filiform, with rooting hairy base; pileus grayish to brownish. S. 283; St. 138; H. 124; M. 75........*M. filipes* Bull.

H.[2] Stipe not filiform.

I.[1] Lamellae broad.

J.[1] Lamellae adnate-uncinate, flesh-colored or whitish; pileus striate;

stipe not striate. S. 268; H. 120; A. 94; St. 130; Mc. 127; M. 74.

M. galericulata Scop.

J.[2] Lamellae adnexed, white or whitish; pileus striatulate only; stipe striatulate. S. 267; St. 128; H. 120; Mc. 126.

M. prolifera Fr.

I.[2] Lamellae linear or rather narrow.

J.[1] Lamellae adnate, pileus livid, or bluish-gray, not umbonate. S. 280; St. 137; H. 125.

M. vitrea Fr.

J.[2] Lamellae not adnate; pileus umbonate or subumbonate.

K.[1] Pileus white to gray; stipe fusiform, fibrillose and rooting. S. 273.

M. cymbalifera Mont.

K.[2] Pileus purplish to yellow, stipe neither fusiform, fibrillose nor rooting. S. 258.

M. conferruminata Berk. & Mont.

F.[2] Pileus or stipe or both viscid.

G.[1] Stipe yellowish or paler; lamellae adnate-uncinate. S. 294; St. 144; H. 129; A. 96.

M. epipterygia Scop.

G.[2] Stipe cinereous; lamellae somewhat decurrent. S. 295; St. 145; H. 129; A. 97.....*M. vulgaris* Pers.

NOTES.

M. lilacina Mont., described from Sullivant's material (S. 257), is a doubtful Mycena. The pileus is said to be lilac-colored and umbilicate; the lamellae remote (when dry) and rosy-ochraceous. The plants may possibly have been M. pura, the abnormal character appearing in drying.

Neither the above nor M. cymbalifera nor M. conferruminata have been recognized since described.

M. vitrea and M. vulgaris have not been definitely reported from Ohio but probably occur here and so are included.

OMPHALIA FR.

A.[1] Lamellae yellow or yellowish.

B.[1] Pilei mostly 2.5 cm. or more broad; stipe yellow.

C.[1] Pileus flocculose or squamulose; lamellae and stipe bright yellow. S. 312; P. R. 45:35; St. 153; H. 135.....................*O. chrysophylla* Fr.

C.[2] Pileus glabrous; lamellae and stipe paler, at first whitish. S. 327; H. 135; M. 76.
O. alboflava Morg.

B.[2] Pilei less than 2.5 cm. broad; stipe not yellow.

C.[1] Stipe tawny-strigose at base, brown; plants on decayed wood. S. 327; H. 130; M. 77; A. 101; Mc. 134; St. 160; P. R. 45:38.
O. campanella Batsch.

C.[2] Stipe not strigose at base, pallid or rufescent; plants on ground. S. 313; H. 133; St. 154; P. R. 45:36.
O. pyxidata Bull.

A.[2] Lamellae white, whitish, gray or cinereous.

B.[1] Pileus depressed only, not umbilicate or infundibuliform

C.[1] Lamellae broad, subtriangular; plants on ground. S. 321; St. 158; Mc. 133; H. 132; M. 76; P. R. 45:38...................*O. umbellifera* Linn.

C.[2] Lamellae narrow; plants on wood, white. S. 337; St. 164; M. 77............ *O. integrella* Pers.

B.[2] Pileus umbilicate or infundibuliform.

C.[1] Pileus sulcate, yellowish or fading. S. 315; St. 156; H. 132.................... *O. caespitosa* Bolt.

C.[2] Pileus even or striatulate only.

D.[1] Pileus sooty-gray or reddish-brown, usually silky or flocculose or becoming so.

E.[1] Pilei usually less than 1 cm. broad; plants on ground. S. 316; St. 156; M. 76. *O. rustica* Fr.

E.[2] Pilei usually more than 1 cm. broad; plants on wood. S. 314; H. 130; M. 76; A. 101; P. R. 45:37........... *O. epichysium* Fr.

D.[2] Pileus not as above.

E.[1] Pileus yellow to orange or paler, 4-10 mm. broad; stipe 2-5 cm. long. S. 331; St. 163; P. R. 45:40; H. 134; M. 77. *O. fibula* Bull.

E.[2] Pileus reddish-brown or grayish-red, 8-25 mm. broad.

F.[1] Lamellae pallid; stipe reddish-brown, 6-12 mm. long. S. 321; St. 158; M. 76.................. *O. muralis* Sow.

F.[2] Lamellae flesh color, grayish-red, or pale yellow; stipe pallid to rufescent, usually longer. S. 313; St. 154; H. 133; P. R. 45:36....... *O. pyxidata* Bull.

NOTES.

O. alboflava is closely related to O. chrysophylla and is probably a variety of the latter. The plants figured by Hard (p. 135, f. 100) as O. alboflava agree more closely with the description of O. chrysophylla.

O. chrysea Peck, reported by Morgan (p. 75), is now regarded by its author as a variety of O. chrysophylla.

O. rhyssospora Mont. and O. strombodes B. & Mont., described from Sullivant's material, do not seem to agree with the characters of the genus. The former is described as having the lamellae adnexed and decurrent by a tooth; the latter, as having the edge of the lamellae obtuse. In Omphalia the lamellae are truly decurrent and the edge acute. (See S. 318 and S. 333.)

PLEUROTUS FR.

A.[1] Partial veil present, usually appendiculate about margin of pileus, pileus usually 5-15 cm. broad, lamellae broad. S. 339-340; M. 79; Mc. 137; St. 166; A. 105-107.
P. dryinus Pers.
P. corticatus Fr.

A.[2] Veil wanting.

B.[1] Stipe present; sometimes short or even suppressed but pileus never resupinate.

C.[1] Lamellae long decurrent.

D.[1] Pileus white, silky-villous. S. 360; St. 173.
P. acerinus Fr.

D.[2] Pileus some shade of yellow or brown.

E.[1] Pileus thin; lamellae close, linear; stipe lateral. S. 361; P. R. 39:64; H. 157; A. 107; Mc. 144; St. 174....*P. petaloides* Fr.

E.[2] Pileus thick; lamellae broad, subdistant.

F.[1] Spores lilac in mass. S. 348; P. R. 39:61; H. 159; M. 79; A. 104; Mc. 141..............*P. sapidus* Kalchb.

F.[2] Spores white.

G.[1] Lamellae entire, anastomosing at base; pileus glabrous. S. 355; P R. 39:62; H. 153; A. 104; Mc. 142...........*P. ostreatus* Jacq.

G.[2] Lamellae eroded, distinct at base; pileus substrigose. S. 359; H. 156; M. 79; Mc. 143; St. 173; P. R. 39:62.....*P. salignus* Schrad.

C.[2] Lamellae not long decurrent; (sometimes uncinate or subdecurrent).

D.[1] Pileus viscid when moist; stipe with minute blackish tomentum. S. 363; M. 80; Mc. 145; A. 109; St. 175; P. R. 39:62

P. serotinus Schrad.

D.[2] Pileus and stipe not as above.

E.[1] Lamellae broad, sinuate; pileus glabrous; stipe thick, solid. S. 341; P. R. 39:60; H. 157; M. 78; Mc. 138; A. 102; St. 167.

P. ulmarius Bull.

E.[2] Lamellae rather narrow, adnate to subdecurrent.

F.[1] Pileus grayish to brownish, glabrous; stipe solid. S. 343; M. 78; St. 169.

P. craspedius Fr.

F.[2] Pileus white, pruinate or floccose; stipe stuffed or hollow.

G.[1] Lamellae adnate to emarginate; stipe subvillous; pileus somewhat irregular. S. 344; St. 170; M. 78; P. R. 39:60; Mc. 140.

P. lignatilis Fr.

G.[2] Lamellae adnate to subdecurrent; stipe glabrous, pileus orbicular. S. 344; H. 163; Mc. 140; St. 171.

P. circinatus Fr.

B.[2] Stipe wanting; pileus definitely sessile or resupinate.

C.[1] Pileus less than 8 mm. broad, cup-shaped when young, gray, bluish-gray or nearly black. S. 379; H. 161; A. 109; St. 180.....*P. applicatus* Batsch

C.[2] Pileus usually 2 cm. or more broad.

D.[1] Pileus glabrous or nearly so.

E.[1] Lamellae very narrow; pileus somewhat spatulate, not viscid when moist. S. 361: P. R. 39:64; H. 157; Mc. 144; St. 174, A. 107..................*P. petaloides* Fr.

E.[2] Lamellae rather broad; pileus at first resupinate, becoming somewhat reniform, viscous when moist. S. 378; St. 180; M. 80. *P. algidus* Fr.

D.[2] Pileus silky, villous or with somewhat pointed scales when fresh; not glabrous.

E.[1] Pileus white or whitish, silky. S. 374; M. 80. . . . . *P. pinsitus* Fr.

E.[2] Pileus darker in color when fresh.

F.[1] Pileus mouse-gray, usually with tufted scales. S. 376; M. 80; Mc. 146; St. 179. . . . . *P. mastrucatus* Fr.

F.[2] Pileus blackish-blue or brownish-gray, villous, not scaly. S. 377; P. R. 39: 65; St. 179. . . . . . . *P. atrocoerulius* Fr.

NOTES.

P. nidulans Pers. is now usually placed in the genus Claudopus on account of its salmon-colored or pink spores. P. sapidus, which has pale lilac spores, is usually regarded as a Pleurotus because of its obvious relations with some species of that genus.

Plants formerly referred to P. serotinoides Peck and P. abscondens Peck, and so listed by Hard, are now regarded by Peck as varieties of P. serotinus and P. lignatilis respectively.

Kellerman and Werner (p. 305) include P. acerinus in the list of Ohio plants. This seems to be the only reference to this species in Ohio literature.

Plants referred by Morgan to P. niger Schw. were probably P. applicatus, which is a rather common species in southwestern Ohio.

The plants referred to P. circinatus by Hard were probably P. lignatilis. He says it may be known by the white gills. The lamellae of P. lignatilis are white.

The occurrence of P. pinsitus in Ohio is rather doubtful.

P. caespitosus B. & C. was first published as a Lentinus, then as a Pleurotus. It is probably the plant now known as Clitocybe monadelpha Morg.

P. corticatus is very close to P. dryinus Pers. It should probably be regarded as a variety of the latter as Atkinson does.

HYGROPHORUS FR.

A.[1] Plants becoming black when bruised or dried; pileus conic; red, orange or yellow or with these colors blended. S. 418; St. 2:89; Mc. 160; H. 209; M. 181; M. B. 116:62. *H. conicus* (Scop.) Fr.

A.[2] Plants not becoming black.

B.[1] Stipe solid.

C.[1] Pileus and stipe glutinous.

D.[1] Stipe punctate or scabrous at top with small scales.

E.[1] Pileus pale brownish or reddish brown to whitish, center usually darker. S. 388; M. B. 116:48; H. 213; Mc. 716; M. 180. *H. laurae* Morg.

E.[2] Whole plant white; (the stipe usually stuffed or becoming hollow). S. 388; M. B. 116:47; St. 2:71; H. 206; Mc. 149; A. 111; M. 180. *H. eburneus* (Bull.) Fr.

D.[2] Stipe not punctate or scabrous.

E.[1] Pileus white, yellow or reddish-yellow in the center. S. 398; H. 210; Mc. 157; M. B. 116: 50 .... *H. flavodiscus* Frost

E.[2] Pileus grayish-brown or smoky-brown, often darker in the center. S. 398; H. 212; Mc. 158; A. 113; M. B. 116:52. *H. fuliginosus* Frost

C.[2] Pileus and stipe not glutinous; pileus may be viscid or moist only.

D.[1] Lamellae distant or subdistant; pileus convexo-plane or somewhat depressed.

E.[1] Pileus white or whitish.

F.[1] Pileus somewhat viscid; lamellae rather close or subdistant, mostly adnate. S. 16:39; H. 220; B. T. 25:322.

H. sordidus Peck

F.[2] Pileus not viscid; lamellae distant, decurrent. S. 402; St. 2:79; Mc. 153; H. 219; M. B. 116:55.

H. virgineus (Bull.) Fr.

E.[2] Pileus not white.

F.[1] Pileus variable in color, not viscid, usually more than 2.5 cm. broad; plants growing on ground. S. 401; H. 205, 206; St. 2: 79; Mc. 152; A. 113; M. B. 116:56.

H. pratensis (Pers.) Fr.

F.[2] Pileus yellow becoming purplish, viscid, 2.5 cm. or less in breadth; plants growing on wood. S. 422.

H. ohiensis Mont.

D.[2] Lamellae crowded, narrow, pileus soon infundibuliform. S. 403.

H. stenophyllus Mont.

B.[2] Stipe stuffed or soon hollow.

C.[1] Stipe scabrous or punctate at apex with small scales; whole plant white, viscid. S. 388; M. B. 116:47; St. 2:71; H. 206; Mc. 149; A. 111; M. 180. .... *H. eburneus* (Bull.) Fr.

C.[2] Stipe glabrous.

D.[1] Plants covered with greenish slime, at least when rather young. S. 420; A. 114; M. B. 116: 64; St. 2: 90.

H. psittacinus (Schaeff.) Fr.

D.[2] Plants without greenish slime.

E.[1] Plants bright red, orange or yellow; pileus thin and fragile.

F.[1] Pileus viscid when moist.

G.[1] Plants yellow; without red or with only slight tinge of red at center.

H.[1] Stipe viscid; lamellae emarginate-adnexed. S. 419; St. 2:90; Mc. 160; H. 208; M. B. 116:66; M. 181.

H. chlorophanus Fr.

H.[2] Stipe not viscid; lamellae adnate or subdecurrent. S. 412; St. 2:86; M. B. 116:61; H. 218; Mc. 155; M. 181.

H. ceraceus (Wulf.) Fr.

G.[2] Pileus red.

H.[1] Lamellae adnexed or emarginate; stipe whitish at the base, rather stout. S. 416; St. 2:88; M. B. 116:63; Mc. 159; M. 181......*H. puniceus* Fr.

H.[2] Lamellae adnate or subdecurrent; stipe yellow at the base, rather slender. S. 412; St. 2:86; Mc. 156; H. 209; M. 181; M. B. 116:63.

H. coccineus Schaeff.

F.[2] Pileus not viscid.

G.[1] Lamellae quite decurrent. S. 414; M. B. 116:59; H. 208; Mc. 156.

H. cantharellus Schw.

G.[2] Lamellae normally adnate or sinuate; sometimes becoming somewhat decurrent by the expansion of the pileus. S. 413; St. 2:87; M. B. 116:61; H. 215; Mc. 159; A. 113 ....*H. miniatus* Fr

E.[2] Plants not bright red, etc., as above; more or less firm and fleshy; pileus not viscid.

F.[1] Whole plant white or whitish; stipe usually less than 5 cm. long. S. 402; St. 2:79; Mc. 153; M. B. 116:55; H. 219.........*H. virgineus* (Bull.) Fr.

F.[2] Pileus tawny, buff, cinereous; occasionally varying to whitish or with tinge of red; stipe usually more than 5 cm. long. S. 401; H. 205,206; St. 2:79; Mc. 152; A. 113; M. B. 116:56.
H. pratensis (Pers.) Fr.

LACTARIA PERS.

A.[1] Latex colored from the first.

B.[1] Latex and plant indigo-blue. S. 438; N. A. F. 187; H. 167; Mc. 171; A. 125; P. R. 38:115.
L. indigo (Schw.) Fr.

B.[2] Latex and plant saffron-red or orange. S. 438; N. A. F. 186; H. 179; Mc. 170; A. 123; M. 184; P. R. 38:116.
L. deliciosus (L.) Fr.

A.[1] Latex white or whitish at first.

B.[1] Latex very acrid.

C.[1] Pileus dry or only moist; not viscid.

D.[1] Latex becoming golden-yellow; pileus zonate. S. 433; H. 181; P. R. 38:117; N. A. F. 188; A. 122; St. 2:101..........*L. chrysorhea* Fr.

D.[2] Latex unchanging; pileus azonate except in L. rusticana.

E.[1] Pileus white, whitish or yellowish.

F.[1] Pileus tomentose; lamellae broad, distant. S. 437; N. A. F. 177; H. 181; Mc. 169; M. 183; St. 2:102; P. R. 38:124.
L. vellerea Fr.

F.[2] Pileus glabrous; lamellae close, narrow.

G.[1] Flesh thick; lamellae usually decurrent, not straw colored, 2 mm. broad; stipe solid. S. 436; N. A.

F. 176; H. 165; Mc. 168; A. 120; M. 183; St. 2: 102; P. R. 38: 125.
L. piperata (Scop.) Fr.

G.[2] Flesh thin; lamellae adnate, becoming straw-colored, 1 mm. broad; stipe stuffed; latex often drying sulfur-yellow. S. 436; H. 166; N. A. F. 176; Mc. 167; M. 183; St. 2: 101.
L. pergamena (Sw.) Fr.

E.[2] Pileus dark colored.

F.[1] Pileus olivaceous; azonate, scabrous-hairy; lamellae close, narrow, staining green. S. 9: 56; H. 175; N. A. F. 178; P. R. 42: 23. . *L. atroviridis* Peck

F.[2] Pileus grayish to brown, or with lurid tints, somewhat zoned, glabrous; lamellae subdistant, rather broad, not staining green. S. 432; St. 2: 100; N. A. F. 178; P. R. 38: 128.
L. pyrogala Fr.
L. rusticana (Scop.) Burl.

C.[2] Pileus viscid.

D.[1] Plants becoming blackish in age or with injury; stipe viscid when moist. S. 426; St. 2: 94; N. A. F. 183; P. R. 38: 120.
L. turpis (Weinm.) Fr.

D.[2] Plants not becoming blackish.

E.[1] Margin of pileus woolly or tomentose, at least in young plants.

F.[1] Stipe scrobiculate-pitted; latex becoming yellow; margin often naked at maturity. S. 424; H. 169-170; M. 182; St. 2: 93; N. A. F. 179; P. R. 38: 118.
L. scrobiculata (Scop.) Fr.

F.[2] Stipe not pitted; latex unchanging.

G.[1] Center of pileus glabrous, usually zonate. S. 424; N. A. F. 178; H.

164-5; Mc. 163; St. 2:93; P. R. 38:120.

L. torminosa (Schaeff.) Pers.

G.[2] Whole pileus tomentose, azonate. S. 425; M. 182; St. 2:94; N. A. F. 179; P. R. 38:119.

L. cilicioides Fr.

E.[2] Pileus glabrous; margin naked or only pruinose.

F.[1] Latex becoming yellow; pileus zonate, white to yellowish. S. 433; H. 181; A. 122; N. A. F. 188; St. 2:101; P. R. 38:117........... *L. chrysorhea* Fr.

F.[2] Latex unchanging (or drying greenish in L. trivialis).

G.[1] Pileus some shade of yellow or orange.

H.[1] Pileus zonate; lamellae about 2 mm. broad.

I.[1] Spores white; stipe usually longer than 5 cm., solid or spongy within, unspotted; pileus usually depressed only. S. 428; M. 183; St. 2:96.

L. zonaria (Bull.) Fr.

I.[2] Spores yellow; stipe usually less than 5 cm. long, stuffed or hollow, sometimes spotted; pileus usually infundibuliform. S. 427; N. A. F. 180; H. 171; P. R. 38:122; Mc. 165; St. 2:96.

L. insulsa Fr.

H.[2] Pileus azonate; lamellae 4-10 mm. broad. S. 428; M. 184; N. A. F. 180; P. R. 38: 121.
L. affinis Peck

G.[2] Pileus lurid to ash-gray or snuff-brown.

H.[1] Pileus usually more than 8 cm. broad; viscidity slimy, persistent; lamellae rather broad; stipe cream-yellow. S. 430; M. 183; H. 170; P. R. 38: 120; N. A. F. 181; St. 2: 98.
L. trivialis Fr.

H.[2] Pileus usually less than 8 cm. broad; viscidity thin, disappearing; lamellae rather narrow; stipe cinereous. S. 428; M. 184; P. R. 38: 122; N. A. F. 190; H. 173.
L. cinerea Peck

B.[2] Latex mild or only slightly acrid.

C.[1] Pileus ash-gray, somewhat viscid....*L. cinerea* Peck

C.[2] Pileus some shade of yellow or brown, dry.

D.[1] Lamellae distant; pileus yellow to fulvous. S. 448; N. A. F. 196; P. R. 38: 129; H. 174; M 184; Mc. 180......*L. hygrophoroides* B. & C.

D.[2] Lamellae close.

E.[1] Pileus zonate; fulvous to brownish. S. 449; N. A. F. 176; St. 2: 110...*L. ichorata* Fr.

E.[2] Pileus azonate.

F.[1] Pileus glabrous.

G.[1] Flesk thick, becoming brownish on exposure to air; stipe stout. S. 447; H. 178; P. R. 38: 130; N. A. F. 195; Mc. 180; A. 115; M. 184; St. 2: 109.
L. volema Fr.
L. lactiflua (L.) Burl.

G.[2] Flesh thin, not becoming brownish; stipe slender.

H.[1] Margin striatulate when moist; (pileus slightly viscid but this character may not be apparent); plants growing among Sphagnum, other mosses and old leaves. S. 451; N. A. F. 189; P. R. 38: 133.

L. paludinella Peck

H.[2] Margin even; pileus not viscid.

I.[1] Pileus rimose-areolate, reddish-brown, with faint aromatic odor; lamellae 4-6 mm. broad; latex somewhat watery. N. A. F. 198; Oh. Nat. 10; 177-8; M. B. 105: 37.

L. rimosella Peck

I.[2] Pileus smooth, fulvous to reddish-fulvous, odorless; lamellae 3 mm. broad; latex white, not watery. S. 450; H. 176; N. A. F. 198; Mc. 182; M. 184; P. R. 38: 132.

L. subdulcis (Bull.) Fr.

F.[2] Pileus velvety or pruinose-velvety.

G.[1] Pileus sooty or smoky-brown, usually umbonate; latex becoming salmon-pink. S. 445; P. R. 38: 129; H. 173; Mc. 177; N. A. F. 194; A. 117..............*L. ligniota* Fr.

G.[2] Pileus yellow to reddish-brown, plane or depressed; latex not becoming pink.

H.[1] Flesh and lamellae staining brown where injured.

I.[1] Pileus reddish-brown; usually much corrugated. S. 449; N. A. F. 197; H. 177-178; Mc. 178; A. 116; P. R. 38: 130.

L. corrugis Peck

I.[2] Pileus yellowish-buff, even or slightly rugose. S. 14: 94; N. A. F. 197; Mc. 178; B. T. 23: 412.

L. luteola Peck

H.[2] Flesh and lamellae not staining brown; pileus golden-fulvous. N. A. F. 197; M. B. 75; 18.

L. subvelutina Peck

NOTES.

The nomenclature in the above key is that employed by Miss Burlingham in her monograph of the genus in the North American Flora. The genus is commonly known as Lactarius, which Miss Burlingham regards as merely a variation in spelling. L. lactiflua is commonly known as L. volema, and L. rusticana is usually published as L. pyrogala. In these cases both names are given.

L. distans Peck, reported by Morgan and Hard, is now regarded by Peck as a synonym for L. hygrophoroides. L. sordida Peck is a synonym for L. turpis.

L. vieta Fr., L. calceola Berk. and L. zonaria (Bull.) Fr. were reported by Lea and included in Morgan's list. The first has not been otherwise reported from North America. L. calceola was probably an abnormal form of L. hygrophoroides. Of the three only L. zonaria is included in the key and its occurrence in Ohio is doubtful.

L. torminosa has not been reported for Ohio but its range is such as to indicate that it will likely be found here.

RUSSULA PERS.

A.[1] Lamellae conspicuously unequal, short and long alternating; pileus firm, margin even, flesh thick.

B.[1] Pileus changing color in age or in drying.

C.[1] Pileus becoming smoky-brown or blackish.

D.[1] Lamellae distant or subdistant, broad, thick; pileus somewhat viscid; flesh turning reddish then blackish. S. 453; M. B. 116: 68; K. 65; Mc. 187; H. 184; St. 2: 114.
R. nigricans (Bull.) Fr.

D.[2] Lamellae close, rather narrow, thin.

E.[1] Pileus viscid when moist. M. B. 116: 69; Oh. Nat. 10: 177-8. . . *R. subsordida* Peck

E.[2] Pileus not viscid.

F.[1] Flesh of pileus not changing color when wounded. S. 454; M. B. 116: 70; K. 66; Mc. 188; H. 183; St. 2: 114.
R. adusta (Pers.) Fr.

F.[2] Flesh changing color when wounded.

G.[1] Flesh becoming reddish then blackish when wounded. S. 454; M. B. 116: 70; K. 67; H. 197.
R. densifolia Secr.

G.[2] Flesh becoming blackish without assuming reddish tint. S. 459; M. B. 116: 69; K. 66; Mc. 190; M. 186. . . . . *R. sordida* Peck

C.[2] Pileus becoming tawny or ochraceous. S. 9: 59; M. B. 116: 71. . . . . *R. compacta* Frost

B.[2] Pileus not changing color in age or in drying.

C.[1] Pileus white, glabrous; lamellae white. S. 455; M. B. 116: 72; K. 64; H. 182; Mc. 190; St. 2: 115.
R. delica Fr.

C.[2] Pileus sordid to brown, flocculose; lamellae becoming somewhat flesh-color. S. 468; M. 187.
R. morgani Sacc.

A.[2] Lamellae equal or with a few shorter ones.

B.[1] Stipe yellow, at least at base.

C.[1] Pileus red, becoming yellowish at center or entirely so; stipe orange-yellow at base; lamellae pale ochraceous. S. 17: 34; B. T. 31: 179; Oh. Nat. 10: 177...................... *R. luteobasis* Peck

C.[2] Pileus wholly yellow, sometimes mealy; stipe wholly yellow; lamellae white. M. B. 116: 78; K. 72; Mc. 197; S. 9: 60.............. *R. flavida* Frost

B.[2] Stipe white or whitish, red or reddish.

C.[1] Lamellae forking much throughout.

D.[1] Lamellae close; pileus purplish, umber or green or with these colors mingled. M. B. 105: 41; K. 73; H. 190........... *R. variata* Bann.

D.[2] Lamellae subdistant; pileus yellowish-green or umber-green. S. 456; M. B. 116: 74; K. 73; Mc. 191; H. 194; St. 2: 116. *R. furcata* (Pers.) Fr.

C.[2] Lamellae not often forking or only near stipe.

D.[1] Lamellae or spores, usually both, white or whitish to cream color.

E.[1] Pileus some shade of red or purple.

F.[1] Taste acrid.

G.[1] Pileus dry, margin even. S. 462; M. B. 116: 79; St. 2: 120; K. 67; Mc. 196; H. 195....*R. rubra* Fr.

G.[2] Pileus viscid or subviscid; margin striate or sulcate, tuberculate.

H.[1] Pileus 2-5 cm. broad; lamellae close. S. 472; St. 2: 126; M. B. 116: 88; Mc. 203; H. 192; St. 2: 126. *R. fragilis* (Pers.) Fr.

H.[2] Pileus usually 5-10 cm. broad; lamellae subdistant. S. 469; M. B. 116: 87; K. 78; Mc. 201; H. 193; St. 2: 125. *R. emetica* Fr.

F.[2] Taste mild.

G.[1] Stipe becoming blackish when bruised or dried; pileus glabrous, bright red, margin striate. B. T. 33: 214...*R. nigrescentipes* Peck

G.[2] Stipe not becoming blackish.

H.[1] Pileus tuberculose-striate on margin, less than 3.5 cm. broad. S. 479; K. 85; M. B. 116: 95; Mc. 208.

R. puellaris Fr.

H.[2] Pileus even on margin, more than 3.5 cm. (except sometimes *R. purpurina.*)

I.[1] Pileus dry, subvelvety or with velvety appearance, rimose - areolate, sometimes becoming yellowish; stipe usually red or tinged with red. S. 461; St. 2: 119; K. 68; M. B. 116: 79; Mc. 195; H. 187.

R. lepida Fr.

I.[2] Pileus glabrous, viscid, not rimose; stipe white (except in *R. purpurina*).

J.[1] Pileus rugose-wrinkled; cuticle not reaching margin; stipe solid. S. 465; St. 2: 122; K. 74; M. B. 116: 82; Mc. 198; H. 189.

R. vesca Fr.

J.[2] Pileus not rugose; stipe stuffed or spongy within, sometimes hollow when old.

K.[1] Pileus deep red; lamellae rather narrow, floccose-crenulate on edge. S. 474; M. B. 116: 89; Mc. 188; K. 83; H. 196.
R. purpurina Q. & S.

K.[2] Pileus variable in color, purplish, bluish, yellowish, etc.; lamellae broad. S. 465; M. B. 116:82; St. 2: 122; K. 74; H. 188; Mc. 198.
R. cyanoxantha (Schaeff.) Fr.

E.[2] Pileus without red or purple.

F.[1] Pileus white to yellow or brownish.

G.[1] Margin of pileus even or nearly so; lamellae distant.

H.[1] Pileus very viscid. S. 17:33; M. B. 116:83; Oh. Nat. 10: 177 . . . . *R. earlei* Peck

H.[2] Pileus not viscid, white. S. 459; St. 2:118; Mc. 194; M. 186.
R. lactea (Pers.) Fr.

G.[2] Margin of pileus deeply striate and tuberculate; lamellae rather close.

H.[1] Pileus glutinous at least when young, usually more than 6 cm. broad; plants with amygdaline odor. S. 467; M. B. 116:85; St. 2:124; K. 78; Mc. 199; H. 186; M. 187.
R. foetens (Pers.) Fr.

H.[2] Pileus viscid but not glutinous, usually less than 6 cm. broad; odor not marked. S. 470; Mc. 202; St. 2: 126.

R. pectinata (Bull.) Fr.

F.[2] Pileus some shade of green, sometimes fading to ochraceous-green or umber.

G.[1] Pileus areolate except center; margin striate; sometimes subviscid. M. B. 116:77; K. 72; Oh. Nat. 10: 177-8; S. 9:61.

R. crustosa Peck

G.[2] Pileus with flocculent patches or warts, dry; margin even. S. 460; K. 72; M. B. 116:76; Mc. 194; H. 190; St. 2: 119.

R. virescens (Schaeff.) Fr.

D.[2] Lamellae and spores yellow or ochraceous.

E.[1] Pileus viscid, at least slightly, more or less polished, glabrous, margin usually striate.

F.[1] Pileus less than 5 cm. broad; stipe rosy-mealy. S. 474; M. B. 116:96; K. 86; Mc. 209; H. 191.

R. roseipes (Secr.) Bres.

F.[2] Pileus broader than 5 cm.; stipe not rosy-mealy.

G.[1] Pileus orange-red, becoming paler; flesh becoming cinereous with age or when broken. S. 476; M. B. 116:94; K. 88; Mc. 205; St. 2: 128. . . . .*R. decolorans* Fr.

G.[2] Pileus red, purplish-red, or brownish red, or with green shades, not orange-red; flesh not becoming cinereous.

H.[1] Lamellae close, rather narrow, pulverulent; spores yellow;

pileus bay-brown-purplish. S. 477; M. 187; St. 2:129.

R. nitida (Pers.) Fr.

H.[2] Lamellae distant or sub-distant, broad.

I.[1] Spores ochraceous; lamellae not pulverulent; stipe usually variegated reddish. S. 479; M. B. 116:98; K. 69; Mc. 207; H. 186; St. 2:129.

R. alutacea Fr.

I.[2] Spores yellow; lamellae pulverulent; stipe white. S. 475; H. 191; M. B. 116: 93; K. 84; Mc. 204; St. 2:127.

R. integra (L) Fr.

E.[2] Pileus dry, unpolished or pruinose; margin usually even.

F.[1] Pileus with whitish pruinose bloom; spores pale yellow. S. 464; M. B. 116:81; K. 70; Mc. 209.

R. mariae Peck

F.[2] Pileus without whitish bloom.

G.[1] Pileus subvelvety, often rimose; spores yellowish; lamellae not powdery. S. 461; M. B. 116:79; K. 68; Mc. 195; H. 187.

R. lepida Fr.

G.[2] Pileus unpolished merely, not rimose; spores ochraceous, dusting the lamellae. S. 14:98; M. B. 116: 80; K. 68; Mc. 193; H. 187.

R. ochrophylla Peck

NOTES.

R. cyanoxantha, R. integra, R. roseipes, R. adusta, R. purpurina, R. fragilis and R. nigricans have not been definitely reported from Ohio as yet. Their range, however, makes it likely that they occur here and they are included in the key for convenience in determination.

Morgan reports R. lutea Fr. but from his notes it is evident that his plants should be referred to R. flavida which is rather frequent in southwestern Ohio during some seasons. R. lutea has not been otherwise reported and is omitted.

Most American plants formerly referred to R. furcata are now more properly referred to R. variata. It is uncertain at present whether the true R. furcata occurs in Ohio.

CANTHARELLUS ADANS.

A.[1] Whole plant bright cinnabar-red when fresh. S. 414; M. B. 1^2:39; N. A. F. 170; M. 189; H. 203. *C. cinnabarinus* Schw.

A.[2] Plants not as above.

B.[1] Pileus deeply infundibuliform.

C.[1] Lamellae close; pileus more than 5 cm. broad. S. 491; M. B. 1^2:37; H. 200; N. A. F. 168; Mc. 218 .... *C. floccosus* Schw.

C.[2] Lamellae distant; pileus less than 5 cm. broad. S. 490; N. A. F. 168; M. B. 1^2:41; H. 203. *C. infundibuliformis* (Scop.) Fr.

B.[2] Pileus plane or depressed, not infundibuliform.

C.[1] Pileus cinereous or grayish brown. S. 485; N. A. F. 170; Mc. 217; M. B. 1^2:36. *C. umbonatus* Fr.

C.[2] Pileus yellow or orange, rarely ochraceous.

D.[1] Lamellae close; plants orange. S. 483; N. A. F. 169; M. B. 1^2:35; H. 200; Mc. 216; A. 129; M. 189............ *C. aurantiacus* Fr.

D.[2] Lamellae distant; plants usually yellow.

E.[1] Pileus thick, 3 cm. or more broad when mature. S. 482; N. A. F. 169; M. B. 1^2:38; H. 198; Mc. 215; A. 128; M. 188 .... *C. cibarius* Fr.

E.[2] Pileus thin, 1-2.5 cm. broad. S. 483; N. A. F. 169; M. B. 1^2:40; Mc. 216; M. 188 *C. minor* Peck

NOTES.

Murrill regards the name Cantharellus as a variant in spelling of Chanterel and discusses the genus under the latter name (N. Am. Flora 9^3:167). He describes C. umbonatus, C. aurantiacus and C. cibarius respectively as Chanterel muscoides (Wulf.) Murrill, Chanterel alectorolophoides (Schaeff.) Murrill, and Chanterel Chanterellus (L.) Murrill.

Plants referred by Hard to C. brevipes Peck were probably young specimens of C. floccosus.

Fries, followed by Saccardo, placed C. cinnabarinus in the genus Hygrophorus. American writers regard this species as a good Cantharellus.

NYCTALIS FR.

Pileus white to brownish, usually powdered with brownish, stellate conidia; lamellae distant; plants on decaying Agarics. S. 501; N. A. F. 9^3:166; H. 204; St. 2:138. *N. asterophora* Fr.

This species is published in the North American Flora as Asterophora clavus (Schaeff) Murrill.

HELIOMYCES LEV.

Marasmius nigripes (Sch.) Fr. is placed in this genus by Morgan (Jour. Myc. 12:93). It will be easily recognized by the thin, white pileus and the black stipe which has a white pruinose covering. In dried specimens the stipe becomes pale brownish. S. 534; M. 193; H. 152.

MARASMIUS FR.

A.[1] Stipe glabrous (except perhaps at base), horny, polished.

B.[1] Pileus radiate-sulcate or deeply striate.

C.[1] Lamellae joined behind in a collar encircling the stipe and free from it.

D.[1] Pileus umbonate. S. 542; H. 146; St. 2:150; J. M. 12:1 .... *M. graminum* (Lib.) Berk.

D.[2] Pileus umbilicate, but often with a small umbo within the depression.

E.[1] Stipe capillary, scarcely thicker than a hair; pileus pale tan; lamellae subdistant. S. 541; M. 194; J. M. 11:247.
M. capillaris Morg.

E.[2] Stipe somewhat thicker; lamellae distant; pileus white or whitish. S. 541; P. R. 23:125; H. 143; St. 2:149; J. M. 11:247.
M. rotula (Scop.) Fr.

C.[2] Lamellae not joined in a collar.

D.[1] Pileus ochraceous or ochraceous-red; stipe without purple tints, blackish-brown below, paler above. S. 535; M. 193; J. M. 11:241; P. R. 23:126 .... *M. campanulatus* Peck

D.[2] Pileus purplish to purplish-brown; stipe purplish when young, becoming brown. S. 535; H. 146,148; J. M. 11:240...... *M. siccus* Schw.
J. M. 11:207............. *M. bellipes* Morg.

B.[2] Pileus not sulcate.

C.[1] Plants with odor of garlic.

D.[1] Pileus grayish-brown, reddish-brown or paler; stipe entirely glabrous. S. 525; H. 144; Mc. 226; St. 2:146; J. M. 11:234.
M. scorodonius Fr.

D.[2] Pileus white or whitish; stipe subtomentose at base. S. 515; H. 145; M. 192; J. M. 11:206.
M. prasiosmus Fr.

C.[2] Plants without alliaceous odor.

D.[1] Pileus white or whitish.

E.[1] Stipe arising from a more or less abundant mycelium, not inserted.

F.[1] Lamellae rather distant, sinuate; stipe entirely glabrous. H. 151; J. M. 11: 206 ....*M. delectans* Morg.

F.[2] Lamellae rather close, nearly free; stipe subpruinate when dry, strigose at base. S. 520; St. 2:144; J. M. 11:207 ...*M. erythropus* (Pers.) Fr.

E.[2] Stipe inserted, mycelium within substratum and invisible. S. 525; H. 145; Mc. 226; M. 192; St. 2:146; J. M. 11:235.
M. calopus (Pers.) Fr.

D.[2] Pileus some shade of brown, yellow, reddish or purplish.

E.[1] Pileus umbonate; plants growing in a tuft with stipes more or less united. S. 522; J. M. 11:238 .....*M. cucurbitula* Mont.

E.[2] Pileus not umbonate; stipes not united.

F.[1] Lamellae united behind but free from stipe; pileus reddish-gray. S. 511; H. 145; M. 192; J. M. 11:208; P. R. 24: 76 .... *M. anomalus* Peck

F.[2] Lamellae not united behind, attached to stipe.

G.[1] Lamellae whitish, close; pileus about 1 cm. broad, striatulate; stipe white at top. S. 543; H. 138; P. R. 23: 126; J. M. 11: 245.
M. androsaceus (L.) Fr.

G.[2] Lamellae purplish-gray, subdistant; pileus 4-6 mm. broad, not striate; stipe not white at top. S. 14: 104;

J. M. 11 : 245; Jour. Cin. Soc. Nat. Hist. 18 : 36, (pl. 1 f. 2).
M. melanopus Morg.

A.[2] Stipe pruinate, pubescent, velvety-tomentose, etc., not glabrous.

B.[1] Stipe solid or stuffed, not hollow at least when young, not horny.

C.[1] Taste mild; stipe not strigose or downy at the base.

D.[1] Lamellae broad, whitish or yellowish. S. 510; Mc. 224; A. 131; H. 136; St. 2 : 142; J. M. 11 : 205; M. 190; P. R. 23 : 124.
M. oreades Fr.

D.[2] Lamellae narrow, brown or brownish. S. 511; M. 190; J. M. 11 : 205; P. R. 23 : 125.
M. plancus Fr.

C.[2] Taste acrid or bitter; base of stipe strigose or conspicuously downy.

D.[1] Margin of pileus not striate; lamellae free, distant. S. 504; St. 2 : 140; H. 138; Mc. 223; M. 189; J. M. 11 : 202. . . . . *M. urens* Fr.

D.[2] Margin striate; lamellae attached or seceding, close or subdistant.

E.[1] Lamellae rather broad, close; stipe yellow or rufescent. S. 504; J. M. 11 : 204; St. 2 : 141; H. 148, 149; M. 190; Mc. 223.
M. peronatus Fr.

E.[2] Lamellae narrow, subdistant; stipe reddish-brown above, to blackish-brown at base. S. 16 : 57; P. R. 51 : 287; J. M. 11 : 202.
M. subnudus (Ellis) Peck

B.[2] Stipe hollow.

C.[1] Pileus white, whitish or pallid.

D.[1] Lamellae decurrent.

E.[1] Pileus usually less than 6 mm. broad. J. M. 12 : 6; M. 193. . . . . . *M. clavaeformis* Berk.

E.[2] Pileus 6-15 mm. broad. S. 561; J. M. 12 : 5.
M. leucocephalus Mont.

D.[2] Lamellae not decurrent.

E.[1] Lamellae close.

F.[1] Plants with odor of garlic; margin not striate. S. 515; M. 192; J. M. 11: 206; H. 145..... *M. prasiosmus* Fr.

F.[2] Plants without alliaceous odor; margin striate. S. 517; J. M. 11: 206. *M. semisquarrosus* B. & C.

E.[2] Lamellae distant or subdistant.

F.[1] Margin of pileus more or less striate or plicate-sulcate; stipe brownish or blackish beneath the covering.

G.[1] Lamellae adnexed. S. 533; H. 142; J. M. 11: 212. *M. candidus* (Bolt.) Fr.

G.[2] Lamellae adnate.

H.[1] Pileus about 1 cm. or more broad; lamellae rather broad and numerous; stipe dilated at base. S. 534; M. 193; H. 152; J. M. 12: 93. *M. nigripes* (Schw.) Fr.

H.[2] Pileus usually much less than 1 cm. broad; lamellae narrow, veinlike, few, very distant; stipe inserted. S. 559; J. M. 12: 3. *M. epiphyllus* Fr.
J. M. 12: 2..*M. felix* Morg.

F.[2] Pileus not striate or sulcate; stipe whitish or rufescent.

G.[1] Lamellae adnate; stipe usually less than 2 cm. long, rufescent toward the base. S. 531; St. 2: 148; J. M. 11: 211; H. 149. *M. ramealis* (Bull.) Fr.

G.[2] Lamellae adnexed; stipe usually

longer, entirely white. S. 532; J. M. 11: 237; M. 192.
M. opacus B. & C.

C.[2] Pileus yellowish, brownish, reddish-brown, etc.

D.[1] Lamellae free or seceding.

E.[1] Lamellae brown or brownish; stipe not strigose at base. S. 511; P. R. 23: 125; J. M. 11: 205; M. 190......*M. plancus* Fr.

E.[2] Lamellae whitish; stipe strigose at base. S 538; J. M. 11: 208...*M. sullivantii* Mont.

D.[2] Lamellae adnate or adnexed.

E.[1] Stipe distinctly velvety, tomentose or hairy.

F.[1] Lamellae distant or subdistant.

G.[1] Plants growing on old wood; stipe long rooting. S. 537; J. M. 11: 239......*M. macrorrhizus* Mont.

G.[2] Plants growing on ground among leaves, etc.; stipe not definitely rooting.

H.[1] Pileus plicate-striate. M. 191; J. M. 11: 239.
M. pyrrocephalus Berk.

H.[2] Pileus not plicate-striate.

I.[1] Stipe glabrous toward the top, not thickened at the base. S. 517; P. R. 25: 79-80; J. M. 11: 206; H. 145.
M. semihirtipes Peck

I.[2] Stipe thickened at the base, not glabrous at the top. S. 513; J. M. 11: 203.
M. spongiosus B. & C.

F.[2] Lamellae close.

G.[1] Pileus striate when moist.

H.[1] Pileus not more than 12 mm. broad; stipe rooting, usually

more than 5 cm. long. S. 517; P. R. 26: 66; H. 146; J. M. 11: 240.
M. elongatipes Peck

H.[2] Pileus more than 12 mm. broad; stipe usually less than 5 cm. long, not rooting. S. 541; J. M. 11: 203.
M. rigidus Mont.

G.[2] Pileus not striate.

H.[1] Lamellae rather broad; stipe thickened below. S. 513; J. M. 11: 203.
M. spongiosus B. & C.

H.[2] Lamellae rather narrow; stipe not thickened at base. S. 521; H. 140; P. R. 23: 124; J. M. 11: 209. .*M. velutipes* B. & C.

E.[2] Stipe pruinate or minutely pubescent, not tomentose or velvety.

F.[1] Lamellae narrow; pileus becoming umbilicate, not more than 12 mm. broad. S. 14: 108; B. T. 23: 413; J. M. 11: 236 ....*M. gregarius* Peck

F.[2] Lamellae rather broad; pileus not umbilicate, usually more than 1.5 cm. broad.

G.[1] Lamellae distant; margin of pileus slightly or not at all rugose-sulcate. S. 565; J. M. 11: 203.
M. viticola B. & C.

G.[2] Lamellae rather close; margin rugose-sulcate. S. 524; H. 148; M. 192; J. M. 11: 204.
M. fagineus Morg.

Notes.

Remarkably cespitose plants referred to this genus by the student should usually be looked for in the genus Collybia. Ohio plants usually known as Collybia lachnophylla are called Marasmius cohaerens (Fr.) Bres. by some writers.

Montagne's species have not been recognized by collectors since their publication.

The plants reported by Morgan in the Mycologic Flora as M. fusco-purpureus Pers. were later referred to M. semihirtipes.

M. elongatipes was first published as M. longipes. The latter name was preoccupied.

M. siccus, M. bellipes, M. campanulatus and several other species not reported from Ohio are very closely related. The pileus of M. siccus is described as "roseo-pallido"; that of M. campanulatus as ochraceous-red. A plant with the pileus bright ochraceous is frequent in Ohio. Another with the pileus pinkish to purplish also occurs. In very young plants the stipe is of the same color, but becomes blackish-brown as it matures, beginning at the base, the apex remaining purplish for some time. Morgan has described this plant as M. bellipes. Even in dried specimens (at least if not too old) the plants can be readily distinguished. In this paper the plants with ochraceous pileus are regarded as M. campanulatus, while those with pinkish or purplish pileus are regarded as M. siccus with M. bellipes as a synonym.

LENTINUS FR.

A.[1] Plants with distinct stipe.
  B.[1] Pileus scaly or squamulose.
    C.[1] Pileus umbilicate to infundibuliform, with blackish, hairy scales. S. 580; St. 2: 154; Mc. 229; M. B. 131: 43; M. 194 . . . . *L. tigrinus* Fr.
    C.[2] Pileus convex to plane.
      D.[1] Margin of pileus sulcate. S. 584; M. B. 131: 44; M. 194 . . . . *L. sulcatus* Berk.

D.[2] Margin even.

E.[1] Lamellae sinuate-decurrent, broad. S. 581; M. B. 131:42; H. 228; St. 2:155; A. 135; Mc. 230..................*L. lepideus* Fr.

E.[2] Lamellae decurrent, not sinuate, rather narrow. M. B. 131:43.....*L. spretus* Peck

B.[2] Pileus glabrous, depressed to infundibuliform.

C.[1] Stipe sulcate, glabrous; lamellae broad. S. 594; M. B. 131:45; St. 2:156; M. 195; H. 229; Mc. 239; *L. cochleatus* Fr.

C.[2] Stipe not sulcate, fibrillose; lamellae narrow. S. 595; M. 195..................*L. curtisii* Sacc. & Cub.

A.[2] Plants sessile, without distinct stipe.

B.[1] Pileus costate-corrugate.

C.[1] Pileus reddish-brown, tomentose at maturity. S. 608; M. B. 131:45; M. 196.......*L. ursinus* Fr.

C.[2] Pileus tan or alutaceous, surface broken up into scales or fibrous teeth at maturity. S. 609; M. 196; St. 2:157; H. 226-7.........*L. vulpinus* Fr.

B.[2] Pileus even, not costate.

C.[1] Pileus densely strigose, brown-tawny. S. 611; M. 196........................*L. pelliculosus* Schw.

C.[2] Pileus tomentose only, reddish-brown. S. 608; M. B. 131:45; M. 196...................*L. ursinus* Fr.

Notes.

Morgan lists L. lecomtei Fr. and L. strigosus Fr. He later decided that the plants so referred were species of Panus (P. rudis Fr.).

L. caespitosus Berk., reported by Lea and Morgan is not a Lentinus. Pleurotus caespitosus B. & C. is another name for the same plants. Lloyd believes it is the plant now known as Clitocybe monadelpha Morg. and the description bears out the opinion.

Peck separated L. spretus from L. lepideus because the lamellae are not sinuate and the spores are smaller. A collection was made at Oxford in 1910.

L. sullivantii Mont. is probably the same as Clitocybe illudens Schw. L. robinsonii Mont. is certainly not a Lentinus. The pileus is said to be tubular at first, then cubshaped, the lamellae are close, linear, long-decurrent. Probably a Cantharellus.

L. curtisii is L. omphalodes B. & C., not L. omphalodes Fr.

L. ursinus and L. vulpinus have doubtless been confused in America. Peck describes the former as being sometimes costate-corrugate. This character is, in Europe, ascribed to L. vulpinus only.

With the meager description of L. pelliculosus it is difficult to separate it from L. ursinus. It may be only a more hairy form of that species — at least the Ohio plants referred to it.

Lentodium squamulosum Morg. is often regarded as an abnormal form of L. tigrinus. It may be recognized by the mycelium or compact tomentum which grows over the hymenium sometimes obliterating the lamellae. Peck says that both forms are sometimes found growing on the same stump (M. B. 131 : 44).

PANUS FR.

A.[1] Pileus scaly, pubescent, strigose or furfuraceous.
  B.[1] Lamellae broad, distant, pileus white.
    C.[1] Pileus 5-8 cm. broad, with a matted covering of rather delicate hairs. S. 620; H. 226; Mc. 234.
    P. levis B. & C.
    C.[2] Pileus 10-20 cm. broad, with a coarse strigose pubescence. S. 620; H. 223; Mc. 234.
    P. strigosus B. & C.
  B.[2] Lamellae narrow, close.
    C.[1] Stipe lateral; pileus 2-4 cm. broad.
      D.[1] Pileus and lamellae cinnamon; pileus furfuraceous-scaly; lamellae determinate. S. 622; M. 197; H. 223; A. 135; Mc. 236.
      P. stipticus (Bull.) Fr.
      D.[2] Pileus and lamellae white to yellowish; pileus pubescent; lamellae decurrent. M. 197.
      P. angustatus Berk.

C.[2] Stipe eccentric; pileus 3 cm. or more broad.

D.[1] Pileus strigose, depressed to infundibuliform, rufescent-tan, purplish when young; stipe hirsute. S. 616; H. 224; A. 135.
P. rudis Fr.

D.[2] Pileus becoming scaly, conchate, cinnamon or paler; stipe pubescent at the base. S. 615; H. 223; M. 196; Mc. 232.
P. conchatus Fr.

A.[2] Pileus glabrous.

B.[1] Lamellae decurrent or sub-decurrent.

C.[1] Stipe lateral; pileus striate on the margin, less than 3 cm. broad. M. 197.........*P. dealbatus* Berk.

C.[2] Stipe eccentric; pileus usually more than 5 cm. broad, margin not striate.

D.[1] Stipe solid, pubescent or tomentose.

E.[1] Pileus cinnamon to paler; stipe pubescent at the base. S. 615; H. 223; M. 196; Mc. 232 ....*P. conchatus* Fr.

E.[2] Pileus flesh-colored to violaceous; stipe with gray or violaceous down. S. 615; H. 225; Mc. 233................*P. torulosus* Fr.

D.[2] Stipe spongy-stuffed, glabrous. S. 617.
P. robinsonii B. & Mont.

B.[2] Lamellae free. S. 620............*P. sullivantii* Mont.

NOTES.

Berkeley's description of P. angustatus agrees well with the plant we know as Pleurotus petaloides Fr. Berkeley says: "Lea describes it as tough when fresh, and it is therefore placed in the genus Panus."

The plants now known as P. rudis have been reported also as Lentinus strigosus Fr., and Lentinus lecomtei Fr.

Neither P. robinsonii nor P. sullivantii have been identified since Sullivant's time.

TROGIA FR.

Lamellae white; pileus sessile, margin sterile. S. 636; N. A. F. 9^3: 164; St. 2: 162; M. 198; H. 234; A. 137.

T. crispa (Pers.) Fr.

This species is described in the North American Flora as Plicatura faginea (Schrad.) P. Karst.

SCHIZOPHYLLUM FR.

Pileus white or whitish; lamellae gray to pale brownish. S. 655; St. 2: 162; M. 198; H. 232; A. 136.

S. commune Fr.

This species is sometimes published as S. alneum (L.) Schroet.

LENZITES FR.

Context and hymenium, white or whitish. S. 638; St. 2:163; N. A. F. 9^2:127; H. 231; M. 197..........*L. betulina* (L.) Fr.

Context and hymenium brown or brownish.

Lamellae thick, distant (about 1 mm.). S. 639; N. A. F. 9^2:130; H. 232; M. 197; St. 2:164....*L. sepiaria* (Wulf.) Fr.

Lamellae thin, rather close (about 0.5 mm.). S. 638,640; N. A. F. 9^2:129; H. 232; M. 197; P. R. 26:67.

L. trabea (Pers.) Fr.

NOTE.

On account of the woody texture and the fact that the hymenium is often porose when young, Murrill places this genus in the Polyporaceae. He places the last two species in the genus Gloeophyllum under the names G. hirsutum (Schaeff.) Murrill and G. trabeum (Pers.) Murrill. The latter was reported from Ohio as L. vialis Peck.

VOLVARIA FR.

A.[1] Plants growing on wood; pileus 7-12 cm. broad, silky, white. S. 656; St. 183; A. 140; Mc. 240; H. 238; M. 97.

V. bombycina (Pers.) Fr.

A.[2] Plants not growing on wood.
B.[1] Pileus usually more than 5 cm. broad.
C.[1] Pileus not distinctly viscid, streaked with blackish fibrils. S. 657; St. 183; H. 242; Mc. 240. *V. volvacea* Bull.
C.[2] Pileus viscid, glabrous.
D.[1] Margin even; pileus whitish or grayish. S. 661; St. 185; Mc. 242 .... *V. speciosa* Fr.
D.[2] Margin striate; pileus smoky-brown. S. 662; St. 185; Mc. 242 .... *V. gloiocephala* Fr.
B.[2] Pileus less than 4 cm. broad.
C.[1] Stipe pubescent with spreading hairs; pileus with minute hairy scales. S. 658; P. R. 29:39. *V. pubescentipes* Peck
C.[2] Stipe without erect, spreading hairs; pileus silky.
D.[1] Margin of pileus striate; stipe solid. S. 16:70; H. 241; B. T. 26: 64.... *V. umbonata* Peck
D.[2] Margin even.
E.[1] Pileus umbonate; stipe stuffed. S. 663; St. 186................. *V. parvula* Weinm.
E.[2] Pileus not umbonate; stipe solid. Berk. Out. 140; H. 242 .... *V. pusilla* Pers.

Note.

V. parvula and V. pusilla are regarded as synonyms by some mycologists.

PLUTEUS FR.

A.[1] Pileus glabrous.
B.[1] Pileus fleshy, more than 5 cm. broad, whitish to brown or brownish; margin even. S. 665; St. 187; P. R. 38:134; H. 237; Mc. 243; A. 138; M. 98. *P. cervinus* Schaeff.
B.[2] Pileus thin, usually less than 5 cm. broad; margin striate.
C.[1] Pileus cinnamon-brown. S. 676; Mc. 249; St. 190; M. 98 .... *P. chrysophaeus* Schaeff.

C.[2] Pileus yellow or reddish-yellow.

D.[1] Pileus rugose-reticulate; stipe hollow. S. 679; P. R. 38: 137; Mc. 248. .*P. admirabilis* Peck

S. 678 . . . . ? *P. chrysophlebius* B. & Rav.

D.[2] Pileus not as above; stipe solid. S. 675; P. R. 38:137; St. 190; M. 98.

P. leoninus Schaeff.

A.[2] Pileus not glabrous.

B.[1] Pileus pruinate or granular and rugose-wrinkled.

C.[1] Stipe granular or velvety-pubescent, brown or yellowish-brown. S. 673; P. R. 38:135; Mc. 247; H. 238; M. 98. . . . .*P. granularis* Peck

C.[2] Stipe glabrous, whitish or pale yellowish. S. 672; St. 189; P. R. 38:136 . . . .*P. nanus* Pers.

B.[2] Pileus fibrillose, hairy or squamulose, not rugose-wrinkled.

C.[1] Pileus thin, prominently striate, not over 4 cm. broad. S. 670; P. R. 38:137.

P. longistriatus Peck

C.[2] Pileus fleshy, not striate, usually more than 5 cm. broad. (See references above.)

P. cervinus Schaeff.

NOTES.

P. granularis is given in Saccardo as P. regularis, probably through error.

P. chrysophlebius has not been reported for Ohio. It is here included in order to call attention to its close relationship to P. admirabilis.

ENTOLOMA FR.

A.[1] Pileus minute-scaly, dry, 1-2 cm. broad, dark brown. S. 693; M. B. 131: 53. . . . . *E. scabrinellum* Peck

A.[2] Pileus glabrous or somewhat fibrillose, not dry, usually more than 2 cm. broad.

B.[1] Pileus hygrophanous, becoming paler in drying.

C.[1] Pileus white or yellowish; stipe solid. S. 698; M. B. 131: 56; H. 244; A. 144. . . .*E. grayanum* Peck

C.[2] Pileus some shade of brown, or gray; stipe stuffed or hollow.

D.[1] Pileus not umbonate; stipe pruinate. S. 694; M. B. 131: 56; M. 99; St. 198; H. 244; Mc. 153 ....*E. rhodopolium* Fr.

D.[2] Pileus umbonate; stipe fibrillose or glabrous.

E.[1] Stipe brown or brownish, 2-4 mm. thick. S. 698; A. 145; M. B. 131: 57; M. 99. *E. strictius* Peck

E.[2] Stipe white or grayish, 4-8 mm. thick. S. 694; St. 198; Mc. 252; H. 247; M. B. 131: 57; M. 99......*E. clypeatum* Linn.

B.[2] Pileus moist or subviscid, not hygrophanous.

C.[1] Stipe brown or brownish; pileus of same color, streaked with darker lines. H. 245-6; J. M. 12: 236-7 ....*E. subcostatum* Atk.

C.[2] Stipe white to rufescent.

D.[1] Stipe solid; pileus subumbonate; plants not growing on wood. S. 682. *E. demetriacum* B. & Mont.

D.[2] Stipe hollow; pileus plane or depressed; plants growing on decaying wood. S. 683. *E. robinsonii* B. & Mont.

CLITOPILUS FR.

A.[1] Stipe stuffed or hollow; pileus hygrophanous, brown to grayish-brown, usually umbilicate, striatulate when moist. S. 9: 86; H. 251; P. R. 42: 43; Mc. 260. *C. subvilis* Peck

A.[2] Stipe solid; pileus not hygrophanous, not umbilicate, not striatulate.

B.[1] Pileus thin, rimose-areolate; taste bitter. S. 702; P. R. 42: 45; H. 252; Mc. 264.....*C. noveboracensis* Peck

B.[2] Pileus rather thick, not rimose; taste mild.

C.[1] Pileus pruinate or mealy; lamellae subdistant; stipe glabrous or villous at the base. S. 699; St. 202; Mc. 255; P. R. 42: 41; H. 249; A. 143. *C. prunulus* Scop.

C.[2] Pileus glabrous or slightly silky; lamellae close; stipe flocculose.

D.[1] Pileus slightly viscid when moist, whitish or yellowish; stipe short. S. 699; St. 203; H. 249; P. R. 42: 41; Mc. 256........*C. orcella* Bull.

D.[2] Pileus dry, grayish to grayish-brown. S. 701; P. R. 42: 42; H. 248; Mc. 257; M. 99.
C. abortivus B. & C.

LEPTONIA FR.

Pileus not striate; edge of lamellae serrate, blackish. S. 710; H. 255; St. 208........................*L. serrulata* Pers.

Pileus striate; lamellae unicolorous, edge entire.

Pileus and stipe brownish-green; lamellae greenish-white then flesh-color. S. 713; St. 210; H. 254.......*L. incana* Fr.

Pileus at length scaly in the center, fuliginous or paler; stipe usually livid but variable in color; lamellae grayish-white. S. 714; St. 211; A. 147; M. 100..........*L. asprella* Fr.

Morgan reported L. asprella from the Miami valley. Hard lists the other two species but without a statement as to their collection.

NOLANEA FR.

Pileus cinnamon-brown; lamellae bright flesh-color; stipe even. S. 723; P. R. 24: 66; H. 255.............*N. conica* Peck

Pileus smoky-brown; lamellae grayish; stipe striate. S. 716; St. 212; H. 255........................*N. pascua* Pers.

Hard describes these species but does not state that they were collected in Ohio.

ECCILIA FR.

Lamellae distant. S. 730; St. 218; H. 252; Mc. 265.
E. carneo-grisca B. & Br.

Lamellae close. S. 729; H. 253; A. 148........*E. polita* Pers.

Both species are listed by Hard but no statement is made as to the occurrence of E. polita in Ohio.

CLAUDOPUS W. SMITH.

Plant yellow or buff; lamellae close, orange-yellow. S. 375; A. 149; H. 256; Mc. 267; M. 198; P. R. 39:67.
C. nidulans Pers.

Plant white; lamellae distant, white then flesh-color. S. 733; H. 256; St. 220; P. R. 39:68..............*C. variabilis* Pers.

C. nidulans is sometimes known as Pleurotus nidulans and is sometimes known in America as Panus dorsalis Bosc.

Hard includes C. variabilis in his book but without a statement as to its collection in Ohio.

PHOLIOTA FR.

A.[1] Plants growing on the ground.

B.[1] Stipe solid; lamellae serrulate; pileus wrinkled. S. 736; H. 260; St. 223; Mc. 270; M. B. 122:143.
P. caperata Pers.

B.[2] Stipe stuffed or hollow; edge of lamellae entire; pileus not wrinkled.

C.[1] Lamellae very broad; pileus dry, finally cracked; stipe stout, about 1 cm. in diameter. S. 738; St. 225; Mc. 271; H. 258; M. 101.. *P. dura* Bolt.

C.[2] Lamellae narrow; pileus moist, not cracking; stipe slender, not more than 5 mm. in diameter. S. 738; St. 226; Mc. 274; H. 257; A. 150; M. B. 122:148; M. 101...................*P. praecox* Pers.

A.[2] Plants growing on wood, rarely on the ground and then near decaying logs, etc.

B.[1] Pileus viscid.

C.[1] Lamellae narrow; pileus lemon-yellow. S. 753; M. B. 122:150; M. 102...........*P. limonella* Peck

C.[2] Lamellae broad.

D.[1] Stipe very stout, 1-2.5 cm. in diameter, solid, not scaly; pileus scarcely viscid. S. 747; St. 229; H. 263....................*P. heteroclita* Fr.

D.[2] Stipe usually less than 1 cm. in diameter, prominently scaly.

E.[1] Pileus white except for the tawny, erect, pointed scales; lamellae sinuate, at first whitish. S. 750; M. B. 122: 150; A. 152; Mc. 274; H. 266; M. 102.
P. squarrosoides Peck

E.[2] Pileus yellow or yellowish-brown.

F.[1] Lamellae at first yellow, close; stipe yellow to tawny-brown. S. 752; St. 232; M. B. 122:150; Mc. 276; A. 151; M. 103.................. *P. adiposa* Fr.

F.[2] Lamellae at first whitish or gray, subdistant, edge white-crenulate; stipe pallid or brownish. S. 760; M. B. 122: 149; M. 102........ *P. albocrenulata* Peck

B.[2] Pileus not viscid.

C.[1] Pileus and stipe with prominent scales; lamellae rather narrow; stipe 6-12 mm. in diameter. S. 749; M. B. 122: 152; A. 152; St. 230; Mc. 273; H. 268...................... *P. squarrosa* Müll.

C.[2] Pileus and stipe with small or appressed scales or not scaly.

D.[1] Pileus more than 5 cm. broad; stipe more than 1 cm. in diameter.

E.[1] Lamellae very broad, sinuate-adnexed; pileus white or slightly yellow; stipe white. S. 747; St. 229; H. 263...*P. heteroclita* Fr.

E.[2] Lamellae narrow, adnate or slightly decurrent; pileus tawny or orange-yellow; stipe yellow. S. 751; St. 231; M. B. 122: 154; H. 265; M. 103......... *P. spectabilis* Fr.

D.[2] Pileus less than 5 cm. broad; stipe slender.

E.[1] Pileus dry, not hygrophanous.

F.[1] Stipe bulbous or tuberculate, lamellae sinuate-adnexed. S. 754; St. 233; M. 103.

P. tuberculosa (Schaeff) Fr.
P. hormophora Mont.

F.[2] Stipe not as above; lamellae adnate. S. 755; St. 233; H. 264; M. B. 122: 154. *P. curvipes* (A. & S.) Fr.

E.[2] Pileus hygrophanous, glabrous.

F.[1] Pileus less than 2 cm. broad; lamellae very broad for size of pileus; stipe subglabrous. S. 759; St. 235; H. 262; M. 104............. *P. unicolor* Vahl.

F.[2] Pileus usually more than 2 cm. broad; stipe fibrillose or somewhat scaly.

G.[1] Margin of pileus even; lamellae rather broad; stipe blackish-brown below. S. 758; St. 235; Mc. 278; H. 263; M. 103. *P. mutabilis* (Schaeff) Fr.

G.[2] Margin striate; lamellae narrow; stipe concolorous or paler. S. 758; St. 235; M. 104; H. 265; Mc. 279 .... *P. marginata* Batsch

INOCYBE FR.

A.[1] Pileus and stipe squarrose- or tomentose-scaly, some shade of brown; stipe concolorous or nearly so.

B.[1] Pileus hemispherical to expanded, obtuse, floccose-scaly, scales of disk pointed; spores nodulose or angular. S. 765; M. 105; M. B. 139: 51; St. 240. *I. lanuginosa* Bull.

B.[2] Pileus convex to expanded, spores even or slightly irregular.

C.[1] Pileus umbonate; stipe soon hollow. S. 763; H. 271; M. 105; St. 240....... *I. dulcamara* Alb. & Schw.

C.[2] Pileus not umbonate; stipe solid. S. 764; H. 271; St. 241 .... *I. cincinnata* Fr.

A.[2] Pileus and stipe not squarrose-scaly, usually fibrillose; stipe paler than pileus or pileus at first whitish or pallid.

B.[1] Whole plant becoming red or reddish; flesh white. S. 776; M. 106; St. 249................ *I. destricta* Fr.

B.[2] Plant not becoming red.

C.[1] Flesh of pileus and stipe reddish; with odor of pears. S. 766; H. 272; M. 105; St. 242.
I. piriodora Pers.

C.[2] Flesh and odor not as above.

D.[1] Pileus not umbonate; stipe somewhat bulbous. S. 775; M. 105; H. 272; St. 248; M. B. 139: 56 .... *I. rimosa* Bull.

D.[2] Pileus umbonate; stipe not bulbous.

E.[1] Cuticle of pileus torn or cracked; lamellae adnate, whitish-crenulate on edge. S. 776; M. 106; St. 248; M. B. 139: 56.
I. euthcles B. & Br.

E.[2] Pileus fibrillose, cuticle not torn or cracked; lamellae adnexed or sinuate-adnexed, edge not whitish-crenulate.

F.[1] Pileus white or whitish or rarely violaceous; stipe stuffed. S. 784; H. 270; M. 106; St. 252; M. B. 139: 61.
I. geophylla Sowerb.

F.[2] Pileus ochraceous-yellow, stipe solid. S 796; H. 270; M. B. 139: 62.
I. subochracea (Peck) Mass.

Notes.

I. auricoma Batsch, listed by Lea, is regarded by Fries as a variety of I. descissa. Morgan, who worked in the same region as Lea, did not collect it. It is possible that Lea's plants were incorrectly determined. The species is omitted from the list.

It is worthy of note here that Peck enumerates 39 species for the state of New York. Of the 9 species reported from Ohio only 5 occur in Peck's list. It is remarkable that such a disparity should occur in states no more widely separated. It is probable, however, that further study of Ohio plants will add a number of species to the Ohio list.

HEBELOMA FR.

A.[1] Pileus glutinous, with whitish superficial squamules, yellowish-white. S. 793; St. 273; M. B. 139:68; H. 273; Mc. 285 .... **H.** *glutinosum* (Lind.) Fr.

A.[2] Pileus moist or more or less viscid but not glutinous, not squamulose.

B.[1] Lamellae very narrow; pileus whitish-tan or brick-color. S. 799; St. 260; M. B. 139:73; Mc. 286; H. 273; A. 158............... *H. crustiliniforme* (Bull.) Fr.

B.[2] Lamellae broad.

C.[1] Stipe solid.

D.[1] Pileus yellow or tan; lamellae subdistant. S. 792; M. B. 139:70; Mc. 284; H. 273; St. 255; M. 107...................... *H. fastibile* Fr.

D.[2] Pileus brownish-clay; lamellae close. S. 16:92, 17:67; M. B. 139:71; H. 274.
H. pascuense Peck

C.[2] Stipe stuffed or hollow.

D.[1] Pileus and stipe brown; plants growing on wood. S. 806; M. 107; M. B. 139:76.
H. illicitum Peck

D.[2] Pileus pallid or clay-colored; stipe white; plants with odor of radishes. S. 799; St. 259.
H. sinapizans Fr. *H. repandum* Schum.

NOTES.

Plants collected by W. A. Kellerman were determined by A. P. Morgan as H. repandum which is given by Fries and Saccardo as a variety of H. sinapizans. Kellerman's photograph (Mycological Bulletin 5:364) shows the stipe to be stuffed and hollow. In the European plant the stipe is said to be somewhat solid.

H. glutinosum and H. crustiliniforme have not been definitely reported for Ohio but probably occur here. They are included in the key for convenience.

H. latericolor Mont. (S. 803), described from Sullivant's material, is probably Hypholoma sublateritium. The color of the pileus, habitat, season and other characters point to this conclusion. H. erysibodes Mont. (S. 795) and H. pyrrholepidum Mont. (S. 798) are doubtless species of Inocybe.

FLAMMULA FR.

A.[1] Stipe spindle-shaped, rooting; pileus reddish-brown. S. 818; St. 269; H. 286........................*F. fusus* Batsch.

A.[2] Stipe not spindle-shaped.

B.[1] Pileus viscid.

C.[1] Pileus with purple and bluish-green, often with other shades. S. 824; A. 156; M. 107. *F. polychroa* Berk.

C.[2] Pileus yellow, buff or tawny.

D.[1] Flesh yellow; pileus smooth; plants growing on burnt ground or charcoal. S. 817; St. 268; H. 285; P. R. 50: 138.......*F. carbonaria* Fr.

D.[2] Flesh whitish; pileus appressed scaly, floccose or fibrillose; plants with different habitat.

E.[1] Stipe solid. S. 815; St. 266; P. R. 50: 138. *F. lubrica* Fr.

E.[2] Stipe stuffed or hollow. B. T. 34: 100. *F. betulina* Peck

B.[2] Pileus not viscid.

C.[1] Stipe solid; pileus more than 8 cm. broad. S. 14: 139; P. R. 50: 142; Mc. 292....*F. magna* Peck

C.[2] Stipe stuffed or hollow; pileus less than 8 cm. broad.

D.[1] Pileus glabrous, light yellow. S. 820; St. 270; H. 284; P. R. 50: 140; Mc. 291. *F. flavida* Pers.

D.[2] Pileus floccose-squamulose, golden-tawny; lamellae broad; stipe often sulcate. S. 824; St. 272; P. R. 50: 142; M. 107. *F. sapinea* Fr.

Notes.

F. anepsia Mont. (S. 812), was described from Sullivant's material. The pileus is said to be reddish-cinnamon; lamellae distant, adnate-decurrent, and stipe fistulous.

F. flavida has not been reported for Ohio but probably occurs.

F. fusus was collected by Hard at Chillicothe; F. betulina at Wooster by Van Hook; F. magna at Cleveland by Beardslee, and F. lubrica at Wooster by Selby. The first three are in the herbarium of the state botanist at Albany, and the last at the N. Y. Bot. Garden in New York City.

NAUCORIA FR.

A.[1] Pileus viscid or somewhat so when moist; lamellae adnate, adnate-decurrent or emarginate-adnate.

B.[1] Pileus usually appressed-scaly; plants growing on or among mosses. H. 282; J. M. 12: 193. *N. paludosella* Atk.

B.[2] Pileus glabrous; plants growing among grass.

C.[1] Pileus yellow or yellowish; stipe usually more than 4 mm. thick, and less than 5 cm. long. S. 843; M. 108; St. 283................*N. vervacti* Fr.

C.[2] Pileus tawny-brown or ochraceous; stipe less than 4 mm. thick and usually more than 5 cm. long. S. 844; M. 108; St. 284; A. 153; Mc. 297. *N. semiorbicularis* Bull.

A.[2] Pileus dry; lamellae adnexed. S. 844; H. 281; Mc. 296; St. 284..............................*N. pediades* Fr.

PLUTEOLUS FR.

Plants growing on dung, often cespitose; pileus pinkish-gray S. 11: 60; P. R. 46: 59................*P. coprophilus* Peck

Plants growing on wood, not cespitose.

Pileus livid-gray, rugose-reticulate. S. 859; P. R. 46: 60; Mc. 282; St. 289; H. 275........*P. reticulatus* Pers.

Pileus smoky-brown, not rugose.

Stipe brownish-fibrillose; pileus more or less lobed, 5-7 cm. S. 867; M. 108....*P. mucidolens* Berk.

Stipe pallid, fibrillose; pileus not lobed, 3-4 cm. S. 11: 60....................*P. leaianus* B. & C.

NOTES.

P. mucidolens and P. leaianus were both collected by Lea near Cincinnati. They may represent one species.

Lloyd regards P. coprophilus the same plant as Bolbitius radians.

GALERA FR.

A.[1] Plants growing on or among Sphagnum. S. 869; P. R. 46: 66 ....*G. sphagnorum* Pers.

A.[2] Plants not growing among mosses.

B.[1] Lamellae much crisped; margin of pileus finally upturned. S. 16: 103; Bot. Gaz. 28: 272; H. 278. *G. crispa* Longyear

B.[2] Lamellae straight and regular, not crisped in fresh plants.

C.[1] Pileus mealy or granular, finally expanded, margin persistently striate. H. 277; J. M. 12: 148. *G. kellermani* Peck

C.[2] Pileus not distinctly mealy, seldom fully expanded.

D.[1] Stipe usually straight or nearly so; lamellae broad or pileus more than 1 cm. across.

E.[1] Pileus even or very faintly striatulate, usually 2 cm. or more across, ovate- campanulate; lamellae very broad; stipe usually more than 8 cm. tall. S. 862; P. R. 46: 64; St. 292; H. 279........*G. ovalis* Fr.

E.[2] Pileus striate, usually less than 2 cm. broad; stipe usually less than 7 cm. tall.

F.[1] Stipe glabrous; pileus broadly conic-campanulate; lamellae rather broad.

S. 860; St. 291; H. 276; P. R. 46; 63; M. 109; Mc. 300.
G. tenera Schaeff.

F.[2] Stipe not glabrous.

G.[1] Stipe pruinate; lamellae very narrow; pileus narrowly conical. S. 860; P. R. 46: 62; H. 276; St. 291; Mc. 299.....*G. lateritia* Fr.

G.[2] Stipe and usually pileus with minute, erect pubescence when moist.
G. tenera pilosella Pers.

D.[2] Stipe flexuous; lamellae narrow or pileus less than 1 cm. broad.

E.[1] Pileus grayish or ferruginous, less than 1 cm. broad.

F.[1] Pileus striatulate when moist; lamellae subdistant; stipe pale brownish. S. 16: 105; B. T. 26: 66.
G. capillaripes Peck

F.[2] Pileus even; lamellae close; stipe pallid. S. 862; M. 109......*G. siliginea* Fr.

E.[2] Pileus yellowish, about 4 cm. broad, margin deeply striate. S. 867..*G. tortipes* Mont.

TUBARIA W. SMITH.

Pileus somewhat viscid, margin striate when moist, glabrous; stipe dark brown. S. 876; M. 109; St. 300.
T. inquilina Fr.

Pileus hygrophanous, margin furfuraceous from seceding veil; stipe pallid. S. 872; M. 109; St. 297.
T. furfuracea Pers.

CREPIDOTUS FR.

A.[1] Pileus bright cinnabar-red; edge of lamellae red. B. T. 22: 489; Oh. Nat. 10: 178..........*C. cinnabarinus* Peck

A.[2] Pileus not bright red; edge of lamellae not reddish.

B.[1] Pileus glabrous; or villous at base only.

C.[1] Lamellae broad, rounded behind. S. 883; P. R. 39:71 .... *C. malachius* B. & C.

C.[2] Lamellae linear, subdecurrent. S. 877; M. 110; H. 280; St. 301 .... *C. mollis* Schaeff.

B.[2] Pileus pubescent, tomentose or somewhat scaly.

C.[1] Pileus white.

D.[1] Pileus 3-6 mm. broad, slightly pubescent, striatulate when moist; lamellae very broad, extending beyond margin of pileus; spores globose. B. T. 26:66..... *C. latifolius* Peck

D.[2] Pileus 8-20 mm. broad, villous, not striatulate; lamellae rather broad, not extending beyond margin of pileus; spores subelliptic. S. 888; P. R. 39:72; M. 110; H. 279; A. 160. *C. versutus* Peck

C.[2] Pileus not white.

D.[1] Pileus appressed-scaly, ochraceous-brown; lamellae bright buff or orange then ochraceous. S. 886; M. 110........ *C. crocophyllus* Berk.

D.[2] Pileus fibrillose-tomentose, reddish-yellow; lamellae yellowish then brownish-ochraceous. S. 883, P. R. 39:73; M. 110.... *C. dorsalis* Peck

CORTINARIUS FR.

A.[1] Pileus viscid or glutinous.

B.[1] Stipe solid.

C.[1] Stipe equal or nearly so, not bulbous.

D.[1] Stipe viscid or glutinous; pileus orange-tawny; lamellae at first bluish-gray. S. 916; H. 293; St. 2:17; A. 161; Mc. 313. *C. collinitus* (Pers.) Fr.

D.[2] Stipe dry; pileus yellow or tan; lamellae at first whitish. S. 890; H. 291; Mc. 309; St. 2:3. *C. turmalis* Fr.

C.[2] Stipe bulbous.

D.[1] Flesh violaceous, blue or bluish.

E.[1] Flesh and lamellae becoming purplish when bruised; pileus usually 10 cm. or more broad. S. 902; H. 291; Mc. 311; St. 2:10 .... *C. purpurascens* Fr.

E.[2] Flesh and lamellae not changing color when bruised; pileus less than 10 cm. broad.

F.[1] Pileus at first blue, becoming in part yellowish or tan; spores less than 12 microns long, even. S. 902; H. 292; M. 178; Mc. 311; St. 2:9.
C. coerulescens Fr.

F.[2] Pileus yellow to tawny; spores more than 12 microns long, tuberculate. H. 302 .... *C. atkinsonianus* Kauff.

D.[2] Flesh white or whitish.

E.[1] Bulb of stipe marginate, depressed; lamellae serrate; stipe white. S. 902; M. 178; St. 2:9 .. *C. calochrous* (Pers.) Fr.

E.[2] Bulb not marginate; lamellae entire; stipe yellowish. S. 892; H. 292; M. 178; Mc. 309; St. 2:4 ... *C. varius* (Schaeff.) Fr.

B.[2] Stipe stuffed or hollow; pileus yellow or olivaceous, flesh paler; lamellae whitish to pale cinnamon. H. 291 .... *C. olivaceo-stramineus* Kauff.

A.[2] Pileus dry or moist only; not viscid or glutinous.

B.[1] Margin of pileus even.

C.[1] Stipe solid.

D.[1] Plants (pileus or lamellae, or both,) some shade of violaceous, purple or lilac, at least when young.

E.[1] Lamellae distant or subdistant.

F.[1] Stipe always distinctly bulbous; whole plant dark violet; pileus with persistent hairy scales. S. 924; H. 296; M. 178; A. 161; Mc. 314; St. 2:23.
C. violaceus (Linn.) Fr.

F.[2] Stipe becoming clavate or attenuate, not distinctly bulbous; pileus silky or squamulose.

G.[1] Lamellae rather narrow; stipe not sheathed; pileus whitish, tinged with lilac. S. 925; H. 295; M. 178; Mc. 316; St. 2:24.
C. albo-violaceus (Pers.) Fr.

G.[2] Lamellae broad; stipe sheathed with universal veil; pileus brick-color or purplish-brown to paler. S. 950; St. 2:40......*C. torvus* Fr.

E.[2] Lamellae close.

F.[1] Whole plant lilac. S. 926; H. 296; Mc. 316; P. R. 26:61.
C. lilacinus Peck

F.[2] Pileus ferruginous or tawny; stipe whitish; pileus slightly viscid. S. 892; St. 2:4; H. 292; Mc. 309; M. 178 ....*C. varius* (Schaeff.) Fr.

D.[2] Plants without purple, lilac or violet shades.

E.[1] Stipe not bulbous; pileus yellowish to whitish; lamellae clay-colored. S. 935; H. 299; A. 163; St. 2:29.
C. ochroleucus (Schaeff.) Fr.

E.[2] Stipe bulbous.

F.[1] Pileus brick-colored; stipe reddish with one to four zones from universal veil; plants with odor of radish. S. 952; H. 311; Mc. 323; St. 2:43.
C. armillatus (Alb. & Schw.) Fr.

F.[2] Plant some shade of yellow; stipe not zoned; inodorous.

G.[1] Pileus saffron-yellow, with erect brown squamules; stipe sheathed by universal veil. H. 304.
15. *C. croceocolor* Kauff.

G.[2] Pileus rusty-yellow, fibrillose only; stipe not sheathed. S. 932; H. 294; Mc. 319; P. R. 23:109.
C. autumnalis Peck

C.[2] Stipe stuffed or hollow.

D.[1] Lamellae close.

E.[1] Whole plant blood-red; with odor of radish. S. 940; Mc. 321; St. 2:24.
C. sanguineus (Wulf.) Fr.

E.[2] Plants not as above.

F.[1] Stipe yellow, slender; pileus umbonate or obtuse. S. 941; H. 297; A. 162; Mc. 322; St. 2:35.
C. cinnamomeus (Linn.) Fr.

F.[2] Stipe lilac-tinged at apex, white below, rather stout; pileus convexo-plane. S. 971; H. 305-6; Mc. 325; St. 2:55.
C. castaneus (Bull.) Fr.

D.[2] Lamellae distant; pileus reddish-yellow. S. 974.
C. rubidus Mont.

B.[2] Margin of pileus sulcate. S. 957....*C. robinsonii* Mont.

PAXILLUS FR.

Stipe very short or wanting; pileus and lamellae yellow or yellowish. S. 989; St. 2:69; M. B. 1^2:32; A. 170; M. 179.
P. panuoides Fr.

Stipe present; pileus brown or reddish-brown.

Stipe with brown or blackish tomentum; lamellae adnate or slightly decurrent. S. 988; Mc. 329; M. B. 1^2:31; St. 2:68; A. 169; H. 288.
P. atrotomentosus (Batsch) Fr.

Stipe not tomentose; lamellae decurrent.

Pileus somewhat viscid, margin at first with grayish down, otherwise glabrous; lamellae close. S. 987; St. 2:68; M. B. 1^2:30, H. 287; A. 166; Mc. 328.
P. involutus (Batsch) Fr.

Pileus dry, minutely tomentose; lamellae subdistant. S. 1139; A. 167; H. 289; Mc. 394.
P. rhodoxanthus (Schw.) Atk.

NOTES.

P. porosus Berk. (S. 991; M. 179) is usually known as Boletinus porosus (Berk.) Peck. It is also known as Boletinellus merulioides (Schw.) Murrill. N. Am. Flora 9^3: 158.

P. rhodoxanthus is difficult to place satisfactorily. It is sometimes known as Gomphidius rhodoxanthus, but Gomphidius has a glutinous universal veil, while this species is never glutinous. Flammula, Phylloporus, and Boletinus have each been proposed as the proper genus for it. P. flavidus Berk. (S. 987; M. 179) is probably the same plant.

BOLBITIUS FR.

A.[1] Pileus viscid when moist.
B.[1] Pileus striate or sulcate; lamellae not decurrent.
C.[1] Young pileus pure white, sordid with age. Myc. Notes 1:18 .... *B. sordidus* Lloyd
C.[2] Pileus not white.
D.[1] Pileus sulcate, brown or brownish, 4-6 cm.; lamellae free. S. 14: 156; Jour. Cin. Soc. Nat. Hist. 18: 36.............. *B. radians* Morg.
D.[2] Pileus striate only, yellow, usually less than 4 cm.; lamellae adnexed. S. 1074; H. 346; St. 362.................... *B. fragilis* (L.) Fr.
B.[2] Pileus not striate or sulcate; lamellae decurrent. S. 1077.
B. macrorrhizus B. & Mont.
A.[2] Pileus not viscid.
B.[1] Pileus yellow, not striate; lamellae adnexed. S. 1075; M. 177; St. 362.............. *B. titubans* (Bull.) Fr.
B.[2] Pileus cinereous, striate; lamellae free. S. 1113; M. 176; P. R. 29: 41...... *B. pulchrifolius* (Peck) Mass.

NOTE.

Lloyd thinks Bolbitius radians the same plant at Pluteolus coprophilus.

AGARICUS LINN.

(Psalliota Fr.)

A.[1] Pileus distinctly brown or tawny.

B.[1] Whole surface of pileus tawny-brown, fibrillose-scaly. S. 1000; St. 307; Mc. 334; M. 112; P. R. 36:48.
A. silvaticus Schaeff.

B.[2] Pileus white or whitish with numerous minute brown scales, disk usually brown and smooth. S. 1003; P. R. 36:48; Mc. 345; H. 315; A. 23.
A. placomyces Peck

A.[2] Pileus (except for scales if present) white or whitish or somewhat yellowish; rarely brownish, never tawny.

B.[1] Mature pileus usually more than 4 cm. broad.

C.[1] Stipe solid. S. 994; P. R. 36:45; H. 308; Mc. 336; A. 20........................*A. rodmani* Peck

C.[2] Stipe stuffed or hollow.

D.[1] Plants occurring in grassy or open fields, etc.

E.[1] Veil large, double; lamellae long whitish or pallid. S. 994; St. 305; P. R. 36:46; H. 310; Mc. 341; A. 21; M. 111.
A. arvensis Schaeff.

E.[2] Veil scant, usually lacerate; lamellae soon pink. S. 997; St. 306; P. R. 36:42; Mc. 332; H. 307; A. 18; M. 112.
A. campester Linn.

D.[2] Plants growing in woods or groves.

E.[1] Pileus with small brown scales, disk smooth, brown. S. 1003; Mc. 345; P. R. 36:48; H. 315; A. 23........*A. placomyces* Peck

E.[2] Pileus glabrous or slightly silky, whitish, or yellowish in center.

F.[1] Bulb of stipe oval. S. 998; Mc. 343; St. 307; P. R. 36:47; H. 309; A. 22. *A. silvicola* Vitt.

F.[2] Bulb of stipe flattened. M. S. M. 163; H. 311........*A. abruptibulbus* Peck

B.[2] Pileus usually less than 4 cm. broad, very thin, pale yellow. S. 1006; Mc. 334; St. 308; H. 313; A. 24; Myc. Notes 1:28........................*A. comtulus* Fr.

NOTES.

A. arvensis and A. silvicola are sometimes regarded as varieties of A. campester.

A brown variety of A. campester occurs but is not common. This species is reported as usually occurring from August to October while A. rodmani is said to occur in May and June.

A. xylogenus Mont. (S. 1010), described from Sullivant's material is not an Agaricus in the present limitation of the term. It is probably a yellow form of Lepiota cepaestipes. A. foederatus B. & M. (S. 1003), also described from Sullivant's material, is said to have the lamellae affixed and the spores brown. It is, therefore, either a Pholiota or a Stropharia. Morgan refers it to the latter genus.

A. fabaceus Berk. (S. 994; M. 111), described from Lea's material, is reported common by Morgan, while Lloyd says it has not been recognized in the last fifty years. The pileus was described as being viscid.

A. abruptibulbus is described as white, becoming yellowish in drying. Plants collected at Oxford and referred by the writer to this species (Ohio Nat. 10:178) were tawny even when young but had the bulbous stipe of the above species. Plants collected at Columbus in September, 1910, are similar in every respect except that the stipe is not distinctly bulbous. These have been referred to A. silvaticus which European writers describe as brown or tawny. The Oxford plants are for the present regarded as a bulbous form of A. silvaticus.

STROPHARIA FR.

A.[1] Pileus viscid or glutinous.

B.[1] Plants growing on dung or richly manured ground.

C.[1] Pileus at first conical then expanded and umbonate. S. 1021; P. R. 30:41; J. M. 14:72.
S. umbonatescens Peck

C.[2] Pileus at first hemispherical, not umbonate; stipe viscid.

D.[1] Pileus soon expanded; stipe stuffed with a pith. S. 1021; A. 32; H. 322; St. 314; Mc. 350; J. M. 14:71; M. 113.......*S. stercoraria* Fr.

D.[2] Pileus never fully expanded; stipe fistulous. S. 1022; St. 314; Mc. 351; M. 113; A. 31; J. M. 14:71; H. 321........*S. semiglobata* Batsch

B.[2] Plants growing on wood or on the ground, not on dung.

C.[1] Stipe hollow, viscid; pileus with bluish-green gluten, at least when young. S. 1013; St. 309; Mc. 349; M. 112; A. 32; J. M. 14:74; H. 322.
S. aeruginosa Curt.

C.[2] Stipe solid; pileus viscid, ochraceous. J. M. 14:73.
S. drymonia Morg.

A.[2] Pileus neither viscid nor glutinous.

B.[1] Pileus glabrous, even, ochraceous. H. 321; J. M. 12: 194; J. M. 14:69....................*S. hardii* Atk.

B.[1] Pileus with minute white scales, fulvous; margin striate. S. 1003; Mc. 339; J. M. 14:70.
S. foederata B. & Mont.

NOTES.

S. micropoda Morgan Jour. Myc. 14:73, does not seem distinct from Flammula polychroa which has a veil in young plants. Remnants of the veil usually mark its position on the stipe.

Morgan reports S. submerdaria Britz. from Preston, O. Britzelmayr's description is not available except the very short one in Saccardo (11:71). S. aeruginosa is given by Morgan as S. viridula Schaeff.

HYPHOLOMA FR.

A.[1] Pileus glabrous except that sometimes cobwebby remnants of the veil occur on the margin.

B.[1] Pileus hygrophanous.

C.[1] Lamellae dark violaceous in very young plants, adnexed. S. 1038; St. 322; A. 28; Mc. 363; J. M. 14:29; M. 114............*H. candolleanum* Fr.

C.[2] Lamellae long remaining white or whitish, adnate or mostly so.

D.[1] Pileus brown or tawny when fresh. S. 1039; St. 323; Mc. 363; A. 27; J. M. 14: 27; H. 325; M. 114........*H. appendiculatum* Bull.

D.[2] Pileus whitish or yellowish. S. 1042; P. R. 29: 40; J. M. 14: 27; H. 323; Mc. 362.
H. incertum Peck

B.[2] Pileus not hygrophanous.

C.[1] Pileus yellow or tinged tawny; lamellae sulfur-yellow then green. S. 1029; St. 318; J. M. 14: 31; Mc. 357; M. 114..........*H. fasciculare* Huds.

C.[2] Pileus red or brownish-red.

D.[1] Taste bitter; mature lamellae sooty-olive. S. 1028; St. 323; Mc. 359; A. 26; J. M. 14:31; H. 326; M. 114....*H. sublateritium* Schaeff.

D.[2] Taste not bitter; mature lamellae purple-brown. S. 1028; H. 327; P. R. 49: 61.
H. perplexum Peck

A.[2] Pileus innately fibrillose or scaly.

B.[1] Pileus hygrophanous; at first velvety or tomentose, becoming glabrous; lamellae black-spotted. S. 1034; St. 321; J. M. 14: 66; Mc. 360; M. 114.
H. velutinum Pers.

B.[2] Pileus not hygrophanous; lamellae not black-spotted.

C.[1] Flesh and veil white; pileus whitish to brown. S. 1033; St. 320; Mc. 361; A. 28; H. 325; M. 114.
H. lacrymabundum Fr.

C.[2] Flesh and veil tawny; pileus tawny-red. S. 1034; St. 320; M. 114; J. M. 14: 66.
H. pyrotrichum Holmsk.

NOTES.

H. perplexum is regarded by a number of writers as not specifically distinct from H. sublateritium. H. incertum is sometimes regarded as a variety of H. candolleanum.

Morgan lists H. candolleanum as H. mutabile Fl. D. and H. sublateritium as H. lateritium Schaeff.

H. comaropsis Mont. (S. 1036), described from Sullivant's material has not since been recognized.

PILOSACE FR.

A single species, *P. eximia* Peck, is reported. The pileus is dark brown and smooth; lamellae free, dull red to brown. The spores are said to be reddish. S. 1012; P. R. 24: 70; M. B. 75: 25; H. 319; J. M. 13: 254.

PSILOCYBE FR.

A.[1] Plants growing in sand; stipe clavate. S. 1050; St. 327; J. M. 13: 145; H. 330........... *P. ammophila* Dur. & Lev.

A.[2] Plants not growing in sand; stipe not clavate.

B.[1] Pileus campanulate or somewhat convex at maturity; plants growing in grassy places. S. 1055; St. 331; H. 328; A. 48; J. M. 13: 248...... *P. foenisecii* Pers.

B.[2] Pileus convex to plane; plants on wood or on ground among leaves.

C.[1] Pileus brown when moist; lamellae adnexed, crowded. S. 1052; St. 329; H. 329; Mc. 365; J. M. 13: 247............... *P. spadicea* Schaeff.

C.[2] Pileus livid; lamellae adnate. S. 1053; St. 330; J. M. 13: 250.................... *P. cernua* Vahl.

NOTES.

P. spadicea has not been definitely reported from Ohio although it doubtless occurs here.

P. rhodophaea Mont. (S. 1050; J. M. 13: 249), P. pulicosa Mont. (S. 1056; J. M. 13: 249), and P. sullivantii Mont. (S. 1047; J. M. 14: 69) have not been recognized since 1856.

PSATHYRA FR.

A.[1] Plant not violaceous.

B.[1] Pileus umbonate. S. 1069; J. M. 13: 152.
P. subnuda Karst.

B.[2] Pileus not umbonate.

C.[1] Pileus striate; stipe arising from mycelial bulb; growing in sand. J. M. 13: 152.
P. miamensis Morg.

C.[2] Pileus even; stipe nearly equal; not growing in sand. S. 16: 126; J. M. 13: 152; B. T. 26: 68.
P. microsperma Peck

A.[2] Whole plant violaceous. S. 1063; J. M. 13: 151.
P. pholidota Mont.

COPRINUS FR.

A.[1] Lamellae crowded; substance of pileus rather thick and fleshy; pileus often striate but not plicate.

B.[1] Pileus scaly or floccose-villous or nearly glabrous, not atomate or mealy.

C.[1] Scales of pileus small or medium, formed by breaking up of surface of pileus.

D.[1] Pileus at first cylindrical; white, shaggy; stipe annulate. S. 1079; St. 348; Mc. 370; H. 332; A. 33-40; M. 173............*C. comatus* Fr.

D.[2] Pileus at first ovoid.

E.[1] Pileus cinerous, scales reddish-brown; stipe with similar scales, annulate. S. 1081; M. 173; pl. 8...........*C. squamosus* Morg.

E.[2] Scales of pileus not reddish-brown; stipe not scaly.

F.[1] Plants growing on fallen trunks or stumps; pileus grayish-brown. S. 1083; M. 174; St. 350; Mc. 374.
C. fuscescens (Schaeff.) Fr.

F.[2] Plants not growing on trunks.

G.[1] Spores smooth; plants in rich soil and grassy places; pileus grayish-brown to lead-colored. S. 1081; St. 350; H. 333; A. 40; Mc. 373; M. 174.

C. atramentarius (Bull.) Fr.

G.[2] Spores rough; plants growing about stumps in woods; pileus grayish-brown. S. 1082; P. R. 26: 60; M. 175 ....*C. insignis* Peck

C.[2] Scales of pileus large, superficial; formed by breaking apart of the universal veil; or pileus densely villous or mealy-floccose.

D.[1] Stipe annulate, at least when young; plants on stumps, soil or old leaves.

E.[1] Scales of pileus ochraceous. S. 1082; P. R. 25: 79; M. 174.......*C. variegatus* Peck

E.[2] Scales of pileus white. S. 14: 158; H. 336; B. T. 22: 491.........*C. ebulbosus* Peck

D.[2] Stipe not annulate; plants usually on dung.

E.[1] Pileus cylindrical to conic. S. 1087; St. 352; H. 338; Mc. 376........*C. fimetarius* Fr.

E.[2] Pileus ovate to campanulate.

F.[1] Pileus and stipe downy-villous, at least when young, white; lamellae adnexed. S. 1088; St. 353; Mc. 378; M. 175.

C. niveus (Pers.) Fr.

F.[2] Pileus buff to darker, with large scales; stipe nearly glabrous; lamellae free. S. 16: 130; B. T. 26: 68.

C. laceratus Peck

B.[2] Pileus with sparkling atoms or with mealy particles, at least when young.

C.[1] Lower part of stipe floccose-downy, plants on dung or ground. S. 1106; Mc. 382; P. R. 24: 71; M. 175........................*C. semilanatus* Peck

C.[2] Stipe not floccose-downy; plants not on dung.

D.[1] Pileus with sparkling atoms, yellowish-brown; usually on ground about stumps; common. S. 1090; St. 354; Mc. 378; H. 335; M. 175.
C. micaceus (Bull.) Fr.

D.[2] Pileus floccose-mealy; usually on trunks or stumps of trees.

E.[1] Lamellae broad. S. 1083; St. 350; Mc. 374; M. 174......*C. fuscescens* (Schaeff.) Fr.

E.[2] Lamellae narrow; plants usually growing from patch of brown mycelium (Ozonium). S. 1092; St. 355.
C. radians (Desm.) Fr.

A.[2] Lamellae distant or subdistant; pileus very thin, plicate-sulcate; usually growing on dung or richly manured ground.

B.[1] Pileus less than 1 cm. broad.

C.[1] Lamellae free. S. 1101; St. 358; M. 176.
C. radiatus (Bolt.) Fr.

C.[2] Lamellae attached. S. 1106; St. 359; Mc. 382; H. 337..........................*C. ephemerus* Fr.

B.[2] Pileus usually more than 1 cm. broad.

C.[1] Lower part of stipe floccose-downy. S. 1106; P. R. 24:71; M. 175; Mc. 382.....*C. semilanatus* Peck

C.[2] Stipe glabrous or nearly so.

D.[1] Lamellae free. S. 1100; St. 358; M. 176.
C. nycthemerus Fr.

D.[2] Lamellae attached.

E.[1] Spores angled or angular. S. 1113; P. R. 26:60................*C. angulatus* Peck

E.[2] Spores elliptical.

F.[1] Disk of pileus raised; lamellae attached to stipe. S. 1106; St. 359; Mc. 382; H. 337............*C. ephemerus* Fr.

F.[2] Disk at length depressed; pileus bluish-gray, disk brownish or rufescent; lamellae united to a collar at apex of stipe. S. 1108; St. 359; Mc. 383; M. 176..........*C. plicatilis* (Curt.) Fr.

NOTES.

C. fimetarius and C. ephemerus have not been definitely reported from Ohio.

C. insignis is said to resemble C. atramentarius and to differ from it in the roughened spores (P. R. 26:60). It may be only a variety.

C. radians in Europe is said to occur on moist plaster walls. The only reference to it in Ohio gives it as occurring on trunks of trees (Myc. Notes 1:145). It is probably the same plant referred by Lea and Morgan to C. fuscescens.

A specimen labeled C. angulatus and collected by Lloyd at Cincinnati is in the state herbarium at Albany.

C. berkleyi and C. stenophyllus, described from Sullivant's material by Montagne, are omitted (S. 1094, S. 1095).

ANELLARIA KARST.

The species of this genus were separated from Panaeolus on account of the zone or annulus about the stipe. Only one species, *A. fimiputris* (Bull.) Karst., has been reported from Ohio. S. 1126; St. 339; J. M. 13: 62; M. 116.

PANAEOLUS FR.

A.[1] Pileus viscid.

B.[1] Stipe annulate or zoned; pileus at first conical, lead-colored. S. 1126; St. 339; M. 116; J. M. 13:62. *P. fimiputris* Bull.

B.[2] Stipe not annulate; pileus at first campanulate, pale tan. S. 1119; St. 339; J. M. 13: 62. . . .*P. phalaenarum* Fr.

A.[2] Pileus not viscid.

B.[1] Pileus white, whitish or grayish when fresh, sometimes yellowish in age.

C.[1] Pileus usually 5-8 cm. broad; stipe solid. S. 1123; Mc. 385; H. 343; M. 116; J. M. 13:60; P. R. 23. *P. solidipes* Peck

C.[2] Pileus usually less than 3 cm. broad; stipe hollow. S. 1122; St. 341; Mc. 386; H. 344; J. M. 13: 59. *P. papilionaceus* Fr.

B.[2] Pileus tan to smoky-black, etc., not white.

C.[1] Pileus with brown or blackish zone about the margin.

D.[1] Pileus conical, acutely umbonate. S. 1124; St. 342; J. M. 13:59..........*P. acuminatus* Fr.

D.[2] Pileus campanulate, not umbonate. S. 1124; St. 342; Mc. 385; J. M. 13:59; M. 116; H. 342. *P. fimicola* Fr.

C.[2] Pileus not zoned about the margin.

D.[1] Pileus moist or hygrophanous.

E.[1] Pileus sooty-black when moist, not reticulate. S. 1121; St. 340; J. M. 13:60. *P. sphinctrinus* Fr.

E.[2] Pileus tan or brown, usually pink-tinged, reticulate-rugose. S. 1120; St. 340; A. 45; H. 339; Mc. 384; J. M. 13:61. *P. retirugis* Fr.

D.[1] Pileus dry, not hygrophanous.

E.[1] Pileus hemispherical; lamellae very broad. S. 1122; St. 341; Mc. 386; H. 344; J. M. 13: 59..............*P. papilionaceus* Fr.

E.[2] Pileus campanulate. S. 1121; St. 340; Mc. 386; J. M. 13:60; H. 342; M. 116. *P. campanulatus* Linn.

NOTES.

P. fimiputris is often placed in the genus Anellaria.

P. phalaenarum has not been definitely reported from Ohio.

PSATHYRELLA FR.

A.[1] Pileus sulcate or plicate-sulcate.

B.[1] Pileus less than 15 mm. broad, whitish to cinereous; common. S. 1134; St. 346; Mc. 391; J. M. 13:54; H. 347; A. 48; M. 117............*P. disseminata* Pers.

B.[2] Pileus usually more than 15 mm. broad, yellow or rufescent when fresh. S. 1134; St. 346; J. M. 13:57.
P. crenata Lasch

A.[2] Pileus striate or striatulate, not sulcate.

B.[1] Pileus with tufts of hair at least when young, brown or reddish-brown. S. 14:163; H. 348; J. M. 13:55; P. R. 50:107.........................*P. hirta* Peck

B.[2] Pileus not hairy-tufted.

C.[1] Lamellae close; plants odorous. S. 1136; P. R. 24:70; J. M. 13:54.............*P. odorata* Peck

C.[2] Lamellae rather distant.

D.[1] Pileus campanulate, sprinkled with shining particles. S. 1132; St. 346; Mc. 390; J. M. 13:57; M. 117..............*P. atomata* Fr.

D.[2] Pileus conical, not atomate, stipe naked. S. 1127; St. 343; Mc. 389; J. M. 13:56; M. 117.
P. gracilis Pers.

NOTE.

P. falcifolia and P. rupincola, described from Sullivant's material by Montagne, are omitted. (See S. 1129, 1134, and J. M. 13:55.)

GLOSSARY.

Acrid, bitter, peppery.

Adnate, attached squarely to stipe (of lamellae).

Adnexed, slightly attached to stipe, or by upper corner only (of lamellae).

Alliaceous, of onions or garlic.

Annulus, the ring on the stipe of some Agarics, formed by the separation of the partial veil from margin of pileus.

Appendiculate, hanging in small fragments from margin of pileus (of veil).

Appressed, applied closely to the surface.

Arachnoid, like a cobweb.

Areolate, divided into little areas.

Azonate, without zones.

Bay, dark reddish-chestnut color.

Buff, light, dull brownish-yellow.

Campanulate, bell-shaped.

Capillary, hair-like.

Cespitose, growing in tufts or clumps, stipes usually more or less united at base.

Cinereous, ash-gray or light bluish-gray.

Clavate, club-shaped.

Conchate, shell-shaped.

Concolorous, used of the stipe when it is of the same color as the pileus.

Conidium, a non-sexual spore cut off from the end of a hypha or hyphal branch.

Context, substance of pileus (or stipe); flesh.

Costate, ridged or ribbed.

Crenulate, with fine rounded notches along the edge.

Decurrent, extending down the stipe.

Deliquescent, becoming liquid.

Denticulate, with small teeth or projections along the edge.

Depressed, slightly sunken (of center of pileus).
Dichotomous, regularly forked into two.
Disk, central portion of pileus.

Eccentric, not attached at center of pileus (of stipe).
Echinulate, minutely roughened (of spores).
Emarginate, with a deep notch at point of attachment to stipe (of lamellae); sinuate.
Even, not wrinkled, sulcate, striate or pitted, etc.
Explanate, becoming expanded, flattened.

Farinaceous, mealy, somewhat powdery (of surfaces); resembling flour or meal (of odors).
Ferruginous, of the color of iron-rust, rust-red.
Fibrillose, with fibrils.
Filiform, thread-like.
Fistulous, tubular, hollow.
Flesh, inner substance of pileus or stipe; context.
Floccose, downy, woolly; with woolly locks.
Floccose Trama, see *Trama.*
Flocculose, minutely floccose.
Free, not attached to stipe (of lamellae).
Fuliginous, dark smoke-color, smoky-brown.
Fulvous, yellowish-brown, tawny, or yellow-gray-brown.
Furfuraceous, with small scurfy scales.
Fuscous, brown or grayish-black.
Fusiform, spindle-shaped.

Gills, see *Lamella.*
Glabrous, without scales, hairs or pubescence; smooth.
Glutinous, covered with a thick sticky or slimy coat.
Granular, Granulose, covered with granules.

Hirsute, covered with stiff hairs.
Hygrophanous, having a watery appearance when moist and becoming paler and opaque in drying.
Hymenium, spore-bearing surface, covering the lamellae in Agarics.

Hypha, one of the elongated cells or filaments of which a fungus is composed.

Infundibuliform, funnel-shaped.
Innate, originating with, or blending with the substance of a part.
Inserted, growing from the substratum without a basal disk and not woolly or tomentose at the base; mycelium within the substratum and invisible.
Insititious, inserted.
Involute, rolled inward.

Lamella, one of the leaf-like plates on the under side of the pileus of an Agaric; a gill.
Lateral, attached to one side of the pileus (of stipe).
Latex, the milky or colored juice of certain plants.
Linear, very narrow and straight (of lamellae).

Marginate, having a well-defined margin.
Micaceous, covered with glistening scales.
Micron, one one-thousandth of a millimeter.
Mushroom, any fleshy fungus of reasonable size.
Mycelium, the whole mass of hyphae or fungal threads forming the vegetative portion of a fungus; among the Agarics this gives rise to the sporophore or fruiting structure known as a mushroom or toadstool.

Ochraceous, brownish-yellow.
Ovate, Ovoid, egg-shaped.

Pallid, pale, of an undecided color.
Partial veil, see *Veil.*
Pileus, the cap-like portion of an Agaric, with or without a stipe and bearing the lamellae on the lower side.
Plicate, folded like a fan.
Pruinate, covered with a bloom or powder.
Pubescent, covered with soft, short hairs.

Pulverulent, powdery or covered with a powder or dust.
Punctate, dotted with points.
Putrescent, soon decaying.

Reniform, kidney-shaped.
Resupinate, attached to the substratum by the back or upper part of the pileus which in this case is not provided with a stipe.
Rimose, marked with small cracks.
Rufescent, tending to a dull red or reddish color.
Rugose, wrinkled.
Rugulose, minutely wrinkled.

Scabrous, with a rough surface.
Sclerotium, a hard, compact, tuber-like body containing stored food.
Scrobiculate, marked with small pits or depressions.
Serrate, margin with saw-like teeth.
Serrulate, minutely serrate.
Sessile, without a stipe; pileus attached directly to substratum.
Sinuate, with a deep notch at point of attachment to stipe; emarginate (of lamellae).
Solid, substance uniform and continuous within, not hollow or stuffed (of stipe).
Spathulate, shaped like a spathula or spoon.
Squamose, with scales.
Squamulose, with small scales.
Squarrose, with erect pointed scales.
Stipe, stem.
Striate, marked with parallel or radiating lines.
Strigose, with stiff erect hairs.
Stuffed (of stipe), interior filled with a material different from the outer part, usually softer.
Substratum, the substance upon or within which a fungus grows.
Sulcate, marked with grooves or furrows.

Toadstool, a fleshy fungus shaped like an umbrella.
Tomentose, more or less densely matted, hairy.

Trama, the inner portion of the lamellae or pileus; when made up of interwoven fibers of a uniform diameter, it is said to be *floccose;* when the hyphae are frequently enlarged so as to give, in section, the appearance of rounded cells, it is said to be *vesiculose.*

Tuberculate, with raised tubercles or nodules.

Umber, olive-brown or dark-brown.

Umbilicate, with a central depression or umbilicus, but not funnel-shaped.

Umbonate, with a central elevation or umbo.

Uncinate, extending down the stipes as a short tooth or hook, but not decurrent.

Universal Veil, see *Veil.*

Veil, a membrane enclosing the entire mushroom when young (*universal veil*), or extending from stipe to margin of pileus and enclosing the lamellae (*partial veil*).

Venose, with swollen lines or wrinkles.

Ventricose, swollen in the middle.

Vesiculose Trama, see *Trama.*

Viscid, covered with a sticky liquid or merely sticky.

Volva, the remnant of the universal veil at the base of the stipe as a cup or sheath, or broken into fragments.

Zonate, marked with zones or concentric bands.

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AN ECOLOGICAL STUDY OF BUCKEYE LAKE.

INTRODUCTION.

The problem of an ecological survey of Buckeye Lake was taken up on account of the many interesting and instructive features which the region offers. It is an artificial lake maintained under artificial conditions and used for the past eighteen years as a pleasure resort. Because the basin is very shallow, aquatic plants if left undisturbed, would soon gain possession of the entire area and render navigation impossible. To prevent this, the vegetation in the main channels and where landing places were desired, has been frequently and perhaps permanently destroyed.

This lake then offers a field for the study of a natural ecological succession in an uninterrupted development since the beginning of the present lake, eighty years ago, and also denuded areas with a more or less successful invasion and secondary succession. It is moreover, the habitat of a Cranberry-Sphagnum bog, which without doubt antedates the lake and the former swamp.

In the following paper I shall attempt to present a general view of the flora of the entire region, obtained by a detailed survey of areas typical of the different phases presented in the region and shall try to trace the development of the flora.

The beginning of a systematic study of ecological phytogeography is of very recent date, Humboldt (1805) is credited by Warming[63] as being "the first to lay stress upon the significance of plant-physiognomy in relation to the landscape," and consequently the subject is experiencing many developmental stages in the methods of study and in the terminology. In the latter especially there is diversity of opinion among the most eminent ecologists, not so much as to the relations existing between the concepts of formation, association, and society; but as to the value of the respective terms. Griesebach[35] was the first to employ the term formation in connection with phytogeography. To him a "phytogeographical formation" is a group of plants which has a fixed physiognomy, such as a meadow or forest. Warming[63] writes:—"A formation may then be defined as a community of species, all belonging to definite growth forms, which have become associated together by definite external (climatic or edaphic) characters of the habitat to which they are adapted. Consequently, so long as the external conditions remain the same, or nearly so, a formation appears with a certain determined uniformity and physiognomy, even in different parts of the world, and even when the constituent species are very different and possibly belong to different genera or families."

Hence Warming's concept agrees with that of Griesebach in making physiognomy the controlling factor in a formation and uses this as the basis of classification. Clements[9] also sees the formation as an organic unit conditioned by the habitat and it must therefore be co-extensive with the latter. Consequently his classification of formations is based on habitat. Adams[4] says:—"A formation or climax society is composed of a relatively limited number of species which are dominant in a given environment of geographic extent. Such dominance implies extensive range, relative abundance and ability to indefinitely succeed or perpetuate itself under given conditions." And Schimper[52] recognizes two ecological groups of formations, climatic or district, composed of three chief types, woodland, grassland and desert; and edaphic or local formations, which are conditioned by the soil; as swamp, rock, sand dune, etc. Graebner[32] advocates making the percentage and nature of inorganic salts dissolved in the soil water, the controlling factor in the character of vegetation. He therefore recognizes the groups of formations; 1, where the water contains a high per cent of mineral salts; 2, where the per cent of mineral salts (supposedly available to plants) is low; and 3, saline water.

Other authors extend the term formation to cover a much larger concept, whose limitation is based on the water available to plants and therefore recognize Xerophytic, Mesophytic and Hydrophytic formations.

The term association is also variously interpreted; but being employed in a more restricted sense than formation there is greater unanimity of opinion.

In this paper an association stands for a unit of vegetation exhibiting a definite growth form, which is characteristic of a certain habitat. For example:—the upland meadows in the vicinity of Buckeye Lake are occupied by grass associations, the bog-meadow of Cranberry Island is occupied by a Cranberry-Sphagnum association. The dominant species in each case giving character to the association.

The various associations include ecologically related communities of species having definite floristic composition. These are grouped in societies to which the principal ones give name and character. In certain areas in the bog-meadow Dulichium arundinaceum occurs with the Oxycoccus and Sphagnum in such abundance as to give a definite character to those areas and forming an Oxycoccus-Sphagnum-Dulichium society. Again altho Sphagnum cymbifolium is the most abundant and widely distributed species of Sphagnum in the bog, there are areas in which Sphagnum acutifolium var versicolor occurs to the almost complete exclusion of S. cymbifolium. As these two species differ greatly in appearance the contrast between the two Sphagnum societies is striking.

A marsh offers another illustration of well defined associations, distinguished by plants of most characteristic growth-form e. g.:—erect plants with slender culm-like stems and long relatively narrow leaves, with the roots, rhizomes and lower portion of the erect stem only, submerged in relatively quiet, shallow water along the margins of lakes, bays and gulfs and sluggish streams. The dominant plant may be a Typha, a grass or a sedge. The particular marsh is then a Typha, grass or a sedge association according to the plant which lends it character.

Associated with the dominant species are others of minor importance, which however may be abundant and conspicuous enough in various parts of the association to lend character to the vegetation of that part. Thus, in one part, Scirpus fluviatilis may be a dominating species of nearly equal rank with the Typha; we have then a Typha-Scirpus society in the Typha association. A society may also consist of a single species only, as an isolated tussock of Scirpus lacustris in a Typha association. The society should always be clearly defined; altho there is generally a transition from one to the other at the margins. The societies are designated by their principal species. With these are generally associated others of secondary importance, secondary species, which may belong to the same or to another succeeding or preceding association. In the latter case they show a relationship to the society in which they occur. As for example, in a Typha-Sphagnum society Potamogeton lonchites belonging to an association of fixed aquatics, is frequently present, persisting and growing well, even where the water has entirely receded leaving a moist but not wet mud flat. The shoots of the Potamogeton are shorter than those in the water but are green and thrifty. That the plant does not suffer from the diminution of water in the substratum seems to be due to the increased humidity of the atmosphere at the level of the shoots.[66] Thus the Potamogeton is benefited by the presence of the taller plants, for if these were absent the Potamogeton would soon succumb.

The societies and associations may develop a zonal or an alternate arrangement. The former term is used in this paper to designate a more or less well defined crescentric arrangement which results typically from a radial growth from a common center. Alternation is used to designate scattered masses, exhibiting no definite relationship in space to one another. The location of each such mass is determined either by local conditions or thru accidents of dissemination.

Transects have been charted in a few areas to develop the succession from one society or association to another. These

FIG. 1.—Topographic map of Buckeye Lake and vicinity; U. S. Geological Survey, 1907; contour interval 20 feet (6 m.); scale, 1 inch=1 mile (2.5 cm.=1.6 km.).

FIG. 2.—Map of the "Big Swamp" of the Survey of 1801. A number of smaller swamps of which the largest is the Bloody Run Swamp are shown at the left.

are included in the description of that region in which they were charted.

Before proceeding with the paper I wish to make acknowledgment to the following persons for the courtesies and assistance I have received. To Dr. Alfred Dachnowski under whose supervision the work was done; Dr. C. A. Davis of the U. S. Bureau of Mines, and Professor J. A. Schaffner for assistance in the identification of plants; Mr. H. H. Bartlett for the identification of the Musci and Hepaticeae, Mr. Wilmer Stover for the identification of fungi; Professor C. E. Sherman and J. R. Chamberlain of the Ohio State University; Messrs. Bootin and Sawyer of the Canal Commission, and to Captain Chittenden for charts, maps and information concerning the reservoir and lake; Miss Clara Mark and Mr. Lionel King for photographs of local features.

LOCATION OF LAKE.

Buckeye Lake, (Fig. 1) is situated in Licking, Fairfield and Perry counties in Ranges 17 and 18, Townships 17, 18 and 19. It is a long irregular body of water with its longest diameter from east to west extending from 82° 25′ 27″ to 82° 31′ 12″ west longitude, approximately $7\frac{1}{8}$ miles long from east to west, and varying in width from one-fourth mile in the eastern portion to a mile and one-half at the extreme western end, and covering an original estimated area of 4,200 acres. Originally used as a reservoir for the Ohio canal,[33] on May 21st, 1894, the General Assembly of Ohio passed an act reserving this reservoir for a public park and summer resort to be known as Buckeye Lake.

The site of the lake was a more or less completely tree-covered impassable swamp known to the Indians and early settlers as the "Big Swamp," "Two Lakes" or "Big and Little Lake."[32] It lay diagonally across the southeast corner of Twp. 17 ,and almost half across the southern border of Twp. 19. In the center of this area was a long narrow lake (Fig. 2) fed by several small streams, of which the largest were Buckeye and Honey creeks. The lake drained into the South Fork of the Licking River.

The region surrounding Buckeye Lake includes the southern townships of Etna, Union, Harrison in Licking County, and the northern townships of Violet, Liberty and Walnut in Fairfield County, and Thorn Township in Perry County, and is covered by both the Illinoian and Wisconsin drift sheets to a depth varying from a few feet to 453 feet, as shown by the records of gas wells in the area.

PHYSIOGRAPHIC FEATURES.

The region to the southwest and west of Buckeye Lake is a till plain devoid of large boulders and characterized by clay containing many small sharp irregular rock fragments; the surface is rolling, broken by low gently sloping hills and the shallow open valleys of young streams, many of the smaller of which are wet weather streams only. The drainage belongs to two systems, the Licking-Muskingum and the Scioto River systems. The water shed is a low table land, 3-5 miles wide, surmounted by low hills, obliquely crossing the boundary between Licking and Fairfield counties and sloping gradually to the plain on which lies Buckeye Lake.

The margin of the table land is dissected by numerous small streams. Those flowing towards the north, northeast and east are tributaries of the South Fork of the Licking River, while those flowing towards the southwest, south and southeast join Sycamore and Little Walnut creeks of the Scioto River system. The surface of the region is marked by many swamps, of which the largest are the Bloody Run or Pigeon Roost swamp, two miles southeast of Kirkersville where the South Fork of the Licking changes its course from almost due east to south, and the "Big Swamp" the present site of Buckeye Lake. All of these swamps except Buckeye Lake, have been drained, the smallest are now mere depressions in meadows or cultivated fields and the largest, Bloody Run swamp, is almost wholly under cultivation. It covers an area of 400 acres of which 250 is muck land. To the east of the road Mr. Brown raises celery and other vegetables, and to the west the Livingston Seed Company have their onion farm. Thirteen years ago this was a bog forest of Soft Maple and Swamp Ash with an undergrowth of Willow and Poison Sumac. The drove well at Mr. Brown's barn shows seventeen feet of peat, three feet of yellow clay, then hard pan covering the gravel from which comes the supply of running water. Impatiens stems were found in the muck at a depth of three feet.

The till plain bordering Buckeye Lake on the west has an elevation of 890 feet close to the lake, while the lake surface is 892 feet above sea level.

The eastern portion of Buckeye Lake is surrounded by moraines in which large boulders are quite frequent. The land has a distinctly hill and valley topography, however, the highest elevation within 5 miles of the lake is 1,100 feet, no higher than the crest of the water shed to the west; but the surface is more deeply dissected and the drift cover is thinner, hence the greater prominence and ruggedness of the hills.

Just east of the southeastern extremity of the lake, the rim of hills is dissected by a valley a mile and one-half wide. Just east of Thornville Station a morainal loop crosses the valley and completely blocks it except for a narrow cut, which is now occupied by the parallel tracks of the Shawnee branch of the Zanesville and Western railroad from the south, and the Baltimore and Ohio from the north. The cut whose present surface is 900 feet above sea level, is partially filled with overflow clays and gravel.

Jonathan Creek has its source in the hills immediately south of the cut and here the present valley of Jonathan Creek is two miles wide. The cut above mentioned is very evidently an overflow channel for the lake. The latter from its shape, position with reference to the valley of Jonathan Creek and the morainal loop must be regarded as a finger lake, formed in the upper portion of the old valley of Jonathan Creek by the morainal loop at Thornville Station.[27] The waters of the lake cut thru the moraine at Thornville Station,[65] then later found a lower outlet to the north into the South Fork of the Licking River. The water level of the old lake after the opening of the outlet to the north could not have been much higher than it is now.

The South Fork of the Licking River rises in Jersey Township near the western border of Licking County, follows a generally southeasterly course, passes into Fairfield County until a short distance northwest of Buckeye Lake where it describes a narrow loop and flows northeast to Newark. The old lake in the Big Swamp drained into the river at this loop.

Surrounding the old lake was a wooded swamp,[32] bearing "White and Black Oak, Black Jack, Elm, Red Maple, Sugar Maple, Beech, White Ash, Hickory, Ironwood, Wild Cherry, Box Elder, Gum, Black Walnut and Dogwood, and many of them were large trees." Stumps four feet in diameter have been taken from the reservoir. Besides these larger forests trees, there was an abundance of "Wild Plum, Hawthorn, Alder and Sumac." It is also reported that cranberries grew plentifully in the swamp.

In the history of Perry County,[34] the statement is made that wild plums, wild cranberries and the red thorn berries were in early times, very plentiful in the northern part of the swamp. The Indians are said to have resorted to the lake in considerable numbers for the purpose of fishing and to the swamp for the various berries.

This swamp was chosen for the site of the reservoir for the Ohio Canal.[33] The "old reservoir" was begun in 1825 and completed in 1828. Then because the water level in the canal was not high enough to permit the carrying of even half a load during the drier summer months, an additional 500 acres, known as the new reservoir was added in 1832 to the west end of the old one.

The size and shape of the present reservoir conforms in general, to that of the "Big Swamp" as shown in the surveys of 1799 and 1801. There are striking disparities in the size and outline of the swamp areas in these two early surveys. That of 1799 conforms more closely to the size and outline of the present reservoir.

In Fig. 3, Plate II the map of the survey of 1799 has been

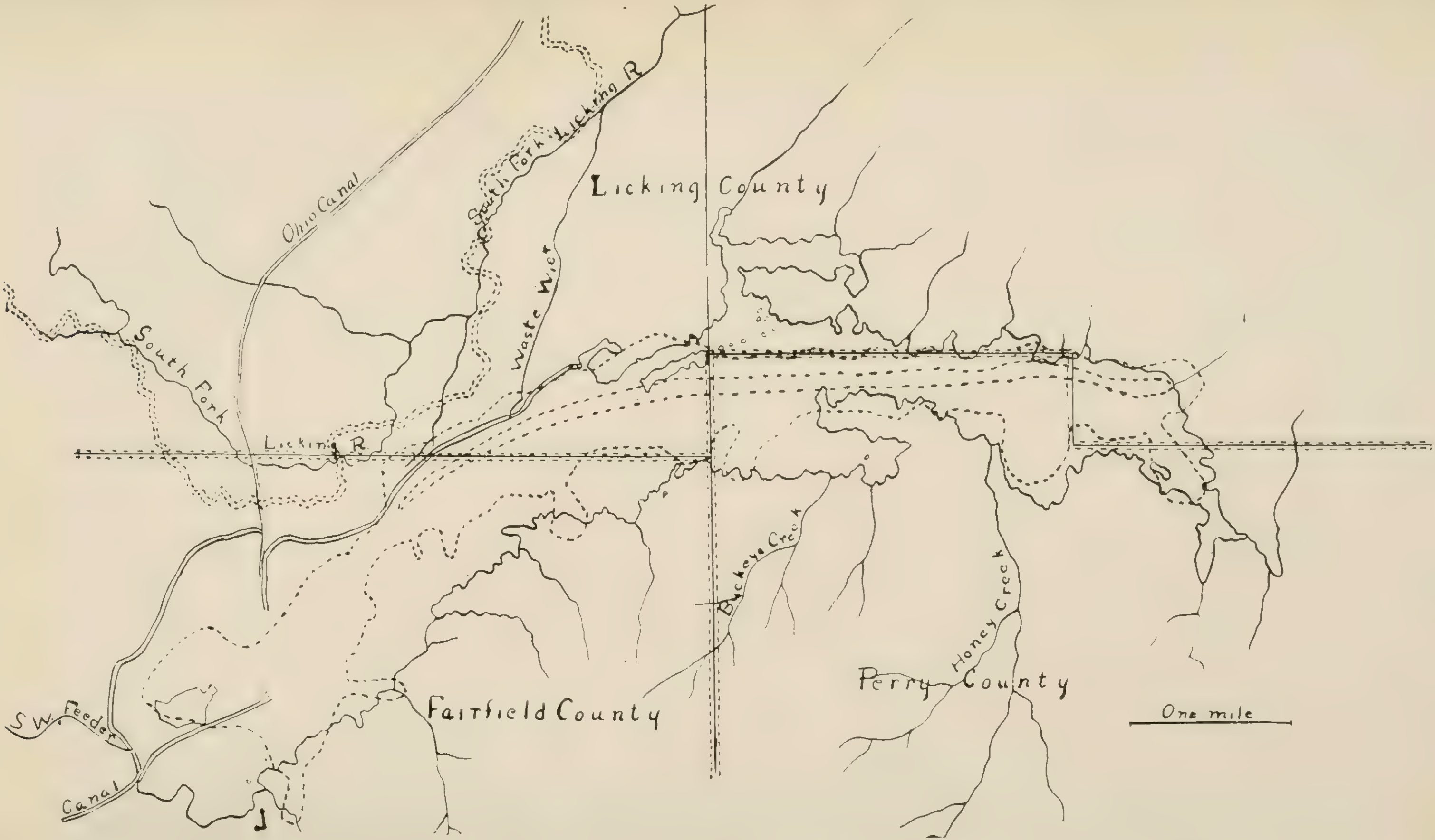


FIG. 3.—Map of the "Big Swamp" of the Survey of 1799 superposed on that of the Survey of 1909 by the Civil Engineering Department of the Ohio State University.

superposed on a composite of the survey made recently by the Canal Commission and one made during the summer of '09 by the Civil Engineering Department of the Ohio State University. The map of the recent surveys is drawn with unbroken and that of 1799 with broken lines. As the water at the standard level is about nine feet higher than that of the original swamp, the reservoir naturally extended farther than the old swamp in those directions where the spreading waters were not checked by a levee or by natural banks; as for example, toward the southwest, south and southeast, where low lands bordered the swamp; and toward the north a long irregular arm of the reservoir extends up a low valley. On the north side a part of the old swamp was cut off by the embankment. A comparison of the superposed areas will show this better than it can be stated in words.

The old lake is represented as a long, narrow ditch with very regular banks. This regular outline seems impossible when one considers the nature of the surrounding land. In the report of the surveys, the swamp is frequently written of as impassable, so the map of the lake is therefore very likely not from an actual survey. Moreover the Indians and early settlers called the waters "Two Lakes" or "Big and Little Lake" indicating the presence of two bodies of water in place of one.

Altho the present lake and its predecessor the "Big Swamp," are distinctly post-glacial and occupy a long shallow kettle in the surface of the upper drift sheet, the basin was a part of the pre-glacial Newark River valley. A probable branch of the Newark River flowed in the valley now occupied by Jonathan Creek,[27] was continuous with the Buckeye Lake basin, and joined the Newark River ½ mile southwest of the present site of the waste weir. There is no evidence that Buckeye Lake was a part of a large post-glacial lake of long duration. The melting of so vast an area of ice caused of course a great sheet of water which, however, could not have endured for a great length of time as there is no evidence of lake sands, clays or beaches and as there seems to be conclusive evidence that there was one and probably two drainage channels, Licking River[47] and Jonathan Creek, open to the east at that time. There were, however, numerous large and small shallow depressions formed by the unequal deposition of the drift in the till plain which were at first shallow lakes and later became swamps.

SURVEY OF THE SHORES.

With the exception of the portion occupied by the levee, the shores of the present lake are generally low and are bordered by a more or less extensive swamp vegetation.

The levee extends along the north shore from the park westward and completely around the western end of the lake. It is interrupted only at the waste weir. The face of the embankment is of rock with clay above and much of this has been recently cemented. The summit is from 4-6 feet wide and clay covered. The steep slope and the firmly packed clay offer xerophytic conditions to plants whose root systems are not deep, and distinctly mesophytic conditions to those whose roots strike deep enough to reach the water level of the lake. The center of the levee is used as the pathway to the cottages bordering the north shore. Along both edges is a more or less interrupted line of trees, consisting of Salix nigra, S. alba, Ulmus americana, Acer rubrum, A. saccharinum, Prunus serotina, Quercus imbricaria, Q. rubra, Q. palustris, Q. bicolor, Populus deltoides, Platanus occidentalis, Celtis occidentalis, besides the few apple and peach trees which have been planted near cottages. The trees were formerly much more dense than they now are; but many have been cut down to make way for cottages. There are scarcely any shrubs, an occasional Sambucus canadensis and Vitis aestivalis along the outer margin is all that is left of the shrub zone. The herbs are but few, only those which can endure strong light exposure and dry soil as Luctuca scariola, Ambrosia trifida and A. artemisiifolia, Oxalis stricta, Erigeron annuus, Anthemis cotula, Achillea millefolium, Polygonum persicaria and P. pennsylvanica.

The outer slope of the embankment is also generally steep. It is in some places grass covered and in others bears trees.

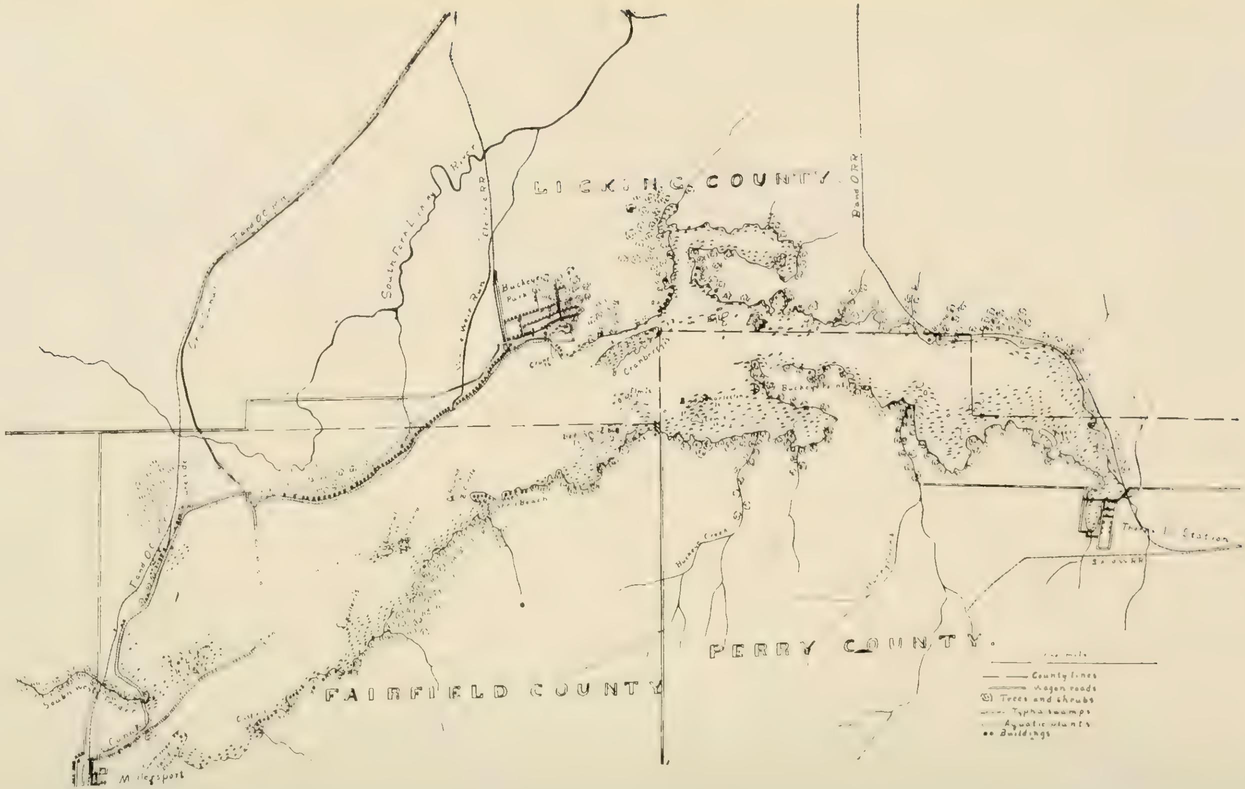


Fig 4.—Buckeye Lake at the present time, showing the areas in which a dense aquatic vegetation has developed and the trees along the shore.

Back of the levee is a low belt 40-50 feet wide. From the park to the waste weir this low land has been drained and small areas have been cultivated. Part of it is overgrown with grasses, Carices, Erigeron annuus, Onagara biennis, Aster sp. An occasional cottage occupies the low land, which is bordered on the north by meadows or cultivated fields.

From the waste weir to a quarter of a mile west, the land slopes from the top of the levee to the fields, there being no intervening ditch. Three-quarters of a mile west of this, the ditch appears again and is only partially drained. It is the bed of a small stream, a tributary to Licking River, which had its headwaters in the large swamp but which has been cut off from the lake by the levee. This creek valley was formerly a wooded swamp with water deep enough to admit of rowing, but is now much disturbed, paths cut thru and partially drained. The trees are the same as those on the embankment, Ulmus americana, Salix nigra and Platanus occidentalis being the most numerous. There are still small areas of Nymphaea advena, Peltandra virginica, an occasional Sparganium eurycarpum and Typha latifolia. The open pools are covered with Lemna trisulca and L. minor and Spirodela polyrhiza.

All the available space on the north slope of the levee has been leased by the State for building sites, most of which are now occupied. This has had a marked effect on the swamp north of the levee. Draining the ground and the building of paths has largely destroyed the former vegetation. The levee extends entirely around the west end of the lake to the canal at Millersport, near which it has been cut thru to admit of the southwest feeder to the lake. The vegetation is much the same as along the north bank except that the smaller number of cottages and less frequent traffic have served to preserve it. The summit of the embankment is generally grass and weed covered except a narrow path along the center; the west slope is quite steep and tree covered for the entire distance. At its foot from Lakeside to the spur track of the Toledo and Ohio Central railroad, is open water with a Scirpus lacustris, Nymphaea advena society. South of the spur track a drainage ditch has converted the swamp into a mesophytic wooded zone with a dense field stratum of grasses and common weeds. At the curve of the levee towards the southwest there is a border of shrubs, Sambucus canadensis and Salix nigra along the ditch. Farther south where the railroad track diverges from the shore the depression between the two is occupied by Typha latifolia and Nymphaea advena in alternating masses, with Homalocenchrus oryzoides, Juncus tenuis and Scirpus fluviatilis and other sedges along the margin and a border of Sambucus and Salix at the foot of the embankment.

Along the water's edge the levee has not been kept in as good repair as that of the north shore. Originally banked with rock at the base, this has in one place broken down, the earth has been washed into the shallow water, building a mud flat about ten feet wide. On this and extending into the water are Sagittaria latifolia, Scirpus fluviatilis and Homalocenchrus oryzoides, Scirpus lacustris, Potamogeton lonchites and Nymphaea advena in the order named.

But few launches enter the western arm of the lake; this and the small number of small docks and the entire absence of large ones, have permitted an abundant growth of fixed aquatics.

Near Lakeside are two Castalia tuberosa beds. Just south of these and near the spur track is an extensive Typha latifolia tussock surrounded by alternating Nymphaea advena, Potamogeton lonchites, Polygonum emersum and Nelumbo lutea societies. About fifty yards farther south an extensive field of Nelumbo lutea begins, it spreads over 300 yards out into the lake and extends to Lieb's Island. The marginal zone of fixed aquatics extends from this point to the mouth of the canal.

The Southwest feeder taps the south branch of the Licking River at Kirkersville; it has a general southwesterly direction and enters Buckeye Lake one-eighth of a mile north of the canal at Millersport. Near its mouth it is a very sluggish stream not more than twenty feet wide, confined between steep banks which are densely wooded on the outer slopes. Immediately at the mouth the banks are low, flat and wet and are covered with a dense growth of Hibiscus moscheutos and with a few Sambucus canadensis and Salix nigra shrubs; this is followed lakeward by a mixed Hibiscus-Scirpus zone which passes into a dense growth of Typha latifolia. In the more open water Nelumbo lutea becomes dominant. Altho the feeder has so little current, enough sediment has been deposited during the eighty years of its existence to form a broad low delta.

Fig. 5.—Zones of vegetation at mouth of S. W. feeder. Clump of willows at the center are on the delta.

The levee which was the eastern embankment of the canal and the western of the old reservoir, is intact only from the southern end to Onion Island. The remainder consists of detached portions with broad open water channels between them. These broken portions bear a few trees, willows and elms. Some places are so broken down that the trees are standing in water. From the margin of the lake to Lieb's Island the levee is clothed with large trees on the south side and a shrub zone, Sambucus and Salix nigra on the north. The shrub zone is interesting as it has had undisturbed possession only since the abandoning of the use of canal boats.

Summerland Beach on the southwest is a rather high, grass-grown point with a thin fringe of trees at the margin, and no marsh zone forming. The cove immediately to the southeast is low and flat and furnishes an interesting example of the succession of marsh and aquatics by ruderal herb societies. There is a marginal zone of Polygonum emersum then Nelumbo lutea and Potamogeton lonchites, followed by a Polygonum-Scirpus fluviatilis zone associated with Roripa palustre, Galium asprellum and Hibiscus moscheutos. In this zone the surface has so recently been under water that it is wet and bears many

Fig. 6.—Lakeward side of Cove southeast of Summerland Beach. At outer margin is a society of Polygonum emersum, this is followed by a Nelumbo lutea zone which is succeeded by sedges.

stranded Potamogeton lonchites whose leaves are broader than when in water, and the tips of whose shoots are erect. This zone is followed by a broad mixed belt; towards the outer margin of which Hibiscus and Scirpus are dominant. There are numerous scattered clumps of Sambucus canadensis, Hibiscus and two Salix nigra, while Polygonum emersum and P. sagittatum are abundant. A narrow line of elms crosses it diagonally as though marking a former shore line. This zone is largely invaded by ruderal herbs of which Ambrosia trifida, Verbena hastata, Lactuca scariola, L. canadensis, Urtica gracilis, Dipsacus sylvestris and Oxalis cymosa are the most abundant. Towards the inner margin of the cove the ruderal societies are dominant. To the south is a clover field so filled with Aster sp., Lactuca canadensis, Ambrosia trifida, Erigeron sp., Geum canadense, Stachys aspera, Achillea millefolium, Anthemis cotula and Dipsacus sylvestris that the clover is visible only on close scrutiny.

No levee was built along the south shore of the lake, which is low, marshy and bordered by a tree zone except in the ex-

Fig. 7.—Head of cove southeast of Summerland Beach. Ruderals have taken almost entire possession of the mud flat.

treme southwest portion near Shell Beach and southeast where cultivated fields extend to the lake. From Summerland Beach to Shell Beach, within recent years, short stretches of embankment of planks stone or concrete have been built in front of cottages and hotels. These together with the docks and boat landings have greatly interfered with the vegetation. From Castle Island to Shell Beach the shallow waters within 50-100 yards from the shore have a more or less dense growth of fixed aquatics and swamp plants. In the quiet waters surrounding

Journal and Orchard Islands and extending to the shore, the swamp shows well defined zonation. The outer zone is an almost pure growth of Nelumbo lutea in water from 4-5 feet deep. Next is a mixed zone of Nelumbo lutea and Polygonum emersum. The latter becomes dominant nearer the shore. This is bordered by a dense growth of Typha latifolia with which Sparganium eurycarpum, Polygonum emersum and sedges are associated. The Typha zone begins in water two and one-half feet deep and extends up above the water level on the mud flat. This is followed by an Hibiscus zone, and this in turn by a thin fringe of shrubs, Sambucus canadensis and Cornus stolonifera. The trees, remnants of the older vegetation, are mostly Salix nigra. There is here and there an Ulmus americana and Hicoria ovata.

The outline of the south shore is very irregular. The hills to the south form a front of irregular lobes 900 feet above sea level extending to near the water's edge. Between these lobes are the valleys of brooks, many of which are now mere depressions in the cultivated fields, a few are still occupied by small streams. The lake has ascended these valleys forming troughs between the lobes of higher land. As the water in these coves is extremely shallow they are all filled with a dense growth of fixed aquatics and shore marsh plants. The mouth of the valley of Buckeye Creek is an almost impenetrable marsh, three-fourths of a mile wide from Custer's Point to its eastern margin back of Buckeye Point. This is the most extensive continuous association of fixed aquatics in the lake. The marsh extends out into the lake as far to the west as Custer's Point and Elm Island and nearly half way across the lake to the north. It completely surrounds Charleston and Lewis Islands, and an island just west of Buckeye Point and also forms a broad zone around the latter. The greatest depth of water is five and one-half feet. At this depth, at the lakeward margin of the association, occur pure societies of Nelumbo lutea, Potamogeton lonchites, mixed societies of several species of Potamogeton lonchites, pectinatus and natans, and often with Castalia tuberosa. Nelumbo lutea is also often associated with Castalia tuberosa. There are several large tussocks of Typha angustifolia at a depth of two and one-half to three and one-half feet. These are always pure societies except that at the margin of the tussocks are generally a few Castalia, Nelumbo, Potamogeton or even Nymphaea advena leaves. In the center of the tussock are no other plants. Not as numerous but alternating with the Typha angustifolia are tussocks of Typha latifolia. This latter species grows in somewhat shallower water, water at a depth of one and one-half to two and one-half feet. It never seems to occur as a pure society, but it always associated with Sparganium eurycarpum, Polygonum emersum and often with Hibiscus moscheutos and Scirpus fluviatilis. Bidens species are often growing on the uprooted masses or even on the sediment covered bases of the living stalks.

The two associations here represented, that of fixed aquatics with floating or submerged leaves and that of a reed marsh, do not exhibit a well defined zonal arrangement, except where they border an island, Buckeye Point or the shore of the cove. Then either a pure Nelumbo society or a Nelumbo-Polygonum emersum society forms the outer zone in water varying in depth from 5 to 2½ feet. This is followed by a Polygonum zone or a Polygonum-Potamogeton or by a Typha zone. The Typha zone in some cases, extends to the exposed shore line; in others there is a Typha-Scirpus, or Typha-Hibiscus followed by a shrub zone. The shrub zone is generally but poorly represented. In the open water the associations exhibit an alternation. Depth of water and wind exposure have some influence on the position of the societies. Typha angustifolia grows in deeper water than T. latifolia; Nelumbo lutea and Castalia tuberosa grow in deeper water than Nymphaea advena. Potamogeton lonchites and P. pectinatus grow in deeper water and where wind exposure is greater than P. zosterifolius and P. pusillus. All the Potamogeton grow more luxuriantly to the lee of an island and of Typha masses than on the windward side. Polygonum emersum is gregarious. It grows in water 5½ feet deep and also in the mud above the water level. It covers large areas as a pure society but is often associated with Potamogeton, Nelumbo, Castalia, Typha and even Hibiscus. Thus in making one's way through the cove at the mouth of Buckeye Creek, one encounters Typha tussocks, a large patch of Nelumbo, Castalia, smaller dense masses of Pontederia cordata, Scirpus lacustris with Utricularia vulgaris or Potamogeton associated. In the center of the cove, sheltered by the point and with water 2½ or less feet deep, is an extremely dense, almost impenetrable mass of Potamogeton zosterifolius with Ceratophyllum demersum under the surface.

According to the topographic map, Buckeye Creek flows through the center of this marsh. There is no evidence of flowing water or an open channel and the zone of Typha latifolia lining the shore is unbroken.

A mile and one-eighth farther east, Honey Creek enters the lake. Its channel has been kept open thru the marsh. The lower portion looks more like a canal than a creek, with its uniform shores and earth banks. The channel at the mouth is about fifteen feet; fifty yards up-stream it is not more than eight feet wide with a uniform depth of 31½ inches. The fall in the creek is so little that the current is barely noticeable. (Fig. 9.) An extensive vegetation with well marked zonation spreads out into the lake on either side of the creek. (Fig. 8.) These zones are composed of:

I. An association of semi-aquatics comprising three societies which show alternation rather than zonation.

1. Nelumbo-Potamogeton society.
   - Principal species
     - Nelumbo lutea
     - Potamogeton lonchites
   - Secondary species
     - Potamogeton pectinatus
     - P. natans

This society covers an area 100 feet broad on the west and somewhat less on the east side of the creek. There are also

FIG. 8.—MAP OF THE MOUTH OF HONEY CREEK.

LEGEND OF THE PLANT SOCIETIES.

1. Nelumbo-Potamogeton society.
2. Nymphaea advena society.
3. Typha-Sparganium society.
4. Homalocenchrus-Scirpus fluviatilis society.
5. Ruderal herb society.
6. Salix society.
7. Ulmus-Fraxinus society.
8. Cultivated fields.

Societies 1 and 2 belong to the association of semi aquatics, 3 to the Typha, 4 to the Sedge, 5 to the Ruderal herb, 6 and 7 to the Mesophytic forest association.

smaller areas occupied by this society farther in shore where it alternates with the Second society of the semi-aquatics and also with the sedge society of the shore plants.

2. Nymphaea advena society: Nymphaea advena is present in clumps between the Lotus bed and the shore, alternating with areas of the Nelumbo and Scirpus societies.

3. Castalia tuberosa-Potamogeton lonchites society: This society forms a fringe bordering the open water of the creek.

FIG. 9.—Plant associations bordering the mouth of Honey Creek, showing Society 1 of Association I, Societies 1 and 2 of Association II, and Societies 1 and 2 of Association V of the map of Honey Creek.

The seasonal aspect is marked in this association. In June the Nymphaea and Scirpus with their erect leaves from 1-3 feet above the water level, were the most conspicuous plants. In the latter part of July and during August, the Lotus is in full bloom, the flower stalks and large leaves standing 2-3 above the water almost conceal the Nymphaea.

Succeeding Association I is an association of shore plants extending from water 1-2 feet deep to well up on the mud flat wholly above the water.

This is II. Typha association, comprising 5 societies as follows:

1. Scirpus fluviatilis society: This society alternates with those of Association I and also forms quite a dense border at the margin of the

2. Typha-Sparganium society: The dominant species of which are Typha latifolia and Sparganium eurycarpum. These in deeper water are associated with Scirpus fluviatilis, Potamogeton natans, P. lonchites, P. pectinatus with Lemna minor on the surface of the water. The Typha-Sparganium zone extends 150 feet up-stream and to the west completely across the cove. Along the inner portion of the zone the Potamogeton and Castalia have disappeared and the society becomes a

3. Typha-Homalocenchrus-Sparganium society: Homalocenchrus oryzoides becoming one of the dominant members. The ground is distinctly wet but is not completely covered with water. The associated plants are Hibiscus moscheutos, Sagittaria latifolia, Rumex brittanica, Scirpus fluviatilis and Boehmeria cylindrica. This is bordered by a narrow (10-foot wide at the widest) crescentric zone of a

III Sedge Association consisting of:

1. Homalocenchrus oryzoides society, with the associated species of Sparganium eurycarpum, Sagittaria latifolia, Carex sparganioides, C. frankii, Hibiscus moscheutos, Peltandra virginica, Rumex crispus, Solanum dulcamara, Sium cicutaefolium, Cicuta bulbifera, Boehmeria cylindrica, Sciprus atrovirens, Convolvulus sepium, Oxalis cymosa, Panicularia nervata, Eupatorium perfoliatum, Mentha spicata abundant near the margin of the creek. This zone lies along the creek between the Willow and Typha zone. Near the head of the cove it merges into a mixed one of a

2. Homalocenchrus-Scirpus fluviatilis society which lies between the broad Typha covered belt and the ruderals.

Between the grass and sedge grass zones, 1 and 2, and the marginal border of trees is a zone which is occupied by a ruderal herb association composed of a variety of plants, several of which are generally found in cultivated fields or in much drier situations as along railway tracks, but which here grow on a mud flat closely associated with river bank and marsh plants. These are Equisetum arvense, Dipsacus sylvestris, Pastinaca sativa and several species of Labiatae.

IV Ruderal Herb Association.

1. Ruderal herb society. Viola papilionacea, Erigeron annuus, Dipsacus sylvestris, Oxalis stricta, O. cymosa, Solanum nigrum, S. dulcamara, Equisetum arvense, Homalocenchrus oryzoides a straggler from the outer zone, Eleocharis obtusa, Juncus tenuis, Eupatorium purpureum, E. perfoliatum, Verbena hastata, Phleum pratense, Poa pratensis, Achillea millefolium, Angelica atropurpurea, Mentha piperita, M. spicata, Geum canadensis, Verbesina squarrosa, Teucrium canadense and Lysimachia numularia at the margin of the tree zone.

This society shows greater seasonal changes than the others. Early in the spring, Viola papilionacea is one of the dominant species, in the latter part of June it is difficult to determine which are the dominant species, for the larger, coarser and therefore more conspicuous plants as the Teasel, Verbena and Eupatorium are about half grown and not dominantly prominent. A month later they overshadow all the others.

V. Mesophytic-forest association: This association includes two very distinct societies. A Salix society which occupies the filled ground bordering the creek and at the head of the marsh and an Ulmus-Fraximus society bordering the lake and of the same type as the original swamp forest.

1. Salix society. A zone of willows borders the banks of the creek from the Typha zone to and into the cultivated fields south of the lake. At the edge of the Typha zone it is a narrow fringe of willows on the immediate banks of the stream, toward the head of the cove it broadens into a belt 50 feet wide on either side of the stream and finally merges into the tree border of the lake. Where it broadens it is open with scattered clumps of willows, shrubs and a luxuriant ground

cover of herbs. The ground is low and muddy but not distinctly wet.

Principal species

Salix nigra	S. alba

Secondary species

Trees:

Young Fraxinus americana	Ulmus americana
Juglans nigra	

Shrubs:

Rosa carolina	
Cornus stolonifera	Rubus nigrobaccus

Herbs, 7-8 feet tall:

Angelica atropurpurea

Herbs, 2-3 feet tall:

Teucrium canadense	Asclepias syriaca
Carex lurida	Juncus tenuis
C. lupulina	Homalocenchrus oryzoides
C. tribuloides	Scirpus atrovirens
Agrimonia parviflora	Lysimachia numularia
Geum canadense	Equisetum arvense
Apios apios	Achillea millefolium
Roripa palustre	Dipsacus sylvestris
Impatiens biflora	Verbena hastata
Rumex crispus	Festuca elatior
Iris versicolor	Phleum pratense

These herbs lack the correlation of distinct societies but Mentha spicata and M. piperita show well defined social unity and may be regarded as herb societies ranking as subordinate members in the forest zone.

The original margin of the lake is outlined by a zone of forest trees, 20 to 30 feet wide and which terminates abruptly at the margin of the cultivated field on the south. This zone is represented by an

2. Ulmus-Fraxinus society

Principal species

Ulmus americana	Fraxinus americana

Secondary species

Trees:

Fraxinus nigra	H. minima
Gleditsia triacanthos	Salix nigra
Cornus florida	S. alba
Hicoria ovata	

Shrubs: Cornus stolonifera is quite abundant especially on the side towards the field but hardly forms a definite shrub zone; there are also Sambucus canadensis, Rubus nigrobaccus and R. occidentalis with Rhus toxicodendron on many of the trees. Herbs much the same as in the Willow zone. Glechoma hederacea and Poa pratensis form the ground cover at the western margin.

The east bank of the creek is a duplication of the west except that there is a pure society of Scirpus lacustris bordering the open channel.

This section is rather unique and only partially typical of the vegetation of the coves. Compared with the marsh farther west and the marsh borders of the larger islands, it lacks that unbroken zonation and graduated layering which is usual. Beginning with the outer margin and passing through the Typha zone the succession is normal, layering graded from the semi-aquatics with floating leaves not raised above the water surface, to Nymphaea standing from one to two and one-half feet above the surface, then the Scirpus and Nelumbo lutea with plants quite uniformily three feet tall, and finally the Typha zone which rises five to six feet above the water level. The

Hibiscus and Shrub zones of the southwestern border and islands are wanting but in their places are the Scirpus and grass zones of lesser height, these are followed by the weed belt in which because of the lack of definite organization among the plants, well defined layering is wanting. The weed zone is very likely due to to the close proximity of the cultivated fields and to the fact that these mud flats are pastured.

Honey Creek is one of the principal feeders of the lake, but the water is generally so sluggish that but little current is perceptible and the channel is so narrow that the lake receives but little water from this source.

The other important tributary to the lake is the southwest feeder near Millersport, but this is in a condition similar to that of Honey Creek. The principal source of water supply seems to be that derived directly from rainfall. Engineer Bootin complains that it is difficult to keep the water level uniform. It falls very rapidly during the summer; as much as 4-5 inches in a week, altho but little water is permitted to run out.

The long narrow southeastern lobe of the lake from the mouth of Honey Creek to Thornville Station at the southeastern extremity is rapidly being filled with vegetation and presents the aspect of a marsh with but few clear areas. Thru its center from northwest to southeast is a boat channel but 3-5 feet wide and not more than 3 feet deep. The marsh includes several small low islands, a few of the larger with trees. Thornville Station is built on a little promontory between two lobes of the marsh. The western one extends to the Zanesville and Western tracks, where it ends in a wheat field. The eastern one is shorter, extending east to the Shawnee Branch of the Zanesville and Western railroad, and south to the southern limits of the town. The vegetation of the western lobe is mostly Potamogeton sp., Ceratophyllum demersum, Batrachium tricophyllum, Lemna trisulca and Spirodela polyrhiza with Typha latifolia along the shore. The eastern lobe bears a dense mass of Nymphaea advena, with Scirpus lacustris and Potamogeton sp. The lobe is fringed by willows.

The highway passing thru the northern edge of the town crosses the marsh on an embankment with a culvert to permit the passage of the boats.

On the east and northeast in the vicinity of Avondale the shore is bordered by rock hills deeply drift covered. These hills descend abruptly to the lake and are separated by large wooded ravines, the valleys of wet weather streams.

Many of these ravines are broad, open and low at the foot

Fig. 10.—Marsh at foot of ravine near Avondale, east side of lake. Typha and Sagittaria in the foreground. Hibiscus dominant in the center, with Phragmites and Zizania in the distance.

where they join the lake. The low, open stretches contain shallow water in which a dense marsh growth has formed, as shown in (Fig. 10) where Hibiscus moscheutos, Phragmites phragmites, Zizania aquatica (Wild Rice) and Typha latifolia are the most conspicuous plants. The shore between the ravines is bordered frequently by forest trees, willows at the water's edge, where, undisturbed by the presence of docks and boat landings there has developed a luxuriant growth of fixed acquatics. These are chiefly pure societies of Nelumbo lutea. Fig. 11 is a view of the shore near Avondale. The sudden transition from a broad zone of Nelumbo lutea to the willows, which is due to deeper water along shore is strikingly shown.

The tracks of the Baltimore and Ohio railroad parallel the shore from Thornville Station to Avondale, the roadbed lying near the base of the hills. The wagon road runs for half a mile upon the summit of this ridge of hills, the deep drift cover

Fig. 11.—View near Avondale. The sudden transition from a Nelumbo zone to the Willows is due to the absence of very shallow water and a mud flat at the shore line.

of which contains many granite boulders. This ridge broadening greatly toward the northeast was the watershed between the old Newark River to the north and Jonathan Creek to the east. The shallow water along the shore bears a rather irregular belt of marsh vegetation which is broadest and most luxuriant at the mouths of the ravines. From Avondale northward, groups of small, generally wooded, islands skirt the shore.

The lake extends into a long irregular arm to the north, the broad, open valley of a former stream. This northern area is very marshy especially along the low, flat west and north shores. The southeast shore is higher, and is part of a land area rising to 920 feet and almost encircled by the marsh. The western half is wooded, the eastern is a cultivated field.

The north shore of the lake from the northern lobe to Cranberry Island is low and marshy and bordered by fields. The bank along the field just north of Cranberry Island is from 6-8 feet high with a steep gradient; at the water's edge is a scanty growth of Nelumbo lutea with Castalia tuberosa and Ceratophyllum demersum. On the slope is a mixed association of Polygonum emersum, Scirpus fluviatilis and Typha latifolia at the base and Hibiscus higher up. Beyond the Hibiscus is a mixed growth of Lactuca canadensis, Erechtites hieracifolia, Verbena hastata, Echinochloa walteri, Afzelia macrophylla, Impatiens biflora, Mentha canadensis, Bidens cernua and Solidago canadensis. A fragmentary shrub zone is in the process of formation. It is represented by a few Sambucus canadensis, Cornus stolonifera, Cephalanthus occidentalis and Rosa carolina shrubs. Beyond the shrubs is a well-trodden path at the edge of the field. A Fraxinus americana and Ulmus americana stand at the water's edge, a Quercus rubra stands on the bank.

West of this field is a wood, 10-12 acres in area, of large Fagus americana, Ulmus americana, Prunus serotina, Acer saccharum, Hicoria ovata and Fraxinus americana. The center of the woodlot is about 8 feet above the lake. The shore slopes very gradually under the water. In late summer a mud flat several feet wide is exposed which is sparsely clothed with a characteristic flora of Heteranthera dubia, Eleocharis acicularis, Bidens cernua, B. comosa and B. discoidea.

The channel between Cranberry Island and the north shore is narrow, shallow and contains stumps and logs and several small islands. The cove to the west is almost filled with a Lotus bed bordered along the shore by a narrow Sedge-Hibiscus zone.

To the west is a rather bold promontory called the "Point." It is grass-covered except a few elms, wild cherry and willows at the water's edge. The shore of this point is exposed to west winds and to the washing of the waves. As a result a small beach began to form around the southwest corner. The drift bank was undercut by the waves, the clay was carried away and the gravel deposited at the foot of the bank. In the winter of 1910 and '11 a cement wall was built around the point to protect it from being washed away. This cement wall extends to the bridge which spans the entrance to Crane's pond, thus protecting Crane Island, a low, wooded tongue of land, from wave erosion. Crane Island is no longer surrounded by water. It is only partially separated from the Point by a narrow, swampy cove. Crane pond now deepened and used as a bathing pool and encircled to the north and south by boat houses, is merely an arm of the lake and was until recently, a swamp in which Typha latifolia and Nymphaea were the dominant plants. To the north of the pond is a low, wet wood. A small stream formerly made its sluggish way from the wood thru the meadow into the lake. The wood and meadow are being drained and rapidly occupied by cottages. All of the shore along the "Park" is occupied by public and private docks which precludes the presence of vegetation. The Park itself, formerly a low, wet wood, has been drained, many of the trees sacrificed, and the area now contains many buildings. It is the lake terminal of the Columbus, Newark and Zanesville electric road.

At several points along the eastern and northern shores, small beaches not more than a few feet wide and from 3 to 30 feet long, are in the process of forming. These beaches front exposed points of somewhat elevated areas, with a steep gradient to the water. Due to the action of waves, wind and rain, they are becoming denuded clay banks. Where the land is pastured the trampling of the cattle going to water greatly accelerates the aggrading. In every case the soil falls into the water, the clay is carried out and the sand and gravel are deposited at the foot of the bank. The absence of a marginal zone of aquatics is characteristic of these beaches.

THE ISLANDS IN BUCKEYE LAKE.

The islands of Buckeye Lake number fully fifty and vary in size from a mass of peat a few feet square to Cranberry Island with an area of approximately 45 acres. According to the manner of formation they may be placed in five classes.

I. Cranberry Island stands in a class by itself. It is a Sphagnum peat bog, which by the character of its flora and from the study of soundings shows that it antedates the lake and perhaps the Big Swamp.

II. There are about 20 islands, all tree covered ranging from Circle Island with an area of one-fifth of an acre; (there may be smaller ones) to Lieb's Island, 33.59 of an acre in area. Many of them are used as dwelling places. These were elevations in or were beyond the original swamp, and have never been submerged. They all bear large trees which are more than eighty years old, the age of the present reservoir.

III. Islands built on a foundation of exposed peat masses. During the latter part of every summer when the water has become thoroughly warmed and when the level is always low, masses of peat rise to the surface. The warming of the gases generated in the peat cause it to rise and at low water it soon becomes exposed. The surface is speedily covered with vegetation. Some of these peat masses remain permanently exposed; then shrubs and even trees gain a foothold in a few seasons and the peat mass becomes an island. Other peat masses are from time to time added to it and drifted logs lodged against it also help to build it up. Such islands are in their youth characterized by an aggregate of small masses with open pools between.

IV. Islands which have been built up in shallow water from the bottom of the lake.

V. Islands formed from the fragments of other Islands. During storm winds of fall and spring, a part of an island may be torn loose, drift with the wind until it is caught against a stump or logs or becomes anchored in shallow water. In the northeastern and southern parts of the lake are several islands evidently formed in this way.

There is evidence here and there of a sixth kind of island. Duck hunters build screens for their boats by driving willow stakes into the bed of the lake. These stakes sprout and if left undisturbed, will develop into a clump of willows around whose bases debris will collect and give rise to a composite vegetation. There is one such clump of sprouting willows just off the shore of the point. Evidently placed there to make a harbor for the boats.

I have made a detailed study of each one of these five classes of islands and shall give them here in order.

I. Cranberry Island.

The island locally known as the Cranberry Marsh, the Marsh, Cranberry Island or Cranberry Bog, lies in the eastern part of the lake close to and parallel with the north shore. Fig. (12). It is a long, irregularly shaped island, 3,250 feet long by 750 feet wide in its broadest part, and has an approximate area of 45 acres, according to the survey made in the winter of 1910 by Professor Chamberlin of the Civil Engineering Department of the Ohio State University. This is the only careful survey ever made of the island. The outline is very irregular due to many indentations and small fringing islands. This irregularity has been caused more by submergence and death of the trees, shrubs and other marginal plants, because of the frequent abrupt and extreme changes in water level, than to the growth and expansion of the island. Within recent years the island has been decreasing in size. The storms of winter every year detach fragments often of large size and sweep them away.

This island is a Sphagnum-Cranberry bog, and is of peculiar interest because, 1, its dominant vegetation composed of boreal species, is a relict of early post-glacial times left stranded in the swamp; 2, because Cranberry bogs are characteristic of regions of higher latitudes and this one is near the southeastern margin of the drift sheet; 3, because the bog, which must be

Fig. 12.—View of Cranberry Island from the west.

considered a relict of a former boreal vegetation is surrounded by a swamp of later formation and which belongs to the normal hydrophytic vegetation of the present climatic conditions;[59] and 4, because in the northern habitat, bog societies are usually related to conifer forests as a climax tree vegetation and the succession is unbroken thru the following zones: the pond or lake with 1, floating; 2, fixed aquatics; 3, the littoral marsh; 4, shore; 5, bog meadow; 6, low shrub or heath zone; 7, high shrub zone; 8, conifer forest which in some bogs is succeeded by 9, hardwood forest. In the cranberry bog the eighth or conifer zone is wanting and never seems to have been developed.

So far as I know, no conifer logs or other evidences of conifers have been found in the island, in the peat forming the bed of the lake or in the immediate vicinity of the lake, that is, within less than ten miles.

Altho the present Ohio forests are dominantly of the hardwood type, there are noteworthy remnants of former perhaps much more extensive conifer forests in the northwestern, northern and northeastern counties, especially those thru which the divide between the lake and Ohio River basins passes. Here were and still are, extensive Tamarack swamps. In the southern half of the State there are now no extensive conifer tracts, nor with one exception are the conifers dominant when associated with deciduous species but form always a scattering growth. Pinus virginiana occurs in the gorge of the Licking River in Licking County, on the sandstone hills in the valley of the Hocking in Fairfield and Hocking counties, and then follows the divide between the Scioto and Hocking rivers to the Ohio River; it also occurs in Scioto and Adams counties farther west. Pinus rigida is associated with P. virginiana on the sandstone hills of Fairfield and Hocking counties and occurs also in Jackson and Scioto counties. The Hemlock (*Tsuga canadensis*) has a scattering representation over the State, occurring quite as frequently in the southern as in the northern part. It is quite abundant on the hills of Fairfield and Hocking counties, where, however, it is but a small tree. It is also found in Greene, Morgan and Scioto counties.

The Arbor vitae (*Thuja occidentalis*) has been collected in the southern half of the State. In an interesting swamp near Springfield, Clark County, known locally as Cedar Swamp, this tree is the dominant one[19]. With it is associated Betula pumila. This is the southernmost range in the State of this northern shrub. In the gorge of the Little Miami near Yellow Springs, Greene County, the Arbor vitae is a fine, large tree. The Red cedar (*Juniperus virginiana*) is also more abundant in the southern than in the northern half of the State. It is generally distributed thru the southwestern counties and along the Ohio River as far east as Gallia County. The Larch or Tamarack (*Larix laricina*) seems to be entirely absent from the central and southern parts of the State. While Oxycoccus macrocarpus, the only Ohio species of cranberry, finds in this cranberry bog its southernmost range. Scheuchzeria palustris is another typical bog plant which seems to be rare in Ohio. In the history of Licking County,[33] the statement is made that the large peat bogs of the county were formerly cedar swamps. "The great peat bog along the north fork feeder in the outlots of Newark, was a cedar swamp and the bogs lie beneath and upon its surface." From personal inspection of the region here mentioned, and from conversation with various residents of Newark, I have not been able to verify this statement. Cedar Hill cemetery in Newark lies on a morainal ridge on which are a large number of cedars, both Thuja occidentalis and Juniperus virginiana. The ridge was forested but the cedars were planted since the beginning of the cemetery sixty years ago. Each person buying a lot, planted cedars, the Arbor vitae in a hedge around the lot. Later the hedges were abolished and the trees at the corners only preserved, which accounts for the present mathematical arrangement of these trees.

5. Because the bog in point of development is still in a state of fluctuation and has not reached a relative stability, a climax society. The bog forest towards which the island is

FIG. 13.—MAP OF

LEGEND OF PLANT ASS

I. Floating aquatics association.
II. Semi and fixed aquatics association.
III. Marsh association.
IV. Bog-meadow.

1. Sphagnum-Oxycoccus society.
2. Sphagnum-Oxycoccus-Dulichium society.
3. Sphagnum-Oxycoccus-Rynchospora society.
4. Sphagnum-Oxycoccus-Carex filiformis society.
5. Sphagnum-Oxycoccus-Carex interior society.
6. Sphagnum-Carex limosa society.
7. Dryopteris thelypteris.

:ANBERRY ISLAND.

:TIONS AND SOCIETIES.

8. Sagittaria latifolia.
9. Menyanthes trifoliata.

V. Gaylussacia-heath association.
I. Bog-thicket association.
I. Most mature areas of forest-shrub mixed association.

10. Typha latifolia.
11. Exposed peat with covering of Bidens sp. and other herbs.
12. Masses of dead timber.
13. Clumps of Decodon verticillatus.
P. Peltandra virginica in bog-meadow.
N. Nymphaea advena in bog-meadow.

tending is being invaded by oaks changing the bog to a mesophytic forest.[13]

The general character of the vegetation of the island is that of a bog meadow surrounded by a border of trees, shrubs and taller herbs, and this by a more or less complete marginal marsh zone. (Fig. 13) The surface of the meadow is interrupted by the presence of thickets of trees and shrubs, by Typha clumps and by open pools. The shrub border is also much interrupted by enclosed pools, marginal lagoons and coves.

A critical study of the flora disclosed the presence of the following associations.

I. Floating aquatics association.
II. Fixed aquatics with submerged leaves.
III. Semi-aquatic plants growing characteristically in shallow water from 5½ feet to emergence on mud flats at low water.
IV. Marsh association.
V. Bog-meadow association.
VI. Heath or low shrub association.
VII. Bog-thicket or high shrub association.
VIII. Bog-forest association.

I. Free floating macroscopic plants.

Spermatophyta wholly on the surface as the Lemnaceae, floating forms as Utricularia minor, Pteriodphyta as the Salviniaceae; Bryophyta as Riccia and Ricciacarpus together with Algae, the filamentous forms as Cladophora sp. and Spirogyra comprise the formation.

The association occupies the shallow water at the margin of the island and comprises the principal, often the entire vegetation of the pools both marginal and enclosed, whether these pools are in the shrub zone or in the bog-meadow.

These plants are associated in various societies whose differences expressed by the dominant species seem to be due to differences in the depth of the water and the light exposure.

The aquatic vegetation of rather small, more or less completely separated and isolated ponds do not form as clearly defined societies as aerial plants or aquatic plants in larger bodies of water where there are currents.[42] They must largely depend on the accidents of dissemination. However, the intensity of the light exposure is a strongly contending factor and in some cases the depth of water and nature of substratum determines the society.

This is well shown by Wollfiella floridana which forms an almost pure society in one of the small pools in the margin of the open Sphagnum zone, and while it does not occur at all in other small pools with exactly the same factors of environment, it does grow in a large shaded marginal pool wholly separated from the small pool and quite a distance from it. The plant is an invader from the south. Up to its discovery in Buckeye Lake it was not reported farther north than southern Missouri and finding its most congenial habitat in the bayous, lakes and ponds of the Gulf states. Buckeye Lake is visited every spring by large numbers of ducks who stop here to rest and feed in their northward flight. The small fronds of Wollfiella must have been clinging to the feet of some of these ducks and were washed off in the small pools in which they were discovered. Later they were carried in the same way to the larger pond. However, after accidental dissemination has taken place, the plant will grow or not grow according to whether or not the habitat be a congenial one, and will form societies with others to which the same environment is congenial, that is, those to which the conditions are suited will survive and flourish and those to which conditions are unfavorable will remain of secondary importance or succumb entirely.

Association I is composed of the following societies:

1. Lemna-Spirodela society
2. Utricularia minor society
3. Wollfiella floridana society

4. Nostoc society
5. Riccia fluitans society

1. Lemna-Spirodela society

Principal species

Lemna trisulca
L. minor
Spirodela polyrhiza

Secondary species

Cladophora sp.
Wollfia columbiana
W. punctata

This society covers the largest areas and occurs most frequently. The surface of the larger pools and marginal lagoons is characteristically covered wholly or in large part with a mat of Lemna trisulca, L. minor and Spirodela polyrhiza; below this surface mat is a thick substratum, an almost pure growth of Ceratophyllum demersum which is in these pools the dominant and often only species of the II association. It is almost impossible to wield the oars in the thick tangle of Ceratophyllum. Wollfia columbiana is not widely distributed but occurs in several marginal pools in the east side. The fronds are so minute that it is seen with difficulty.

2. Utricularia minor society

Principal species

Utricularia minor

Secondary species

Riccia fluitans
Lemna trisulca
L. minor
Spirodela polyrhiza.
Spirogyra sp.
Nostoc sp.

This society is not found in exposed situations, it occupies small, shallow pools in the open margin of the shrub zone. In several very shallow, open basins in a Typha latifolia tussock, excepting a scanty growth of Algae, the dominant and only clearly visible plant was Utricularia minor.

3. Wollfiella floridana society.

This plant is indigenous to sub-tropic regions and is found in swamps and pools of stagnant water often associated with Ricciocarpus natans. It was reported from Florida as early as 1877, later in 1896 it was found in a swamp in southeastern Missouri and up to the time (1906) of its discovery by Dr. W. A. Kellerman in the pool in Cranberry Island, the Missouri station was its farthest north. It forms an almost pure society in a small basin about 12-18 inches deep in the Bog meadow near the thicket border. Here it forms so copius a growth that the surface is filled with clusters of the small filamentous fronds. During the winter the plants sink to the bottom to rise again in the warm days of April.

4. Nostoc sp. society.

Several small, narrow pools, mere depressions in the Sphagnum cover, situated at the margin of the wooded belt and shaded by a border of Typha latifolia and lined with Sphagnum and Oxycoccus macrocarpus stems, contain a copious growth of Nostoc glomeratum and N. pruniforme. These pools were almost without standing water, September 23, 1910, and the Nostoc had collected thickly over the Sphagnum and the Oxycoccus leaves and stems on the sides and bottom of the pool. They had evidently been in this condition for several days as the exposed Nostoc nodules were soft and decaying; only those still submerged were firm to the touch and dark green.

5. Riccia fluitans society.

Many of the small, shallow depressions in the bog meadow at the edge of the thicket have during some years, as 1911, an almost pure growth of Riccia fluitans.

The vegetation of the pools shows a marked seasonal variation. The plants sink to the bottom during the cold season and rise to the surface and are most abundant during the warmer months of late summer and early fall. In July, 1910, a small depression, 1 by 2½ feet in diameter and 6 inches deep, on the north side of a clump of Alnus in the open zone contained an abundance of Spirogyra and scarcely anything else.

II. Fixed submerged aquatics.

This association is but poorly represented at the island's margin. Close to the shore and often among roots of trees and under dead trunks there is a sparce growth of Ceratophyllum with Potamogeton pusillus and P. pectinatus.

In the sheltered land-locked coves of the south and east side and in the larger pools within the bog, Ceratophyllum demersum forms a dense substratum. It is always underneath a cover of floating aquatics, Lemna trisulca, L. minor, Spirodela polyrhiza, and Wollfia columbiana. In some of the smaller pools in the bog meadow, Batrachium trichophyllum is associated with Ceratophyllum. In two other small, very shallow pools fully exposed to the light, Utricularia vulgaris is dominant.

III. Association of Semi-aquatics.

Semi-aquatics are plants rooted in the substratum and generally with leaves and flower stalks above the water. They may also have floating leaves as Castalia and Nelumbo. The latter, later in the season and especially in shallow water, lifts its leaves and blossoms several feet above the water surface. (Fig. 14) Nymphaea, Peltandra and Pontederia always bear their leaves well above the surface. This association grows in water 5½ feet deep in Buckeye Lake and from this depth to emergence on the shore.

There is but a scanty and fragmentary representation of this association as a marginal one in the immediate vicinity of Cranberry Island. Formerly Castalia tuberosa was quite abundant in the larger lagoons at the east side of the island, but for the past four or five years the water level in the lake has always been low during the winter and the Castalia has almost been eradicated, possibly thru freezing, or it may be thru the tearing up of the rhizomes. Other portions of the lake, especially the southeastern lobe, still show extensive lily pads. In a protected indenta-

FIG. 14.—A habit picture of Nelumbo lutea.

tion of the shore of the main land northwest of the marsh, there is a large patch of an almost pure growth of Nelumbo lutea which extends eastward to the small group of islands fringing the north shore of the bog. At the outer margin of the Nelumbo area are some Castalia plants. There are also some in sheltered coves on the east side of the island.

Associated with the Castalia and always present in appreciable numbers are several species of Potamogeton. In fact the semi-aquatic plants which have gained a foothold are mostly Potamogeton lonchites, P. natans, P. pectinatus, P. pusillus and P. foliosus, of these P. lonchites is the most abundant. The best development of the association is on the northwest and north sides where the water is shallow and where the irregularity of the shore line affords many sheltered coves. The association is spreading from the north shore of the lake toward the island and if not too much disturbed by the fluctuations in the water level, will no doubt soon fill this narrow and shallow water area. The south and southeast sides of the island extend abruptly into deeper water, and are also exposed to the full sweep of the wind. Here the fixed aquatic association is almost wanting along the margin. A few Potamogeton plants and Algae are in evidence close against the bank sheltered by the exposed Alder roots and Hibiscus stems.

There are small scattered Peltandra virginica societies in small, shallow depressions in the shore at the water's edge, all thru the thicket border and also in such depressions in the open bog. They are also a prominent part of the vegetation of the small islands skirting the shore of the bog. One such, north of the bog, is merely a rather dense growth of Peltandra virginica and Pontederia cordata growing on a slightly elevated mass of peat.

Nymphaea advena, another fixed aquatic tho quite abundant in other parts of the lake, is wanting near the margin of the bog; this makes the presence of the plant in a single small pool well towards the center of the bog-meadow all the more striking. (Fig. 25.)

The shallow coves on the northern, northeastern and eastern margins and all the larger lagoons on the east side have an abundance of dead timber chiefly Rhus, Alnus and Acer trunks.

(Fig. 15.) This indicates submergence due to settling of the peat. At low water the exposed peat bench quickly becomes covered with land plants. The extreme fluctuation in water level, 5-8 feet at times, 6.85 feet below the normal water level during the winter of 1909, has destroyed or at least greatly disturbed the fixed aquatics.

Fig. 15.—Masses of dead Rhus, Acer and Alnus at low water in a large lagoon on the east side of Cranberry Island.

III. Vegetation of the shore.

A typical reed association, frequently the bordering zone of bogs, marshes and swamps, and well developed in other portions of the lake, is here but imperfectly formed. Typha latifolia is present in considerable numbers. The relative position of these species in the association, especially with reference to the depth of water, is also subject to variation; so it seems to me, that here, rather than a zonation of swamp societies is an

FIG. 16.—Cove southeast side of Cranberry Island. Typha latifolia is dominant at the head of the cove with Decodon verticillatus at either side on the more exposed outer margins.

alternation or even mixture of several societies of the shore and semi-aquatic associations. Sometimes Peltandra virginica grows in the water at the outer border and again it occupies the center or even the inner margin of the zone. Thus it is with the other species present.

In the more sheltered waters along the north shore, and everywhere at the head of small coves, Typha holds a conspicuous place at the water's edge, while the more exposed apices of points of land extending into the water are covered by clumps of Decodon verticillatus, whose long, pendulous branches extend in all directions. (Fig. 16.) When they touch the water or mud, the nodes at the point of contact develop roots and anchor the shoot; the free tip elongates and the result is a Decodon shrub established sometimes 3-4 feet distant from the parent plant. Decodon is best adapted to reaching out and extending the margin of vegetation several feet in advance. The large, thick root stalks and fibrous roots of Typha serve well to gain a foothold and thus prevent the soil from washing away and by the accumulation of the large stalks and leaves build up the surface level.

Often the marsh zone is invaded and crossed by the thicket. Then Rhus and Alnus shrubs or even maple trees grow at the extreme edge of the island, their roots exposed or under water.

At other points the marsh extends thru the thicket; or if the latter be wanting, into the bog-meadow in tongues or isolated patches. The larger pools in the bog are bordered by a fringe of Typha latifolia, Decodon verticillatus and Hibiscus moscheutos. (Fig. 17.) Sometimes small depressions hold one or a few Peltandra virginica or Nymphaea advena plants. Sagittaria latifolia is becoming very abundant in the southwestern portion of the bog-meadow.

The characteristic species of the marsh zone are Typha latifolia, Decodon verticillatus, Peltandra virginica, Hibiscus moscheutos, Dianthera americana and Rosa carolina. In early summer the clumps of Rosa make a rose garden of the swamp;

later this is changed to a rose mallow garden by the large rose-colored bells of Hibiscus moscheutos.

Associated with these dominant species is a large number of plants, additions to which are made from year to year by the successful ecesis of invaders from nearby regions. The secondary species of the marsh zone are in large part also the associated species of at least the outer portion of the thicket association, due to the invasion of the marsh by the shrub zone. Altho in general the water level is not as high as in the marsh, the surface is broken by innumerable small pools and depressions between the clumps of ferns and roots of shrubs, and there the marsh plants find sufficient water.

The most marked difference between the two associations is in the light exposure. In the deeper shade of the thicket many of the marsh plants as Impatiens biflora and Triadenum virginicum, tho numerous, are small and weak and do not blossom.

The secondary species of the marsh association given in general in the order of their abundance are as follows:

Impatiens biflora is generally distributed thruout the formation. When growing in full light exposure at or very near the water's edge, it is tall and vigorous and generally covered with Cuscuta gronovii which also grows luxuriantly on Decodon. Solanum dulcamara grows in detached masses over shrub's and herbs or roots at the outer margin of the zone, the long branches hanging down to the water. It is a very conspicuous plant in the late summer and autumn with its numerous clusters of bright-red berries.

Three species of Bidens, Bidens cernua, B. discoidea and B. frondosa grow at low water on the shelf of exposed peat. Bidens cernua and B. discoidea grow even in shallow water. In a remarkably short time after masses of peat have risen above the surface, they are taken possession of by one or several of these species of Bidens and the unsightly peat mass shortly becomes a varitable carpet. Echinochloa walteri is frequently associated with the Bidens. They take possession of every rotting stump and log as soon as it comes above the surface.

Fig. 17.—Pool south side of Cranberry Island, with a dense border of Typha latifolia, Decodon, Dryopteris, Peltandra virginica and other marsh herbs. The surface of the water is covered with Lemna trisulca and Spirodela over a dense mat of Ceratophyllum demersum.

Bidens trichosperma shows its brilliant yellow flowers at the margin of several of the smaller islands and with B. comosa is quite adundant on the long south lobe of the island. Roripa palustris is another plant which grows on exposed points or old root masses in the shallow water. Roripa americana and Cardamine bulbosa are frequent in the wetter portions of the more shaded border. Galium trifidum, G. asprellum, Scutellaria lateriflora and Campanula aparinoides are closely associated, especially on the long southern lobe. The tall panicled inflorescence and large leaves of Rumex brittanica are conspicuous features of the border where the water level is high.

Another plant growing in the water or at the margin of the island among Hibiscus and Typha is Polygonum emersum, an extremely abundant amphibian in the lake. Eleocharis acicularis forms a thick mat over small areas of exposed peat, on old root masses and often on the mud at the entrance to paths.

The following species are present in small numbers in often but one locality or they may be found scattered sparingly thru the swamp zone, sometimes they are even fairly abundant but not strikingly so. Sagittaria latifolia, Rumex verticillatus, Boehmeria cylindrica, Polygonum acre, P. cicutaefolium, Gerardia paupercula, Comarum palustre, Viola blanda, Carex decomposita, C. pseudo-cyperus, C. comosa, C. stipata, C. alata, C. vulpinoidea, Scirpus fluviatilis, Cyperus erythrorhizos, C. strigosus, Echinochloa walteri, Homalocenchrus oryzoides, Muhlenbergia racemosa, Calamagrostis canadensis, Panicularia nervata, Eragrostis hypnoides.

Typha angustifolia which normally grows in deeper water than at the very margin of the peat shelf, occurs in two situations at the margin of small islands forming the eastern portion of the bog.

Scirpus lacustris is wanting at the margin but there is a thin growth in small, shallow depressions in the bog-meadow.

Of the seventeen species of grasses and sedges which occur in the marsh zone, none are present in sufficient abundance to lend character to the zone. The majority are found as isolated plants or caespitose in only one or two situations and then generally at the extreme margin of the island or bordering a pool. Carex decomposita is new to the state list. It occurs here in two places, both on the east side of the island. The one is at the extreme water's edge at the base of a dead alder on a small island bordering the larger one, and the second is at the edge of a lagoon surrounded by the bog-forest.

During the fall of 1909 the long southern lobe of the island was cleared of trees and shrubs. During the following spring and summer the area was covered with an exceedingly dense growth of Alnus, Rhus, Salix and Acer shoots from the old stumps together with a very large number of herbs, which with the stronger light exposure had a much better chance to grow. A large number of sedges and grasses grow in this cleared area, and since it is open to invasion, certain plants were found growing here that could not be discovered anywhere else on the island. Dianthera americana grows in such masses on the western border of the lobe as to dominate the zone over a small area. Last August two plants of Onagra biennis were found among the branches of a fallen maple. This lobe was formerly wooded to the water's edge at the south end with but a narrow swamp border on the west and east sides. The water is quite deep just to the south, and if the maps of the survey of 1801 and 1799 are correct, the bog was nearest the margin of the old lake at this point. Aquatic plants are almost wanting.

V. Bog-meadow association.

The greater portion of the island is a Sphagnum Oxycoccus bog, of which everywhere the dominant plants are several species of Sphagnum and Oxpcoccus macrocarpus. (Fig. 18.) These two are nearly always associated with other plants in such numbers as to form characteristic societies with them.

The bog-meadow corresponds to the High moor or Heidemoore of Europe as described by Warming, [63] Schimper, [52] Gräbner, [32] and Früh and Schröter.[28] It is a formation according to these authors, characteristic of high temperate latitudes where the low temperature, abundant moisture with the exclusion

Fig. 18.—A characteristic view of the bog-meadow, Cranberry Island. The cranberries are fruiting freely. In the distance are shrub invaders chiefly Rhus vernix and finally the shrub border.

of oxygen, and the acidity of the bog substratum permit a large accumulation of peat. The water of the Heidemoore is characteristically poor in mineral salts expecially lime, and rich in organic matter to which the dark color and the accumulation of gases as methane and hydrogen sulphide is due.

It is said to be a formation poor also in available nitrogen compounds, for the nitrogen tho present in abundance in the organic matter, is in the form of insoluble proteins "Humificirte Eiweisskoerper"; and unless decomposed by mycorhiza and bacteria cannot be used by the higher plants. Neither the low soil temperature of high latitudes, the acidity of the bog water, the low per cent nor the character of the inorganic salts present, play, however, as important a role in determining the character of a bog flora as has been until recently claimed.[17]

In the Cranberry bog the temperature of the peat substratum during the spring and summer is not lower than that of other soils, and is more uniform than that of the air. The living portions of stems and roots extend but a few inches below the surface of the soil which is saturated with or covered with water and consequently has a less variable temperature than that of the overlying air. And altho Sphagnum bogs find their optimum development in high temperate latitudes, being rare in arctic regions and rare as far south as 40° north latitude they are not unknown in lower temperate latitudes and even in the subtropics. Harper[36] reports Sphagnum bogs in Florida; and in discussing the formation of peat in Florida swamps and bogs, says: "High temperature alone would hardly prevent the formation of peat where the humidity and topography were favorable. The scarcity of peat in the humid tropics where vegetation is so luxuriant can probably be explained on topographic grounds."

The notion prevalent until two or three years ago that the formation of peat is inhibited in the humid tropics by the high temperature is due to the lack of discovering peat in the tropics and not to its absence. Potonie[18] reports the discovery of typical peat in a bog forest in the island of Nusa Kambangan in the province of Banjumas, Java.

The statement is frequently and positively made that Sphagnum will not grow in the presence of lime (calcium carbonate) and that the presence of Sphagnum is an indication of a low per cent or the absence of lime. Sendtner states positively that when Sphagnum is brot in contact with water containing lime it dies. Gärbner[39] finds the contrary. He watered Sphagnum cultures with lime-water and when the experiment was continued under normal conditions, the plants did not die; but on the contrary grew well. They even after a winter's duration grew well in the following spring. Weber grew various species of Sphagnum in pure lime. These experiments demonstrate that altho Sphagnum normally grows in lime-free soil or with but a low per cent of lime, the presence of lime is not fatal. In the upper peninsula of Michigan about 6 miles west of St. Ignace is a Sphagnum bog in which Chara, an alga which frequents water containing lime, and Sphagnum grow side by side. Calluna vulgaris, an Ericad characteristic of High moor formations in Europe, grows in lime-free soil but also occurs in lime soil in great enough abundance not to be accidental.[39]

That a bog is an ecological vegetation unit under conditions of physiological drouth to which is due the xerophilous character of the flora, is now generally accepted; but not until recently has it been discovered and demonstrated that the unavailability of the water is due to the decomposition products of microorganisms in the soil.[17] These products are toxic to the plants, check root absorption and are instrumental in the development of structures characteristic of xerophilous plants.

Sphagnum is the dominant plant in the bog-meadow; and in this locality the recognized peat builder of the present upper stratum. Its habit of growth and structure adapt it well to the continued development of the shoots above the accumulation of dead Sphagnum. According to Reichart a Sphagnum frond continuing to grow at the apex while it is dying beneath may attain to the age of our oldest trees. No roots nor internal conducting systems develop but the elongated hyaline cortical cells of the stem and branches, and the hyaline cells of the stem and branch leaves offer a system of capillaries thru which water is readily conducted. At every fourth stem-leaf a fascicle of branches from 2-3 inches long, tapering and very slender hang down, close appressed to the stem, around which they form an absorbing and water-conducting mantle. The leaves of both stem and branches are but one layer of cells in thickness. They are convex, imbricated and closely invest the axis, forming thus narrow spaces thru which water passes by capillarity. The hyaline cells of stem and leaves act as water reservoirs; they are large, elongated cells whose walls are strengthened by spiral thickenings. The close massing of the fronds contributes largely to the sponginess of the Sphagnum turf.

The capacity of Sphagnum for absorbing water is enormous. Lesquereux found that air-dry Sphagnum in contact with water absorbed seventeen times its own weight. Dueggeli obtained results of 18.5 to 22.96 times the weight of Sphagnum. Because the external cells so readily absorb and conduct water, the plant is independent of a water supply from the soil and the shoots continue to live and grow. The result is a characteristic elevation of the surface of the bog from the margin to the center, giving rise to the term High moor of the German writers. Schimper[52] states that the center may lie four meters higher than the border. Ganong[29, 30] made a similar observation on peat bogs in New Brunswick which were from 14-15 feet higher in the center than at the margin and still rising.

In Cranberry Island the meadow is so interrupted by masses of shrubs that this uniform elevation does not occur; but it is noticeable in smaller areas. The Sphagnum has built up hummocks or little mounds from 3 to 6 or 7 decimeters (12-24 or 32 inches) high around the base of isolated shrubs, clumps of ferns, the border of a thicket and the margin of small pools, and in some areas as in the northeastern portion of the meadow, these hummocks are very frequent where there are no shrubs.

The Societies of the Meadow.

Certain small areas contain an almost pure Sphagnum-Oxycoccus society (indicated on Fig. 13 by 1) and forming a banked up narrow border surrounding the large masses of thicket. All other areas are dominated by one or two other plants, in most cases a sedge, taller and more conspicuous than the cranberry or sphagnum. These societies altho quite clearly differentiated the one from the other, at their centers where the dominance prevails, blend at their margins so that the secondary species of all the Sedge-Oxycoccus-Sphagnum societies are the same and will be listed together. The societies are:

1. Oxycoccus-Sphagnum:—A pure society of the two dominant species, Oxycoccus macrocarpus and Sphagnum cymbifolium is rather rare, and covers but a small area of the entire bog-meadow. In the broad, open stretch of meadow towards the northern border there are areas from ten to fifteen feet square which have but a scanty intermixture of other plants. The water level is not high and the Oxycoccus is at its optimum. The plants are not unusually large but they flower and fruit freely. The borders of thickets have an almost pure growth of this society, showing the characteristic banking. In the shade of the shrubs the Oxycoccus quite hides the Sphagnum thru its luxuriant growth but it is uniformly sterile. Towards the western end of this open meadow, Sphagnum cymbifolium is being largely replaced by the small, closely set, reddish fronds of Sphagnum acutifolium versicolor. The plant is conspicuous in the late summer and fall when the fronds are most highly colored.

The Oxycoccus-Sphagnum society is most strikingly a seasonal one. During the spring months of April, May and early June, the sedges have not attained their full development and are consequently not as prominent as later. This is well illustrated by Eriophorum virginicum. The Eriophorum is very conspicuous in the late summer and fall.

2. Oxycoccus-Sphagnum-Dulichium arundinaceum society: (Fig. 19). Dulichium arundinaceum is an extremely widely disseminated sedge, it is not only very abundant in the meadow but also frequent in the thicket and bog-forest. It is clearly a dominant species over noticeable areas of the meadow. The pro-

Fig. 19.—Oxycoccus-Sphagnum-Dulichium arundinaceum society. In the distance to the right Eryophorum virginicum, in the center and to the left Osmunda cinnamomea with the strict habit typical of this plant in the open bog.

minently three-angled stem thickly set with divergent leaves are characters which clearly distinguish it from the other sedges.

3. Oxycoccus-Sphagnum-Rynchospora alba society:—Rynchospora alba favors parts of the meadow with high water level. It is frequent in the wet paths and other shallow depressions of the meadow.

4. Oxycoccus-Sphagnum-Carex filiformis society:—To-

wards the east side of the meadow adjacent to the thicket association in hummocky Sphagnum is quite an area of Carex filiformis associated with Oxycoccus macrocarpus and Sphagnum cymbifolium. Its characteristic tall slender culms and filiform involute leaves are in sharp contrast to the sedges of adjacent societies. There is a similar area on the southwest portion of the island.

5. Oxycoccus-Sphagnum-Carex interior society:—Carex interior, a slender narrow-leaved low plant with strongly marked caespitose habit, is the dominant sedge in areas near the shrub border.

6. Sphagnum-Carex limosa society:—In a small shallow pool not more than 40 square feet in area, on the north side of the meadow is an almost pure growth of Carex limosa. The bottom and sides of the pool are lined with Sphagnum acutifolium. Carex limosa has here the prostrate creeping rooting-at-the-nodes habit of C. chordorrhiza. Carex limosa occurs in abundance in also another portion of the meadow under quite different conditions. The Sphagnum is very hummocky, there are numerous shrubs, other sedges as Dulichium, Rynchospora and Eryophorum, also Menyanthes trifoliata and Pogonia ophioglossoides. The Carex flowers and early matures its seeds; the brown pendulous spikes are quite unlike those of any other sedges associated with it. Later, after the seeds have fallen, the spikes disappear and then the presence of Carex limosa can scarcely be detected among the other plants.

Eryophorum virginicum (cotton grass) tall and particularly striking in late summer when the inflorescence is a white plumose mass, is also very abundant especially in the Dulichium and Rynchospora societies.

In the southwestern portion of the island, where marginal coves are large, inland pools numerous, and the water level is generally high, Dryopteris thelypteris associated with Oxycoccus and Sphagnum cymbifolium and S. acutifolium covers quite a large area of the open bog.

In the same portion of the island, but closer to the pools, Sagittaria latifolia has become very abundant.

Secondary species occurring in the above six societies of the bog-meadow are:

Aster paniculatus	Triadenum virginicum
Dryopteris thelypteris	Dulichium arundinaceum
cristata	Rynchospora alba
Osmunda cinnamomea	Eryophorum virginicum
regalis	Drosera rotundifolia
Sagittaria latifolia	Menyanthes trifoliata
Eleocharis obtusa	Scheuchzeria palustris
Scirpus cyperinus	Carex interior
Peltandra virginica	filiformis
Juncus brachycephalus	limosa
effusus	leptalea
canadensis	stricta
Cephalanthus occidentalis	Pogonia ophioglossoides
Viola blanda	Calopogon pulchellus
Habenaria leucophaea	Arethusa bulbosa
Seedling Rhus vernix	Decodon verticillatus
Seedling Acer rubrum	Scutellaria lateriflora
Seedling Alnus rugosa	Solidago uliginosa

Many of these are of general distribution, others are more local, some are more characteristic of the thicket border and have strayed out into the meadow; they are found, therefore, near the edge of the thicket. Drosera rotundifolia is a typical bog plant and is quite generally distributed but it is most abundant towards the southern end of the meadow. Menyanthes trifoliata and Scheuchzeria palustris also are of general distribution and grow best where water covers the surface. They are most often found, therefore, in shallow depressions, in pools and where the trampled paths are under water. The three orchids, Pogonia ophioglossoides, Limodorum pulchellus and Arethusa bulbosa when in blossom, are the most attractive plants in the meadow. All three are more common near the shrubs in the margin of the meadow close to the thicket border. One specimen of Habenaria leucophaea was found in the summer of 1910 in the extreme southwestern portion of the meadow close to the shrubs.

In the southwestern part of the meadow are numerous shrubs scattered singly or in groups; among these Dryopteris thelypteris is very abundant. It is an invader from the shrub zone. It occurs in other portions also where there has been a general invasion from the shrub zone. Osmunda cinnamomea and

Fig. 20.—Osmunda cinnamomea in the open bog-meadow. The strict habit and stunted leaves are typical.

O. regalis are also invaders from the shrub zone. Of the two the former is the more abundant and more generally distributed. The greater number of the Rhus and Alnus shrubs in the meadow are surrounded at the base by this fern. The presence of these three ferns in the open bog is clearly a case of endurance and not of congenial habitat and is a striking illustration of the difference in the intensity of illumination and the greater satura-

Fig. 21. Osmunda cinnamomea in the margin of the shrub zone. The large spreading fronds are in strong contrast to the strict habit shown in Fig. 20.

tion deficiency of the air of the open bog as compared with the thicket. Out in the open the fronds are small and stunted and held rigidly erect with pinnules folded and pinnae pressed against the rachis. (Fig. 20). In the margins of the shrub zone, the tall spreading fronds attain their maximum growth with pinnae and pinnules expanded to their fullest extent. (Fig. 21). All the plants of the bog-meadow show adaptation or adjustment to the more xerophytic habitat; but the ferns offer the most striking example. Peltandra virginica, a marsh plant, occupies small pools in the central bog. These pools at normal water level are nearly full of water, the walls are closely covered with Sphagnum which grows down to or even below the water. On such moist banks as these Viola blanda is enabled to invade the bog. In the fall when the water is low, the pools are almost free from standing water and contain the dead decaying Peltandra leaves and the large fruit clusters. In one such depression on the west side of the meadow are thrifty Nymphaea advena plants. (Fig. 25).

V. The Gaylussacia heath or low shrub association.

The heath association is of the low shrub character of vegetation. In a typical bog the characteristic plants of this association are low shrubs of the Ericaceae and Vacciniaceae families as Gaylussacia resinosa, Andromeda polifolia, Chamaedaphne calyculata, Ledum groenlandicum and Potentilla fruticosa, of the Rosaceae associated with Sphagnum sp. and often with Rubus hispidus as a ground cover. These form a dense, compact, almost impassable stratum. This association is almost wanting in Cranberry Island. There are a few small clumps of Gaylussacia resinosa, which are with two exceptions just at the inner margin of the shrub zone or entirely within this zone. (Fig. 22.) The two exceptions are two small groups of Gaylussacia in the open meadow (Fig. 13 V). The shrubs are stunted and did not blossom in 1910. They have blossomed freely during the spring of 1911. The heath is spreading quite rapidly but is still mostly confined to the shrub zone. The association is composed of but one society, the Gaylussacia society, in which are no other species of the heath association; but Sphagnum cymbifolium, S. acutifolium var. versicolor, and Oxycoccus macrocarpus, species of the bog-meadow and Alnus rugosa and Aronia arbutifolia of the bog-thicket occur.

VI. Bog-thicket association.

The bog-thicket zone is the most conspicuous feature of the island. The bog-meadow is surrounded on all sides by the thicket

Fig. 22.—Gaylussacia resinosa society at margin of and extending into the thicket. The belt transect Fig. 26 was taken through this society.

and trees. From all approaches the island presents the appearance of being densely wooded. It is the most gregarious and complex association, being composed of characteristic bog plants as Rhus vernix, Aronia, Ilex, bog ferns and mosses, together with a large addition of swamp species as Rosa carolina, Peltandra virginica, Triadenum virginicum, Impatiens biflora and others; besides these, Alnus rugosa is very abundant. There are many invaders from without, some of these remain and so from year to year the association receives additions to its flora. This is partially due to the position being a marginal one. In this it resembles the marsh but the greater shade afforded seedlings by the shrubs seems to protect them from excessive transpiration. Winds carry seeds from surrounding areas, the marginal thicket serves as a wind break and many of the seeds do not reach the central zone. Other seeds are transported by water currents and become lodged on the peat shelf among the exposed roots at the margin or may be washed farther in. The trees and shrubs offer a resting place for the birds; and the fruits and seeds they carry are dropped among them. The seedlings of Quercus palustris, Q. imbricaria and Fagus americana can only be accounted for in this way.

The position of the thicket is unique in that it lies between the marsh and meadow. In many bogs the meadow is wanting; where it is present, it is generally a sedge-grass meadow and intervenes between the shore vegetation and shrub zone. The normal order of succession seems to be:

1. Floating aquatics.
2. Fixed aquatics, submerged or with floating leaves.
3. Marsh.
4. Meadow.
5. Low shrub or heath.
6. Thicket.
7. Forest.

This succession has not developed uniformly on Cranberry bog, for the thicket has invaded the marsh zone on the one side and the bog-meadow on the other; so that not only is the inner margin of the thicket quite irregular, but detached individuals and masses of shrubs have pushed into the meadow and are scattered all thru it. (Fig. 23.)

It is also difficult to draw a line of demarcation between the bog-thicket composed of shrubs and the bog-forest or even to distinguish a transition zone between them.

The dominant tree and the only one present in appreciable numbers and of mature age and size is Acer rubrum. Whereever the shrub zone is well developed this tree is also present. It has likewise invaded the meadow. All thru the latter, stunted straggling maples appear.

The bog-forest is just becoming established. In certain por-

Fig. 23.—View of bog-meadow, Cranberry Island, with shrubs scattered singly and in masses. Decodon verticillatus is here the most conspicuous but there are many half dead Rhus and Alnus and one Acer to the left.

tions of the wooded belt, Acer rubrum is present in such numbers and has attained such a size that it dominates the vegetation. Almost in the center of the island is one such area, another is in the wooded belt skirting the north shore, another and this is the most pronounced forest, is on the northeastern border of the island (Fig. 13 VII). Besides Acer rubrum a few other forest trees are becoming established. In the wood on the northeast is a young Quercus palustris about 25 feet tall. There are also a number of Q. palustris seedlings, and two, two-year old Q. imbricaria. Close to the water's edge is a young Prunus serotina. Quercus palustris seedlings were also found in the other forest areas. Associated with Acer rubrum and equally characteristic are Alnus rugosa and Rhus vernix. Both of these are small trees rather than shrubs where the environment is most favorable.

From readings taken from stumps, it is estimated that the largest maples are about 35 years old, they are about 50 feet tall and from 15 to 18 inches in diameter.

As the entire wooded zone is a blending of the two associations, forest and thicket, I shall treat of them as one. The dominant species of the entire wooded belt are Acer rubrum, Alnus rugosa and Rhus vernix. Other tall shrubs and small trees form with them a dense growth. Aronia arbutifolia and A. nigra are everywhere present. Ilex verticillatus is frequent at the more open margins. On the north, east and south sides, Cornus stolonifera forms conspicuous clumps at the water's edge. Also near the water but sometimes in the open bog is an occasional Cephalanthus occidentalis; Sambucus canadensis is not infrequent in the more open or central portion of the bog-forest. Scattered all thru the thicket border are the strong thorny canes of Rubus nigrobaccus. Rosa carolina and Decodon verticillatus, members of the marsh zone, occur also in the western portion of the shrub thicket. Salix discolor, the most abundant willow in the bog, occurs at the margin associated quite frequently with S. petiolaris. A low shrub layer is wanting but at a height of from 2.5-3 feet, the tall broad fronds of Osmunda cinnamomea form a dense stratum. In the more open regions of the shrub and forest zone these ferns have found optimum conditions for growth. The large branching rhizomes and strong leaf bases form hummocks which with the exposed roots of trees and shrubs form in many places the only dry spots in the zone. Where Osmunda is abundant the shade of the fronds permits no growth of vegetation underneath. The ferns form a green border just within the outer edge of nearly the entire wooded zone.

Other areas, generally where the taller trees are most numerous, bear a field or low herb stratum of sedges such as Carex interior, C. retroflexa, Eleocharis palustris, Dulichium arundinaceum and other low herbs such as Triadenum virginicum, which in the shade is low and sterile, Boehmeria cylindrica, Adicia pumila, Impatiens biflora, Cardamine bulbosa, Roripa americana, Comarum palustre, Dryopteris thelypteris, D. cristata, Habenaria lacera and H. clavellata.

Sphagnum sp. forms a ground layer which extends often to the marsh zone. In this are many Rhus, Acer and Aronia seedlings. Immediately beneath the larger shrubs and trees the ground often seems bare but scrutiny reveals a dense closely packed mat of a pure growth of Cephalozia and Pallavicinia lyellii or of Pallavicinia alone. These small Hepaticeae lie so firmly pressed against the ground and are often so dark in color that they have not the appearance of living plants. Scattered singly, in twos or in threes everywhere thruout the central portion of the zone is a small slender herb with pale green thread-like, angled, erect and rigid stems, 3-5 inches tall, with small scale-like leaves and slender spikes of small flowers, a most insignificant little plant, one of the Gentianaceae family, Bartonia virginica, which next to the dominant shrubs and trees, is the most characteristic and abundant plant in the association.

There are several large pools in the wooded zone; these are surrounded by marsh plants and bear the same pond vegetation already discussed.

Between the exposed roots of trees and shrubs and between clumps of ferns are small depressions filled with water. Bryophyta as Sphagnum sp. Polytrichum commune or P. ohioense, the water moss Brachythecium plumosum and Pallavicinia lyellii line the sides and bottom of these pools. Spirogyra and other algae float on the water or cover submerged leaves and stems. Viola blanda and Cardamine bulbosa grow in the water or on the margin. Some times such a pool is almost filled with long rhizomes of Rumex verticillatus or with Menyanthes trifoliata.

The following is a complete list of the plants of the bog-thicket and forest:

Dominant species.

Acer rubrum
Alnus rugosa
Rhus vernix

Secondary species:

Shrubs and small trees.

Aronia arbutifolia
atropurpurea
nigra
Ilex verticillatus
Cornus stolonifera
Salix discolor
petiolaris
sericea
Cephalanthus occidentalis
Sambucus canadensis
Rubus nigrobaccus
Decodon verticillatus
Oxycoccus macrocarpus

Herbs:

Osmunda cinnamomea
regalis
Dryopteris thelypteris
cristata
spinnulosa
Carex filiformis
interior
retroflexa
leptalea
Aster paniculatus
puniceus
puniceus lucidulus
Solidago uliginosa
Comarum palustre
Apios apios
Bidens trichosperma
comosa
Eryophorum virginicum
Triadenum virginicum
Impatiens biflora
Menyanthes trifoliata
Roripa americana
Cardamine bulbosa
Habenaria lacera
clavellata
Gyrostachys cernua
Boehmeria cylindrica
Adicea pumila
Polygonum punctatum
arifolium

Homalocenchrus oryzoides
Agrimonia parviflora
Geum canadense
virginicum
Cicuta bulbifera
Sium cicutaefolium
Erigeron canadensis
Erechtites hieracifolia
Scutellaria lateriflora
Lycopus virginicus
Mentha arvensis canadensis
Gerardia paupercula
Viola blanda
Echinochloa walteri

Ground cover.

Bartonia virginica
Sphagnum cymbifolium
parvifolium
acutifolium
Pallavicinia lyellii
Eleocharis acicularis
Amblystegium varium
kochii
riparium in small pools
Aulocomnium palustre on ground and in pools
Thuidium virginianum on base of tree trunks
recognitum on ground
delicatulum
padulosum
Pylaisia intricata on base of tree trunk.
Cephalozia connivena
lunulaefolia

These two small Hepaticae thickly cover small patches of ground in the tree zone in the northeastern part of the island. They are generally associated with Pallavicinia lyellii.

Brachythecium plumosum.
Spirogyra sp.
Naucoria paludosella

Badhamia papaveracea on leaf of Osmunda regalis and on a twig in a pool.

The entire island is in a condition of transition tending toward maturity as expressed in a mesophytic forest climax society of deciduous trees. This is shown in the forest zone by the invasion and successful ecesis of its most mature area, where the surface is driest and trees largest in the extreme eastern portion, by oaks, Quercus palustris and Q. imbricaria. In another portion of the forest zone two beech seedlings were found in the summer of 1910 but they have not survived.

There are also well marked invasions of one zone by another. The most advanced is that of the shrub-forest association into that of the bog-meadow. A survey shows that the meadow is dotted with numerous single maples, alders and Rhus; with small groups of a single species or two or three associated. Shrub copses and extensive tongues of the tree-shrub-border have invaded the meadow.

In the spring of 1910 there was an unusually heavy crop of maple seeds on the bog as elsewhere. These were disseminated everywhere. A very large number which fell in the meadow, sprouted and grew; so that during the summer of 1910 there were thousands of maple seedlings. The seedlings were counted in an area of 176.7 square feet in two distinct places; which showed a fair average. The one was to the north of a lobe of the thicket which encircled the area on the west, south, and east, leaving a northern exposure. The seedlings were thus shaded from the direct rays of the sun. In this area were 55 thrifty seedlings. The second area was out in the open, exposed all day to the sun and had been trampled over by cranberry pickers. There were no shrubs except two nearly dead Rhus. In this space were 110 seedlings. These seedlings have a poorer chance of survival than those in the more sheltered situation. Each year there are also many Rhus seedlings in the open bog. That these pioneers are not wholly successful is evidenced by the half-dead condition of the majority of the maples and shrubs; however, if but 1-2 per cent. of the seedlings reach maturity the bog-meadow will soon be a forest.

Besides the maples and shrubs there are numerous areas varying in size occupied by Typha (Fig 24), Peltandra, Sagittaria and Decodon stragglers from the marsh zone. These are laggards of the inhabitants of former larger marsh or pond areas.

Many of the smaller pools show the characteristic manner of invasion by the meadow. The depression may have but a plant or two of Peltandra or Nymphaea advena. (Fig. 25). The margin is banked up by the Sphagnum which grows over the edge and

Fig. 24.—Typha latifolia in the bog-meadow. A laggard from the marsh.

into the pool, often under the water, thus filling the depression from the margin to the water, raising the surface level so that the marsh plant can no longer survive.

In the northwestern part of the meadow the Sphagnum is dying in many places. The diseased portions vary in extent from a few inches to more than a foot in diameter and in degree from Sphagnum beginning to look wet, grayish and decayed to wholly dead and dried plants. I have not yet been able to satisfy myself as to the cause of the disease. It may be of fungoid origin or due to the mechanical breaking and crushing of the plants. This portion of the bog is frequented by hunters and cranberry pickers

FIG. 25.—Nymphaea advena a semi aquatic completely surrounded by the encroaching bog-meadow.

and is crossed by many paths. Much of the diseased Sphagnum lies in and along these paths. Many of the affected areas are on top of the hummocks at the bases of Rhus and Alnus shrubs.

The first evidence of a diseased condition is the wet, greenish-gray appearance of the Sphagnum. Microscopic examination revealed that the fronds are covered with Algae imbedded in gelatin. A Gleocapsa is very abundant both on the surface and in the large hyaline cells of the scales. Nostoc and several other

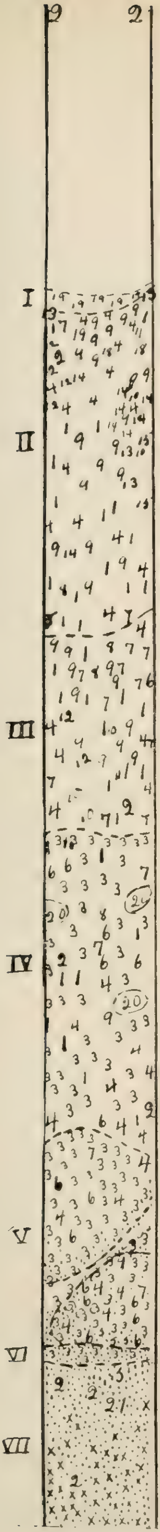
Cyanophyceae are present. Frequently fungal threads lie on the leaf and seem to be in the cells. In later stages the branches and finally the entire top of the frond becomes black. They are covered with small masses of Algae surrounded by fungal threads resembling the soredia of Lichens. The apothecia of two Discomycetes were found on the fronds. These have been identified by Professor Bruce Fink as the apothecia of the Lichens, Gyalecta lutea and Lecidia uliginosa. Examination of living fronds discovered fungal threads in the hyaline cells of the Sphagnum scales. Finally the Sphagnum dies and dries completely. The result of this dying of the Sphagnum is of ecological interest. Even before death occurs, Pallavicinia lyellii comes in frequently in the wetter areas. Aulocomnium palustre and Polytrichium commune or ohioense invade the drier areas of dead Sphagnum.

Study of a belt transect.

In order to present in detail the sequence of the associations of the island, the components of each and also the succession of one by another, a belt transect, 10 feet wide from a-a' and b-b' on the map, was studied and platted, (Fig. 13).

Beginning with the little cove at the shore the belt transect surveyed passes thru, I, a very narrow zone of aquatic plants; II, a mixed zone of marsh plants and bog shrubs; III, the high shrub; IV. the heath and V includes fifteen feet of the bog meadow. The transect was platted in a part of the island which would include the heath zone, for here the normal high lattitude bog succession is developing except that the order of zones III, IV and V are reversed with reference to zone I, with a clearly outlined marsh wanting. Normally, the meadow when present, immediately follows the marsh, then the heath and the last in order is the high shrub and forest. The transect also revealed the rapid development of the heath zone, Fig. 26 is a diagram of this transect showing the relative breadth of zone and the position of the principal species.

The cove, thru the center of which the transect was taken, is almost closed, affording only a narrow passage from the



LEGEND OF PLANT ZONES AND ASSOCIATIONS.

I. Zone of floating and fixed aquatics.
II. Zones of marsh and bog-thicket association.
III. Bog-thicket association.
IV. Transition zone.
V. Gaylussacia-heath association.
VI. Transition zone.
VII. Bog-meadow.

1. Rhus vernix
2. Acer rubrum
3. Gaylussacia
4. Alnus rugosa
5. Pogonia ophioglossoides
6. Aronia arbutifolia
7. Osmunda cinnamomea
8. O. regalis
9. Typha latifolia
10. Dryopteris thelypteris
11. Carex interior
12. Cephalanthus occidentalis
13. Solanum dulcamara
14. Decodon verticillatus
15. Rosa carolina
16. Rumex brittanica
17. Peltandra virginica
18. Hibiscus moscheutos
19. Potomageton sp.
20. Pools
21. Menyanthes trifoliata

x Diseased Sphagnum

—Sphagnum sp. and Oxycoccus macrocarpus.

FIG. 26.—Belt transect from a—a′ to b—b′ Fig. 13, map of Cranberry Island.

lake. At each margin stands a large dead maple. Water at the entrance is two feet deep and clear of vegetation, June, 1911.

The associations included in the transect are:

I. A zone with an association of floating and one of fixed aquatics: A narrow fringing border, two feet wide, of Potamogeton lonchites associated with P. pectinatus, P. pusillus, P. zosterifolium and the floating aquatics Spirodela polyrhiza, Lemna trisulca and Spirogyra sp. This zone is but poorly developed and lies close to the shore.

II. Mixed zone of high shrubs and marsh plants: This zone covers a belt 30 feet broad and is very typical of the margin of the island. An Alnus-Rhus society is the dominant one in the shrub and a Typha latifolia in the marsh association. The soil in the border, which is covered by the marsh and shrub association, is of an entirely different consistency from that of the Sphagnum mat. It is compact, has become compressed by the weight of shrubs and trees and no longer responds to the alterations in water level of the lake. Consequently when the water rises in the lake it rises over the border of the island, and the trees and shrubs at the margin stand in water; if this condition continues long enough they are killed, hence the prevalence of dead wood at the margin of many parts of the lake. On the other hand, when the water sinks in the lake, the island margin does not respond and a peat shelf is exposed. Depressions have arisen in the shrub border by the permanent sinking due to settling of the soil; these are filled with water when the general water level is high and become dry during periods of low water.

The water in the depressions of zone II is from 6 inches to 1 foot deep, and the surface is covered with a dense growth of Lemna trisulca and Spirodela polyrhiza. At the bases of several shrubs are small hummocks on which is a thin growth of Sphagnum. At the extreme margin of the lake is a more distinctly Typha border, interrupted, however, by a Rosa carolina at the eastern margin of the transect, several dead and one living Alnus rugosa, two Rhus vernix and a clump of Peltandra at the western margin, four small Cephalanthus occidentalis, the tallest of which is 30 inches, and a clump of Decodon verticillatus at the water's edge. Back from the margin, the shrubs Alnus and Rhus, become more frequent, the Typha being confined to the more open water of the pools. There is a scattering growth of marsh herbs as Comarum palustre, Triadenum virginicum; Bidens tricosperma and B. discoidea at the base of the shrubs and on the stalks of the Typha, Impatiens biflora, Viola blanda often in the shallow water, Cicuta bulbifera and Dryopteris thelypteris. There is an entire absence of a sedge zone, the sedges being confined to one small clump of Carex interior.

A well defined stratification or layering is represented by the following species:

1. Rhus vernix-Alnus rugosa rising to a height of 12-15 feet. Many of these are in a half dead condition and there is also much dead timber.

2. Typha latifolia, thrifty plants in fruit and 6-7 feet tall.

3. Rosa carolina, a few shrubs at a height of 4-5 feet. Rumex brittanica, Hibiscus moscheutos, all at maturity as tall as the Rosa.

4. Low shrubs from 2-4 feet tall, Cephalanthus occidentalis, Decodon verticillatus, Solanum dulcamara.

5. Herbs. The height which these herbs attain varies of course with the season, at maturity they are from 1-2 feet tall. Comarum palustre, Bidens tricosperma, B. discoidea, Impatiens biflora, Carex interior, Triadenum virginicum, Cicuta bulbifera, Peltandra virginica and Roripa americana.

6. Ground cover. Viola blanda, Aulocomnium palustre, Sphagnum acutifolium, S. cymbifolium and seedling Acer and Rhus which are abundant near the outer portion of the zone.

III. Bog-thicket association: This covers a belt 18 feet wide on the western and 20 feet on the eastern border. The water level is high, the surface a succession of hummocks separated by a labyrinth of small irregular waterways with an average depth of 3 inches. The zone is characterized by a Rhus-Alnus society, with Rhus vernix and Alnus rugosa the dominant species.

The Rhus is taller and more abundant than the Alnus, and is fruiting freely.

Secondary Species.

Tree etage 15-20 feet	Acer rubrum
Shrub etage 10-12 feet	Aronia arbutifolia
Tall herb 2-5 feet	Osmunda cinnamomea, large spreading fronds
Low herb 8 in.-2 feet.	Impatiens biflora, abundant near inner border
	Triadenum virginicum
	Dryopteris thelypteris
Ground cover	Sphagnum acutifolium
	cymbifolium
	Aulocomnium palustre

A society of floating aquatics, Spirodela polyrhiza with Lemna trisulca underneath covers the surface of the waterways.

The shrub society is much interrupted by stools of Typha latifolia growing in the water. The plants are not quite as tall as in the marsh zone and not flowering as freely.

IV. Transition zone composed of a mixed vegetation of the Heath and High shrub associations: This is a zone 28 feet broad, characterized by tall thrifty Gaylussacia resinosa together with several Rhus, Alnus and Acer rubrum. The ground is dry, with surface entirely above the water, wanting in vegetation and covered with dry leaves and twigs.

There are three small pools, one at the western and two near the eastern margin of the transect, with Aulocomnium palustre and Naucoria on its borders. The pools themselves contain no macrophytes. The zone is a dense shrub growth with no herbs except a few Osmunda cinnamomea and Dryopteris thelypteris at the outer, northern margin, where the growth of Gaylussacia ends abruptly and the High-shrub zone begins. There are well defined etagen or layers, the tallest maple rises to 25 feet, the smaller one and the tallest Rhus about 15 feet; the Alnus and smaller Rhus 9-12 feet and then the dense growth of Gaylussacia

4-4½ feet tall, thrifty but sterile. In the outer margin of the zone is a thin ground cover of Sphagnum.

V. Gaylussacia association: The association covers a zone 18 feet wide and consists of a dense growth of Gaylussacia resinosa with but few associated species which are: small Aronia arbutifolia, Alnus rugosa, Osmunda cinnamomea and a thin ground cover of Sphagnum cymbifolium, S. acutifolium var. versicolor, Aulocomnium palustre and Oxycoccus macrocarpus. The zone consists of two small mounds separated by a narrow ditch and seems to have been formed by two clumps of Gaylussacia meeting at and finally overgrowing the ditch. At the base of the first mound the Gaylussacia are no taller than the Oxycoccus but increase in height to 30 inches in the center of the mound. The mound bordering the shrub zone shows a more luxuriant growth and the plants bordering zone IV attain 3 feet.

This is the first year I have found these plants blossoming and forming fruit. The few Alnus are weak, stunted plants, with the main branch dead. One Alnus at the eastern margin of the zone, is a tall shrub. The Aronias are but a few inches taller than the Gaylussacia and but one bears a few fruits. The Osmunda has the strict habit and short leaves characteristic of this fern in the open bog. The ground underneath is dry and the Sphagnum which grows well at the margin of the zone and the western edge of the ditch is almost wanting in the center. This ditch was evidently a path and is now filled with dry leaves. On the southern slope of the first mound are a few small Pogonia ophioglossoides and Triadenum virginicum not in blossom.

VI. A narrow, ½ foot wide, transitional zone, where the Sphagnum of the bog-meadow is beginning to form the mound of the Heath zone: The zone is occupied by a Sphagnum-Oxycoccus society. The Oxycoccus shows luxuriant growth and there is a scattering of two-year old Gaylussacia resinosa, 3-10 inches taller than the Sphagnum and which are not seedlings but shoots from underground stems that have spread out from the Gaylussacia plants.

VII. Bog-meadow association: The transect includes 15 feet of the bog-meadow with a Sphagnum-Oxycoccus society.

Dominant species:

Sphagnum cymbifolium Oxycoccus macrocarpus

Secondary species:

Drosera rotundifolia, Scheuzeria palustre, Dulichium arundinaceum, and Rynchospora alba are uniformly distributed and here named in the order of their abundance. Five feet from zone VI and in the eastern half of the transect, are 49 Menyanthes trifoliata; three feet from zone VI are 13 Pogonia ophioglossoides not blooming. On the western margin of the transect are two almost dead Rhus. The larger is within two feet of zone VII, and has two shoots, of which the taller is 18 inches long and six years old. The smaller has 2, 3, and 4 year old shoots from 6-10 inches tall. Near the center is another Rhus with 2 two-year old shoots from 3-6 inches long. In each case the terminal bud of the main stem is dead. In the case of the largest Rhus the bud was killed at the end of the fourth year, and the present shoots have developed from lateral buds. This seems to be a prevalent condition of the Rhus in the open bog. There are also three seedling maples as shown on the diagram. In this zone the Oxycoccus is fruiting freely and has done so in past years; and the fruit has been gathered by the cranberry pickers. The outer portion of the zone shows a number of patches of diseased Sphagnum. By actual count thirty-four small areas were found varying from 4 to 120 square inches of diseased Sphagnum, from that which is just commencing to look wet and gray to completely blackened fronds.

The most striking feature of this transect is the prominence of the heath zone. It is here better developed than at any other place on the island and extends farther into the meadow. At other points the heath is confined to the shrub zone. During the past year (1911) the plants were much more thrifty than in former years and the society has made a striking advance into the meadow.

Where the heaths have once gained entrance they are better able than the taller shrubs as Rhus and Alnus, to supplant the vegetation of the meadow. The growth is dense, the lower strata become so dry and shaded that the Sphagnum and Oxycoccus cannot long survive. Again the pioneer Gaylussacias do not come in as seedlings but as the advancing margin of shoots from the parent zone. This zone if left undisturbed, will supplant the meadow faster and more effectively than will the shrub-tree zone.

II. Forest-clad islands which were elevations on the swamp floor or were parts of the forest not included in the original swamp. Orchard Island is an example of the first and Lieb's Island of the second type of this class of islands.

Orchard Island.

(Fig. 27.)

Orchard Island is one of a group of four wooded islands situated in the southwest portion of the old reservoir and close to the south shore. These islands were elevations in the Big Swamp of which Buckeye Lake is the successor, and were high enough to escape inundation when the swamp was converted into the reservoir in 1832, and later when the addition of the new reservoir in 1836 occasioned the raising of the water level an additional four feet. The highest portions of these islands remain above water at the standard or high water level, which is twenty-three inches above the normal. They bear large forest trees, some of which are twenty-eight inches in diameter.

Orchard Island is the largest of these. It has an area of 2.95 acres and is irregular in shape with the longest diameter from the southeast to the northwest. It lies about 200 feet from the south shore of the lake and is connected on the west by a marsh with State Journal Island. The entire surface has been apportioned into lots with an undivided area of common ground at the foot of the public dock, a narrow marginal area,

FIG. 27.—MAP OF ORCHARD ISLAND.

LEGEND OF PLANT SOCIETIES.

1. Nelumbo society,
2. Polygonum-Nelumbo society,
3. Polygonum-Nelumbo-Typha society,
4. Polygonum-Typha-Bidens society,
5. Hibiscus-Typha society,
6. Shrub society,
7. Forest society,
8. Hibiscus society,
9. Polygonum-Scirpus society,
10. Sedge society,
11. Beach without vegetation.

and one in the center of the island. There were, October, 1910, eight cottages and five docks.

Sixteen years ago, Mr. Wells leased the entire island, cleared the center and planted peach trees. His orchard must not have prospered as not one living peach tree remains today. This area is now covered with young forest trees; Ulmus americana, Hicoria minima, H. ovata, Fraxinus nigra, F. americana, Tilia americana and others.

There is a sparse growth of shrubs, Rubus nigrobaccus, Rhus glabra, R. toxicodendron, Vitis vulpina, etc. The herbage is also poorly developed; it consists of a thin growth of grass and common weeds which have been frequently mowed and in some places burned. A narrow border of larger trees, remnants of the original forest, surround this central area. On the south and west this forest border is twenty to thirty feet wide; but to the north and east there is sometimes but a single tree, the lawns extending to the water's edge.

An interrupted zonation of marsh plants occupies the shallow water and the now exposed mud plain surrounding the island. The marsh is well developed on the west, south and southeast, but has been more or less completely cleared away in the vicinity of the docks on the north, northeast and east sides.

The island exhibits a striking example of the invasion of plants into new areas, successful ecesis, the resultant succession, the consequent filling of the lake and the upbuilding of new land areas along the margin; and in the center a secondary succession in a partially denuded area. A detailed floristic study was made of a belt sixty feet broad and extending directly across the island from the southeast to the northwest, from a-a' to b-b' on the map. This belt covers a representative area of the island, including a section of the well developed marsh on the southeast, and on the northwest the marsh disturbed and reforming; a section of the oldest forest zone and of the rejuvenated central area.

There are four distinct groups of vegetation units or associations based on habitat and growth forms:

I. The pond association
II. The shore association
III. The swamp-shrub association
IV. The mesophytic-forest association

The first, second and fourth are well developed, the first exhibits a striking lateral and vertical zonation, the third is fragmentary, but it is of interest as an illustration of the intrusion and development of a zone between two previously existing ones.

I. The pond association on the southeast: This consists of an association of semi-aquatics with

1. Nelumbo lutea society

   Principal species:
      Nelumbo lutea

   Secondary species:
      Potamogeton pectinatus
         lonchites
         natans
      Ceratophyllum demersum
      Cladophora sp.
      Spirogyra sp.

The society forms a zone 20-40 feet broad. At the outer margin the water is 4-4.5 feet deep, at the inner about 8 inches. In the deeper water is a pure Nelumbo lutea family; in the shallower, the other plants, especially Potamogeton pectinatus and lonchites, are quite abundant. There is some evidence of vertical zonation or layering; in the deeper water the Nelumbo leaves float on the surface; and in the shallower rise 12 inches above the surface.

2. Nelumbo-Polygonum society

   Principal species:
      Nelumbo lutea
      Polygonum emersum

Secondary species:

Ceratophyllum demersum	Brachythecium plumosum
Spirogyra sp.	Riccia fluitans
Lemna trisulca	Ilysanthes gratioloides
Cladaphora sp.	Sium cicutaefolium
Spirodela polyrhyza	

This society forms a dense zone 60 feet broad, and extends from water 8 inches deep to wholly emersed surface. Thirty-five feet of the zone covers a mud flat which is submerged at the normal water level. The Polygonum has advanced into the Nelumbo. Towards the inner margin the Nelumbo is 2 feet tall and fruiting freely.

A short distance west of the belt studied, the Polygonum has entirely outdistanced the Nelumbo, replacing society 1 with a Polygonum zone external to a mixed Polygonum-Nelumbo zone.

Of the secondary species, Brachythecium plumosum is the most abundant, especially on the exposed mud surface, quite large patches of which are covered by a pure growth of the moss. The Riccia is also a conspicuous member of the ground cover. The herbs are very sparse.

Towards the west of the median line of the belt is,

3. A Polygonum-Nelumbo-Typha society. A zone composed of societies from the I and II associations.

Principal species:

Polygonum emersum
Nelumbo lutea
Typha latifolia

Secondary species:

Spirodela polyrhyza
Lemna trisulca
Cladophora sp.
Ceratophyllum demersum

The secondary species, which are normally floating plants, are stranded on the mud and form but a thin covering. The society covers a narrow lens-shaped area not more than 3 feet in its broadest portion. At the normal water level the surface is submerged, but now it is wholly exposed. The Polygonum is tall and vigorous with branches from 3-4 feet tall; the Nelumbo has large erect leaves and the plants are fruiting freely; the Typha is stunted in growth and sterile, the largest leaves are not more than 4 feet tall.

This zone is followed by the shore association which covers the low very gently sloping mud flat between the pond association and the forest. Typha latifolia is the dominant species on the outer and Hibiscus moscheutos on the inner margin. The following two societies are very evident.

4. Typha-Polygonum-Bidens society

Principal species:

Typha latifolia	Bidens cernua
Polygonum emersum	

Secondary species:

Cyperus strigosus	Cicuta bulbifera
Eleocharis acicularis	Bidens frondosa
Riccia fluitans	Roripa palustre seedlings
Spirodela polyrhyza	Hibiscus moscheutos seedlings
Brachythecium plumosum	Polygonum emersum seedlings

Society 4 occupies a narrow zone less than 3 feet in width. The Typha is larger and more vigorous than in 3, but not fruiting; Polygonum emersum is still conspicuous but not nearly so much as in the preceding zone, while the Nelumbo lutea has entirely disappeared and Bidens cernua, represented by a few large plants, has come in. There are but a few of the taller herbs of the secondary species, but an abundant ground-cover of the Cyperus, Riccia and Eleocharis. This zone merges into:

5. Hibiscus-Typha society

Principal species:

Hibiscus moscheutos	Typha latifolia

Secondary species:

Taller herbs:

Polygonum acre
Triadenum virginicum
Scutellaria lateriflora
Cicuta bulbifera
Solanum dulcamara
Echinochloa walteri
Homalocenchrus oryzoides
Aster paniculatus
Erechtites hieracifolia
Impatiens biflora
Galium trifidum
Epilobium strictum
Boehmeria cylindrica
Agrimonia sp.
Acnida tamariscina

Seedling trees:

Acer rubrum
Gleditsia triacanthos
Quercus palustris

Ground-cover:

Cyperus strigosus, small mat plants
Riccia fluitans
Phialea scutula on dead Hibiscus stems
Spirodela polyrhyza
Brachythecium plumosum
Cladophora sp.

This zone is 40 feet wide and the ground surface is entirely above water, but so recently exposed that the stranded Spirodela and Algae are still green. The Hibiscus roots form small hillocks on which the Spirodela and Algae become stranded and on which the Riccia is very abundant. The taller herbs form a sparse weak growth due to the density of the Hibiscus which forms a 7-foot wall difficult to penetrate. The Typha is confined to the outer portion of the zone and has here obtained optimum conditions of growth, the plants are not copious, but are tall, vigorous and fruiting freely.

II. Swamp-shrub association

6. Cornus society

Principal species:

Cornus stolonifera

Secondary species:

Rosa carolina	Hibiscus moscheutos
Sambucus canadensis	Solanum dulcamara
Micrampeles lobata	Homalocenchrus oryzoides
Polygonum acre	Galium trifidum
Erechtites hieracifolia	Carex lupulina
Scutellaria lateriflora	Convolvulus sepium
Mentha canadensis	Ulmus americana

This society consists of nine Cornus stolonifera in the section studied, and occupies an area 20 feet broad. About 10 feet to the west is another Cornus stolonifera far down into the Hibiscus-Typha zone; and about 40 feet still farther west, is a group of 15-18 feet tall Cephalanthus occidentalis which extends through the Hibiscus zone to the water's edge. Just east of the eastern margin of the transect is another group of Cornus with Sambucus canadensis.

The swamp-shrub association does not exhibit lateral zonation, but alternations as it consists of isolated shrub societies of which Cornus stolonifera is the principal species in one and Cephalanthus occidentalis in another. The associated species are grouped closely around the Cornus, most of the herbs form a sparse growth in the shade of the shrubs and Micrampeles and Solanum climb over them.

The two bordering associations the marsh-herb on the one side and the forest on the other, merge in the areas between the shrub societies. The presence of seedling Ulmus, Quercus and Gleditsia in the Hibiscus-Typha society shows clearly that the forest is invading the marsh, and if the higher portion of the mud flat is not again submerged, the shrub zone may never become more complete than it is now; it may be formed farther down on the shore or it may be entirely replaced by the forest. The incompleteness of the shrub zone is due to the existence of the forest prior to the development of the marsh.

III. Mesophytic-forest association

7. Ulmus-Fraxinus society

Principal species:

Ulmus americana	Fraxinus americana

Secondary species:

Trees:

Fraxinus nigra	Celtis occidentalis
Hicoria ovata	Tilia americana
minima	Gelditsia triacanthos
Ulmus fulva	Morus rubra
Quercus palustris	Salix nigra

Lianas:

Rhus toxicodendron	Smilax hispida
Vitis vulpina	Solanum dulcamara
Parthenocissus quinquefolia	Dioscorea villosa

Shrubs:

Cornus stolonifera	Rosa carolina
Rubus nigrobaccus	Cephalanthus occidentalis
occidentalis	

Herbs:

Muhlenbergia diffusa	Nepeta cataria
Agrostis perennans	Teucrium canadense
Syntherisma sanguinalis	Carduus lanceolatus
linearis	Arctium minus
Chaetochloa glauca	Helianthus decapetalus
Carex tribuloides	Urtica gracilis
vulpinoidea	Erigeron canadensis
frankii	Hedeoma puligioides
Rynchospora alba	Mentha canadensis
Solidago canadensis	Lycopus americanus
Aster paniculatus	Oxalis stricta
sagittatum	Onagra biennis

Solanum nigrum	Meibomia viridiflora
Epilobium strictum	Eupatorium ageratoides
Verbena urticifolia	purpureum
Rumex obtusifolius	Bidens bipinnata
Geum canadense	

Fungi:

Agaricus campestris	Lycoperdon wrightii

The forest association extends across the island from margin to margin, and presents two distinct zones: 1. A border zone 20-30 feet wide, consisting in part of large trees, the remnant of the original forest. It is a very open border, not more than three trees deep, the tallest of these trees having attained a height of 60-65 feet. The shrub stratum is very poorly developed. It is represented on the south side by a few Cornus, Rosa and Cephalanthus, at the outer margin of the zone; these are wanting on the north side. The field stratum is composed almost wholly of grasses of which Muhlenbergia diffusa, Agrostis perennans and Syntherisma sanguinalis and linearis are the principal species. Associated with these is a scanty growth of herbs; and on the south side an abundant growth of Rhus toxicodendron, Parthenocissus quinquefolia and Vitis vulpina trailing over the ground. The Rhus has also climbed two Ulmus americana. The grass and weeds have been mowed, so that the shrubs too are kept in a stunted condition.

Surrounded by the older forest zone lies a rejuvenated area clothed with young forest trees, among which Ulmus americana predominates; fully nine-tenths of the trees are of this species. This is a part of the area which was cleared sixteen years ago; but the forest has again invaded it and become established. The ground slopes gently downward toward the southeast and more abruptly toward the northwest. The elevation of the highest portion is not more than 4 or 5 feet above the standard water level. The gentle slope and the thin shade of the young trees, together with the loose, light soil, provide a dry, sunny habitat on which Carduus, Aster, Arctium, Hedeoma, Nepeta, Erigeron and other sun-loving plants find a congenial environment. The remains of large Burdocks and large Rubus nigrobaccus canes are frequent. There are scarcely any grasses in this central area, and as it has been mowed and burned, all the herbage is scanty.

On the northwest margin of the transect, the forest association is followed immediately by the marsh or shore association. The swamp shrub association is wanting. The marsh association is represented by three societies:

8. Hibiscus moscheutos society
9. Polygonum-Scirpus society and
10. Scirpus lacustris society. None of which show the development of the marsh zones on the south side.

8. Hibiscus society

Principal species:

Hibiscus moscheutos

Secondary species:

Hypericum mutilum	Bidens cernua
Impatiens biflora	Xanthium canadense
Hedeoma pulegioides	Rosa carolina
Echinochloa walteri	

The society forms a narrow, interrupted border not more than four feet wide, of mature fruiting but not tall Hibiscus moscheutos. Of the secondary species the Hypericum is quite abundant at the outer margin of the eastern portion of the zone. The other species are very sparse, of the Xanthium and Rosa there is but a single plant.

9. Polygonum-Scirpus society

Principal species:

Polygonum emersum	Scirpus fluviatilis

Secondary species:

Cyperus strigosus	Typha latifolia
Ilysanthes gratioloides	Alisma plantago
Hypericum pennsylvanicum	Amaranthus hybridus
Polygonum acre	Arctium minus
Agrostis perennans	Acer rubrum seedling
Gratiola virginiana	Ulmus americana seedling
Erechtites hieracifolia	Hibiscus moscheutos seedlings
Echinochloa walteri	Scirpus lacustris
Eupatorium purpureum	Cladophora sp.
Roripa palustris americana	

This society is 40 feet wide with the entire surface exposed at the present low water level. Hence the extremely heterogenous collection of plants among the secondary species. Dead Typha latifolia stalks are so abundant in the wstern portion of the zone as to warrant considering it a dominant plant; but the Typha is not at all abundant in the eastern portion of the zone. Articum minus and Alisma plantago growing close together illustrate strikingly the submerged and emersed stages of the society and the rapidity with which a new habitat is adopted by plants. That the ground has been recently exposed is evidenced by the fresh masses of Cladophora.

10. Scirpus lacustris society. This is a fringing zone 40 feet wide and extending only about half way across the belt, the surface is partly emersed. There is a 20-foot wide sandy beach scantily clothed with the Scirpus.

Secondary species:

Potamogeton natans
pectinatus
lonchites
Nelumbo lutea

The pond association along the north shore is represented only by a Nelumbo lutea society. A small bed of Nelumbo lutea borders the Scirpus lacustris society to the north-northeast. The leaves are but few and widely scattered.

Fifteen feet east of the belt is a public dock, four feet wide and extending 78 feet out into the water, and 54 feet up onto the shore. The marsh zones are not formed immediately on either side of the dock. On the upper portion of the beach close to the dock, the Hibiscus zone is coming in. Twenty feet east of the western margin of the belt, the marsh zones are interrupted

FIG. 28.—View of the vegetation from the S. E. side of the island in belt transect a-a′, showing associations I, II and III; and societies 1, 2, 3, 4, 5, 6 and 7 of map.

by a boathouse on the beach with a runway for boats extending into deeper water. The development of the marsh association on the north side has thus been interfered with and the margin is also more exposed to storm winds and waves. A sandy beach 60 feet wide is building; it is occupied in part by the Polygonum-Scirpus and in part by the Scirpus lacustris zone.

At the south end of the section studied, both lateral zonation and layering (etagen) are strikingly shown. There is a marked increase in elevation from one lateral zone to another, from the floating Nelumbo leaves to the tall Ulmus americana and Quercus palustris. This is well shown in the photograph. (Fig. 28.) There is a poor development of etagen in the indi-

FIG. 29.—View farther west than Fig. 28. Polygonum emersum forms the outermost zone, then follow zones or societies 2, 3, 4, 5, 6 and 7 of map.

vidual associations. In some there are the dominant plants and then the ground cover, in others a weak, irregular growth of taller herbs, while in the forest, the shrubs have either been cut or are young plants, and the vines generally trail over the ground.

LIEB'S ISLAND.

With the exception of the Cranberry Bog, this island is the largest in the lake, having an area of 33.59 acres. It lies in the southwestern portion of the new reservoir and is now connected with the old levee by a wagon bridge over the canal. The bridge permits of communication by land with Millersport.

Probably one-half of the island is under cultivation. There is a house surrounded by a lawn and orchard near the western border, and a cornfield occupies the rest of the cultivated area. The soil is a sandy loam with gravel subsoil, the general slope is from west to east.

Approaching the island from the north, the water 200 yards from the shore is very shallow, from 4-5 feet deep and is occupied by a pure Nelumbo lutea society. Between this and the shore is a narrow Potamogeton lonchites-natans-Polygonum emersum zone. This is followed by a more or less interrupted zone of Typha latifolia and Sparganium eurycarpum. This zone is interrupted by belts of Scirpus fluviatilis which extend to appreciable distances inland. On the margin of the island above water is a narrow zone of large forest trees of Salix nigra, Acer rubrum, Ulmus americana, Fraxinus nigra and F. americana. Beyond the trees is a rather fragmentary shrub zone with Cornus stolonifera, Rosa carolina, Sambucus canadensis, Rubus nigrobaccus and R. occidentalis as the principal species. Following the shrub zone and blending with it, is a narrow border which had not been cultivated; the ground is quite wet, and bears a mesophytic herb society. Impatiens biflora, Rynchospora alba, Carex vulpinoidea, Triadenum virginicum, Echinochloa walteri, Viola papilionacea, Rumex brittanica and Ambrosia trifida are the principal species. From this zone to the cultivated field is an irregular border from a few to about twenty feet wide which had been cultivated and sown to corn the previous year but this had been abandoned to a society of ruderales among which were also the mesophytic herbs of the preceding zone.

The following species were noticed: Arctium minus, Solidago canadensis, Oxalis stricta, Geum canadense, G. vernum, Sambucus canadensis, Onagra biennis, Lycopus americanus, Ambrosia artemisiifolia, A. trifida, Polygonum hartwrightii, P. persicaria, Convolvulus sepium, Plantago rugelii, Veronica perigrina, Triadenum virginicum, Asclepias incarnata, A. seriaca, Apocynum cannabinum, Echinochloa walteri, Valerianella chenopodifolia, Nepeta cataria, Viola papilionacea, Galium aparine, Carex davisii, Verbascum blattaria, Rubus occidentalis and Taraxacum taraxacum. This area extends for about fifty yards from a dense growth of Scirpus fluviatilis, a remnant of the swamp, on the east to a roadway and barnyard on the west.

The Scirpus fluviatilis society on low, wet land extends from the marginal marsh zone, thru the tree and shrub border well up into the cultivated field. It is a dense growth of the Scirpus overrun with Convolvulus sepium and with numerous Solidago canadensis which toward the higher and drier portion of the area becomes dominant.

Farther east the island is now connected with the embankment of the canal by a dense Typha latifolia society, with a zone of fixed aquatics, Nelumbo lutea and Potamogeton sp. towards the open water and a sedge zone, with Scirpus fluviatilis dominant, toward the land.

South of this the island touches the canal embankment, the former open water between them is a low, wet hollow overgrown with vegetation. The canal embankment bears a mesophytic tree and shrub society with Ulmus americana, Fraxinus nigra, F. americana and Salix nigra the dominant trees, and Rhus glabra the dominant shrub. At the foot of the embankment the ground is low and wet and covered with a jungle of Salix nigra, Ulmus americana, Fraxinus nigra and americana, Gladitsia triacanthos and Platanus occidentalis, with Cornus stolonifera, Rhus glabra the dominant shrubs and Rhus toxicodendron, Celastrus scandens, Vitis aestivalis climbing over trees and shrubs. The paths are under water in places. The drier portions are covered with sedges, Rynchospora alba, Carex vulpinoidea and sparganoides associated with Impatiens biflora, Geum canadense, Viola sp.

The lowest portion of the depression between the island and the canal bears a Typha latifolia society. The land surface is a few inches under water. Surrounding this are the following zones in the order given:

1. Polygonum emersum, ground still under water.
2. Eleocharis obtusa, Polygonum emersum and Hibiscus moscheutos zone.
3. Hibiscus moscheutos
4. Shrubs.
5. Trees.

On the west side of this low area, that is, on the side toward the field, the tree belt is thin and chiefly of Ulmus americana. This is bordered on the west by a wet sedge zone, chiefly Carex tribuloides, shortiana, lurida, lupulina, vulpinoidea and sparganioides and Rynchospora alba. The outer or western margin has become a belt of brambles, Rubus nigrobaccus. Numerous Solidago canadensis border the cornfield.

On the western end of the island is the farm house and barn. A grass lawn surrounds the house and close to it are planted several apple, peach and cherry trees, one large Tsuga canadensis, a Pinus strobus, Acer saccharum, Thuja occidentalis, a large spruce and near the gate at the southeast a large Castanea dentata. The lane leading from the gate to the bridge over the canal is bordered on either side by alternating apple and chestnut trees to the belt of low ground. From this to the bridge are willows, principally Salix nigra and alba. This is the only region on the island or on the shore of the lake where I have found chestnuts and conifers. The healthy condition of the trees indicates that the soil of Lieb's Island is suited to them. Southwest of the lane of chestnuts is another small cornfield which is bordered by a fringe of willows at the margin of the island beyond which is a Typha zone in shallow water. A repetition of the marsh and fixed aquatic zones borders the island on the southwest and west, the latter zone extends across the lake and unites with that of the west shore at the mouth of the southwest feeder.

Another interesting feature of this region is the rapidity with which the lake between the island and canal is being filled in. Part of it is already above the water level and supporting a mesophytic vegetation.

III. Islands built on a foundation of exposed peat.

Near the north shore of the lake, between Cranberry Island and the woodlot, a small mass of exposed peat was studied as an example of the third class of islands. The islet, Sept. 23, 1910, was a small mass of peat 12 feet long and 8 feet wide at the broadest portion, with a very irregular shore line, and had been so recently exposed during the season that the surface was wet and stranded Spirodela, Ceratophyllum and Cladophora were still fresh and green.

The surface slopes very gently from the water level at the margin to the highest point just north of the center which is 8 inches above the water. On this highest portion are 4 Bidens cernua, 3 Bidens frondosa, 5 Salix nigra from 2-3 years old and 6 Polygonum acre. These are the tallest plants, 1.5-2 feet tall. In their shade are 2 seedling maples, 4 seedling Hibiscus and numerous Eleocharis acicularis. In the center is a Lotus leaf.

The dominant species on the lower portion are Eragrostis hypnoides, Cyperus strigosus and C. erythrorhizos. The Eragrostis lies prostrate with roots at each node. Cyperus strigosus is erect and varies in height from 1-6 inches, while C. erythrorhizos is about 2 inches tall. Associated with these are 20 Bidens cernua seedlings, 7 Hibiscus moscheutos seedlings, 2 Amaranthus hybridus in bloom, 3 small Typha latifolia near the margin, 14 Impatiens biflora seedlings, 1 Decodon verticillata on the east side near the edge, 4 small Peltandra virginica on the west, with a number of stranded Potamogeton lonchites. Two areas of about one square foot each covered with the closely set capillary culms of Eleocharis acicularis, 1 Ilysanthes gratioloides, 3 seedling Erigeron sp., 1 seedling Solidago sp., 1 Homalocenchrus oryzoides. In small depressions where the peat is still distinctly wet it is covered with Heteranthera dubia, Spirodela polyrhiza, Ceratophyllum demersum, Potamogeton foliosus and Cladophora sp. One large decayed Lotus leaf covers an area of 1½ feet. In the margin of the islet are 2 small pools, 4 inches and 1 foot in diameter and the surface of each bears a Spirodela mat.

The peat shelf slopes gradually to water a foot deep within

Fig. 30.—Small peat mass which has been alternately exposed and submerged during several years. In a very short time after emergence it bears a varied and abundant vegetation.

five feet of the islet, which lies in the eastern margin of an extensive Nelumbo lutea society. The condition of the surface of the peat indicated recent exposure, the presence of 3 year old willows, that it had been in existence at least 3 years, and the two together that it had undergone alternate emergence and submergence.

This islet was again examined Aug. 1911. The vegetation had changed somewhat and the area was larger, the greatest length was 15 and greatest width 12 feet. On the northern end were 15

Typha latifolia, 7 Peltandra virginca were scattered over the southern half. The willows in the center were not more than 2 feet tall, stunted and much branched. The sediment clinging to the tips of the branches showed that they had been entirely submerged. The ground cover was almost wholly composed of Elocharis acicularis, no other sedges or grasses could be found and but a few Bidens, Hibiscus and Impatiens seedlings. The peat shelf surrounding the island and with its surface just under water bore everywhere a copious growth of Heteranthera dubia, which had also invaded the mud flat. Fig. 30 is a photograph of the islet taken Aug. 4, 1911.

IV. Islands originating in shallow water thru the gradual upbuilding of the surface by the accumulation of vegetal remains, as illustrated in a Typha tussock.

In the eastern part of the lake from Custer's Point to the southeastern extremity are many Typha tussocks of both Typha angustifolia and T. latifolia, which differ strikingly in the structure of the flora, but which gradually pass from the one type to the other.

One of each type of tussock was studied. The Typha angustifolia tussock formed a pure society about 24 feet in diameter and grew in water 3 feet deep at the margin and 2½ feet in the center. The culms were fully ten feet tall and blooming freely. Only at the margin on the leeward side were there any other plants. Here, June 24, 1911, were a few Potamogeton lonchites and small Castalia tuberosa leaves with Lemna trisulca on the surface of the water.

The Typha latifolia tussock was 50 feet south of the T. angustifolia. Surrounding it in water from 3.5-3 feet deep was a zone of Nelumbo lutea, Potamogeton pectinatus, P. lonchites, P. natans and Polygonum emersum, the last nearest the Typha, which occupied a zone about 18 feet broad. In the outer margin of this zone were Nelumbo leaves. Associated with the Typha throughout the zone was Sparganium eurycarpum, Polygonum emersum and Roripa americana. The water decreased in depth towards the center where it was 9 inches. Here was a clump of Hibiscus moscheutos with Lemna trisulca floating on the water.

One of the causes of the difference in structure of a Typha angustifolia society and that of T. latifolia is the difference in depth of water at which they generally grow. The former grows in deeper water than the latter, however, the angustifolia sometimes grows at the very margin of a shore in water but a few incehs in depth.

Another cause seems to be the habit of growth. The culms of T. angustifolia are massed forming a dense growth, while those of T. latifolia are farther apart permitting better light exposure and freer circulation of air at lower levels. A T. latifolia society always shows stratification, as in the one just described, the Typha forms the upper stratum at a height 5-6 feet above the water, the Sparganium the second at 4-5 feet, the Polygonum the third at 2.5-3 feet and the Roripa americana the fourth at one foot to 15 inches. This species occurs near the margin of the zone. At the extreme outer edge are the Nelumbo and Potamogeton leaves floating on the surface. The two species of Typha form characteristically distinct tussocks separated by open water. However, on the east shore of Buckeye Point a Typha angustifolia and T. latifolia society are adjacent and in the more open swamp there is a T. angustifolia society surrounded by a T. latifolia zone.

The thick root stalks and tough roots of Typha are firmly imbedded in the muck and are not easily uprooted, the thick tough culms and large leaves add materially each year to the surface level, so that it soon becomes high enough to support an amphibious and later a dry land flora. In general the bed of the lake is being built up in this way. Similar but less striking examples can be found in the beds of Polygonum emersum, some of which are quite extensive, as near Castle Island and another in water at a depth of 2 feet, 4 inches just west of Beech Island. Polygonum emersum does not form as dense a growth as the Typhas but the long creeping stems rooting freely at the nodes, and the numerous branches are the cause of the rapid extension of the mat, the tangle of branches catch and hold debris so that the surface soon becomes high enough to permit other plants as

Nymphaea, Peltandra and Pontederia to join the society. Polygonum emersum grows at a depth of 5½ feet, not much of the lake basin is therefore forbidden ground to this pioneer upbuilder of the land surface.

V. *Islands formed from fragments of other islands.*

This is rather a means of dissemination and multiplication of islands than the forming of new ones.

Swamp and bog plants have but shallow root systems, the roots extend to a much greater distance laterally than vertically. The roots of even the largest trees on the Cranberry marsh reach a depth of not more than 10-12 inches below the surface. Such plants are but insecurely anchored and when in exposed situations as the margin of the island, are readily torn away in masses by the storm winds, swept before the wind to finally find lodgment in shallower water or against logs and stumps. There are a number of such fragments near the northeastern shore. They are characteristically small areas with relatively large trees and shrubs and with an entire absence of a marginal society of fixed aquatics. One such small island about 50 feet square, near the east shore of the lake so closely resembles the shrub-forest association of Cranberry Island that it seems a fragment of it bodily transported to its present position. I have designated this island Sphagnum bog Island No. 2. With the exception of the absence of Oxycoccus and the presence of another northern bog plant, Rubus hispidus, the flora is identical. The dominant species are Acer rubrum, Rhus vernix and Alnus rugosa. The living maples of which there are 12 fair-sized trees, are none of them more than 6 inches in diameter, one dead maple measures 8 inches in diameter 12 inches from the ground, and one maple stump is 14 inches in diameter. There are also two seedling Quercus palustris. The surface is high enough to be scarcely wet to the foot. Near the eastern end is quite an abundant growth of Rubus hispidus, a characteristic plant of the Tamarack bogs in the northern counties. In the Pymatuming bog on the border between the northeastern part of Ohio and western Pennsylvania, it is a conspicuous member of the ground cover in the Heath zone.

Immediately north west of Sphagnum bog Island No. 2 is a somewhat smaller island which is a replica of the bog-meadow of Cranberry Island No. 1. In the center is a sphagnum-cranberry meadow and this is surrounded by a fringe of bog shrubs and trees. To this I have given the name Cranberry Island No. 2. This island and Sphagnum bog No. 2 are shown as Bog Islands on map Plate III, Fig. 4.

During the winter of 1911-12 a portion of the long southern lobe of Cranberry Island was dislodged and carried to the south side of the lake, where it now lies in several fragments near Custer's Point. This is the portion which was cleared of trees and shrubs two winters ago.

Of the many islands in the lake, but few besides the Cranberry bog Islands 1 and 2 bear Sphagnum. Until recently there was a small island mass with sphagnum in the shallow water just north of the Cranberry-bog. This has been dismembered. A fragment which is merely a mass of peat covered with Peltandra and Pontederia still occupies the original location, another fragment containing Decodon, Hibiscus, Polygonum and one Salix lies farther east near the shore, the remainder has entirely disappeared.

THE FLORA OF THE LAKE BED.

Attention has been called in the preceding pages to the shallowness of the lake basin. By this, of course, is understood the present lake and not its predecessor. The bed of the old swamp at the time of the beginning of the deposition of plant remains, must have been at the bottom of the deposit of peaty soil. This the cores, taken in the soundings at various stations of the lake, have shown. No well defined beach or shore lines remain; so that it is impossible to determine the original depth and extent of the lake; but after it reached its final outlet into the Licking River, the water cannot have stood at a much higher level than it does now. When the ancient lake stood at or above the 900 foot level it must have spread over the plain which extends from the present lake to Newark. This broad sheet of water must, however, have been a temporary one, more in the nature of a broad river than a lake as there are no beaches or other evidences of a lake. The water must soon have fallen to a lower level than the plain and was confined to the long narrow basin occupied by the "Big Swamp." The lowest place in the rim was about ½ mile south west of the Waste weir, and served as the outlet into the Licking River. This was considerably lower than the present lake. The field just north of the levee at this point is about 880 feet above sea level, whereas the surface of Buckeye Lake at the normal water level is 892 feet.

Were the vegetation permitted to grow without interference almost the entire lake would in a few years become a continuous growth of fixed aquatics and littoral marsh plants. As it is, large areas are now so covered, notably the western end of the lake which is scarcely more than 4.5 feet deep, the coves of the south shore, the extension of the lake to the north and the whole southeastern lobe. The various societies except in the coves where the growth is dense and competition more active exhibit alternation and not zonation. Accidents of dissemination have been the chief factors in the distribution of the societies. Depth of water and wind exposure have influence on the development, structure and succession of the societies. Soundings were taken to determine the greatest depth in which many of the fixed aquatics will grow. Nelumbo lutea frequently forms pure societies at a depth of 5-5.5 feet. In many places it is associated with Castalia tuberosa at a depth of 5 feet. Potamogeton lonchites was found at a depth of 5 feet; Polygonum emersum is gregarious. It was found at a depth of 5.5 feet and from that in all depths to the exposed mud flats. It has prostrate stems and floating leaves, the apex of the shoot ascending when growing in water, with an erect habit in very shallow water or in the mud. It forms pure societies and is also found associated with fixed aquatics as Nelumbo, Potamogeton sp. and swamp plants Typha and Hibiscus. Typha angustifolia grows at a depth of 3.5 feet, T. latifolia 2.5 feet. Nymphaea advena was found at a depth of 2 feet and 10 inches.

Potamogeton zosterifolius was never found in as deep water as the other species of Potamogeton, and generally in sheltered situations as a well surrounded cove. In such situations it forms a dense mat, the stems and leaves floating on a substratum of Ceratophyllum. All the fixed aquatics form denser growths on the leeward side of shores, islands and tussocks. The disseminules drift and collect in sheltered places and the anchored plants are not torn loose by wind and waves.

DEVELOPMENT OF THE FLORA.

It is now well established that there is a broad pre-glacial river valley from Dresden westward past Newark to the Licking Reservoir (Buckeye Lake) and thence continues southwest to the Scioto River. There is also good evidence that a large valley from the southeast, now occupied in part by Jonathan Creek, joined Newark River Valley near the western end of Buckeye Lake. These two streams were diverted from their westerly course at a very early period, possibly by the first ice invasion.

Buckeye Lake lies in and was a part of this south east branch of the old Newark valley. Towards the eastern end the old valley was not much wider than the present one; but at the western extremity the lake basin is not over one-fourth the width and lies on the southern slope and not in the deepest portion of the old valley. The present basin is entirely post-glacial, as shown by the thickness of the drift, 100-390 feet, in wells immediately adjacent to the lake. Its longer axis is transverse to the direction of advance of the Wisconsin ice sheet and it extends from the till plain of the ground moraine in which the western part lies, to the terminal moraine which surrounds the eastern end.

Ecologically the present flora of Buckeye Lake is an example on a large scale of secondary invasion. Until recently a swamp forest, then denuded by submergence, there was provided a rich peat substratum for the present lake vegetation. With the exception of Cranberry and two smaller islands near the east shore, the flora belongs to the present climatic conditions of the region. That invasion and migration are rapid and where not disturbed by man, successful, is shown almost everywhere in the lake. After ecesis the normal succession of fixed aquatics by marsh societies and these by shrub or, if adjacent to cultivated field or pastures, by ruderal societies follows rapidly and surely. The climax stage, the mesophytic forest, a remnant of the "Big

FIG. 31. Exposed mat of peat at margin of Cranberry Island.

Swamp" forest, forms almost everywhere a marginal fringe; and readily extends into the new territory as soon as a suitable habitat is provided. More than half, possibly three-fourths of the lake is not too deep for the pioneers, Nelumbo lutea, Polygonum emersum, Castalia tuberosa and Potamogeton lonchites, pectinatus and natans to become established. Floating macroscopic plants seem to have but little part in building up the flora. They are present only in limited and local areas in sheltered situations and shallow water where they have been preceded by fixed aquatics.

The plankton or floating microscopic organisms have not yet been studied.

During periods of low water large areas of peat are exposed. Such a mat is shown in Fig. 31, close to the margin of Cranberry Island. The tree stumps indicate that it once was a part of the forest zone of the island. The weight of living trees destroyed the buoyancy of the mat and caused it to sink. The death and removal of the timber released the load holding it down, then the lowering of the water and the warming of the mat caused the gases contained in the peat to expand and the peat to rise above the water surface. Every summer during the past five years the water has been lowered from a few to 6.85 feet. As it is late summer when this has been done the peat in the shallower portions of the lake, becomes warmed and rises to the surface. Very soon after exposure the surface is covered with Bidens cernua, B. discoidea and B. frondosa, with these are often associated Cyperus strigosus and Echinochloa walteri. Such peat mats bordering Cranberry Island are often veritable carpets of gold. When the water level is restored the peat is submerged and the vegetation disappears.

Cranberry Island has a longer record. The bog-meadow is a relic of the flora of the climatic conditions which prevailed at the close of each ice invasion, or perhaps more correctly at the beginning of each interglacial period. The vegetation may be very old or it may be post-Wisconsin; the position of the lake basin on the Wisconsin drift sheet would indicate the latter.

The meadow was undoubtedly much larger than it now is; but the former extent of the Sphagnum-Oxycoccus mat cannot now be determined. Soundings in the bog show that Sphagnum peat extends to a depth of 14 feet, forming a coarse fibered, loosely aggregated peat, with many water pockets. At 14 feet the core contained fragments of Potamogeton and Scirpus lacustris imbedded in a dark brown plastic peat. The stratum of dark brown peat with sedge remains is approximately 8 feet thick and is underlain by a more or less sandy marl containing small shells; beneath this varying from the 28-foot depth to the

40-foot level is a fine-grained blue clay. The peat deposit is thicker towards the south than towards the north side of the island [22]. The vertical section indicates by the marly deposits at the bottom of the series the presence of Characeae and Cyanophyceae; [23] [24] above this a long interval of a sedge bog and finally a Sphagnum-Cranberry bog. The bog developed as a marginal formation in the old lake and at the time of the beginning of the reservoir was more or less surrounded by the forest. Whether there was but the one or several Cranberry fields in the swamp I cannot determine. The report of cranberries growing in the northern part of Thorn Township, if correct, would mean either the extension of the present bog over a larger area to the south and east, or several small bogs. When in 1828 the old reservoir was completed and the waters rose and covered the swamp, the bog too was submerged. Near the shore, however, the lake as now must have been shallow and the light spongy sphagnum mat was soon enabled to rise to the surface. The current belief that it was at first a floating island appearing now here now there in the lake, seems unfounded. Mr. Gabriel Gritten, a man now 85 years old and hence five years older than the reservoir, lived in Millersport at the time and remembers having been on the island when he was a boy of eight. He says it was always where it now is and was like the present island except that there were no trees.

At the present time, in this restricted area, plants from a southeastern center of dispersal and which have been in the Ohio valley so long as to be recognized as endemic, have overtaken a small company of stragglers of the last great northward retreat, and the inevitable struggle for existence and supremacy results. Surrounded by a mesophytic forest, with meadows and fields close at hand the disseminules of many species find their way into the bog. That many invaders have entered the field before the soil was prepared for them is attested by dead or partially dead maples, alders and Rhus scattered thru the meadow; but that in the main the invasion is successful is demonstrated by the numerous copses of the same and allied trees and shrubs, which finally become confluent and in time will usurp the whole area.

ANNOTATED LIST OF PLANTS FROM BUCKEYE LAKE.

The following list is based on the plants collected at Buckeye Lake by myself and others. It is as yet incomplete as but few of the Thallophyta have been listed. This is due to the lesser prominence phytogeographically of this group and also to the want of adequate means of identifying them. It is hoped in the near future to greatly extend the list especially among the Thallophyta. Gill fungi are quite abundant in the forest zone of the shore and larger islands but few have as yet been identified. The plants are given in order beginning with the most primitive, the name of the series, class and family as well as the technical name of each plant is given.

THALLOPHTA

Myxomycetae

Physareae.

Badhamia papaveracea Beck and Rav. On leaf of Osmunda regalis and on a twig. Both leaf and twig were lying at the edge of a small pool in the forest zone of Cranberry Island.

ALGAE

Cyanophyceae

Nostocaceae

Nostoc cuticulare (Brebisson) Bornet and Flahault. Generally distributed on the leaves of Potamogeton and other aquatics.

N. pruniforme (Linn.) Agardh. Occurs in abundance in small shallow pools in the bog meadow of Cranberry Island.

N. coeruleum Lyngb. Small pools in the bog meadow of Cranberry Island.

N. sp. In shallow pools, clinging in clusters to the sphagnum and cranberry stems lining the basin. Bog meadow, Cranberry Island.

N. sp. Frequently found in the large hyaline cells of sphagnum.

Anabaena sp. Forms a fine green powdery layer over the surface of the ponds and lagoons at the margin of Cranberry Island.

Conjugatae

Mougeotiaceae.

Mougeotia sp. In the ponds of the bog meadow, Cranberry Island.

Spirogyraceae.

Spirogyra sp. Various species of Spirogyra are quite abundant and of general distribution in shallow water.

Protococceae

Protococcaceae.

Chlorochytrium lemnae Cohn. Endophytic in the leaves of Lemna trisulca.

Siphoneae.

Cladophoraceae.

Cladophora sp. Of general distribution in shallow water.

FUNGI.

Pyrenomycetae.

Erisibaceae.

Erisiphe cichoracearum DC. On leaves of Aster puniceus, shrub zone, Cranberry Island.

Discomycetae.

Helotiaceae.

Phialea scutula (Pers.) Gill. (*Helotium scutula* (Pers.) Karst.) On dead Hibiscus stems Orchard Island.

Basidiomycetae.

Agaricaceae.

Agaricus campestris L. On ground, forest zone Orchard Is. and often very abundant on the grassy slopes of the levee on the north shore and in the fields bordering the south shore of the lake.

Hygrophorus miniatus sphagnophilus Pk. Abundantly associated with Sphagnum on Cranberry and other bog Islands.

Naucoria paludosella Atkinson. Abundant on the ground in the shrub and tree zones, Cranberry Island.

Polyporaceae.

Stereum sericeum Schw. On Alnus branches, shrub zone, Cranberry Is.

Irpex tulipifera Fr. On dead Rhus twigs, shrub zone, Cranberry Island.

Coriolus versicolor (L.) Murrill. On fallen tree trunk, shrub zone, Cranberry Island.

Polyporus ferruginosus Schrad. On fallen twigs, shrub zone, Cranberry Island.

Clavaria vermicularis Scop. Growing among diseased sphagnum in the southern extremity of the bog-meadow, Cranberry Island.

Gastromycetae.

Lycoperdaceae.

Lycoperdon wrightii Bk. and Curt. On ground in forest zone, Orchard Island.

Sphaerioideae.

Sphaeriopsidaceae.

Phyllosticta acericola C. and E. On the leaves of Acer rubrum.

Especially abundant on seeding maples. The small leaves are almost covered with the discolored spots caused by the fungus.

Hyphomycetae.

Dermatiaceae.

Cercospora sp. On the leaves of Decodon verticillatus. Bog plants are rather conspicuously free from parasitic fungi infesting their stems and leaves; but Acer rubrum and Decodon on Cranberry Is. are both badly infested and injured by fungi.

Lichenes.

Gyalectaceae.

Gyalecta lutea (Dick) Tuck. On diseased sphagnum. Bog meadow, Cranberry Island.

Lecideaceae.

Lecidia uliginosa. On diseased sphagnum, bog-meadow, Cranberry Island.

Parmeliaceae.

Parmelia cylisphora (Ach.) (*P. caperata* (*L.*) Ach..) On dead Alnus, forest zone, Cranberry Island.

P. tiliacea (Hoffm.) Ach. On branch of Alnus, forest zone, Cranberry Island.

BRYOPHYTA.

Hepaticae

Ricciaceae.

Riccia fluitans (L.) Occurs in abundance in small pools near the southern end of the bog-meadow on Cranberry Island; and also in the shallow waters or stranded on the mud at the margin of many of the other islands and the lake shore.

Metzgeriaceae.

Pallavicinia lyellii (Hook.) S. F. Gray. Thickly covering the ground over small areas of the drier portions of the forest association, also at the margins of small pools in the thicket and forest zones; and in areas of diseased sphagnum in the bog-meadow of Cranberry Island. It occurs also on the two smaller bog islands.

Jungermanniaceae.

Cephalozia connivena (Dicks.) Lindb. Occurs on the ground over small areas in the drier parts of the forest association, Cranberry Island.

C. lunulaefolia Dumort. This species grows in dense masses over small areas in the drier portions of the forest association, Cranberry Island.

Sphagneae

Sphagnaceae.

Sphagnum Cymbifolium Ehrh. The most abundant species of Sphagnum of the bog-meadow, thicket and forest on Cranberry Island. Also the two smaller islands towards the northeast on which sphagnum occurs.

S. parvifolium (Sendt.) Warnst. Thicket where water level is high, east side of Cranberry Island.

S. acutifolium var. versicolor. Covers quite large areas in the western portion of the bog-meadow and is invading the heath zone, Cranberry Island.

S. recurvum Beauv. Bog-meadow, northern portion, Cranberry Island.

S. recurvum var. amblyphyllum. Thicket southeast side of Cranberry Island.

Musci

Dicranaceae.

Dicranum flagellare Hedw. Bog-meadow in patches of diseased sphagnum, Cranberry Island.

Pottiaceae.

Pottia truncatulata (L.) Lindb. On the ground in ruderale zone north side of Lieb's Island; on base of tree, Rabbit Island.

Aulocomniaceae.

Aulocomnium palustre (L.) Schwaeger. Very common in the thicket and forest zones and also occurring in the bog-meadow in patches denuded by the death of the sphagnum. Cranberry Island and the two smaller bog islands.

Polytrichaceae.

Polytrichum commune L. Quite widely distributed in the woods. In the bog-meadow it forms dense masses at the summits of hummocks surrounded by shrubs and is also replacing the dead sphagnum in the bog-meadow of Cranberry Island.

Climaciaceae.

Climacium americanum Brid. Forest association, Cranberry Island.

C. americanum var. kinderbergii R. and C. Forest zone, Sphagnum bog Island No. 2.

Entodotaceae.

Pylaisia intricata (Hedw.) Cardot. On tree trunk, wooded belt, northeast border of Cranberry Island.

Leskeaceae.

Thuidium virginianum (Brid.) Lindb. On tree trunks, wooded border, Cranberry Island.

T. delicatulum (L.) Mist. On the ground, forest zone east side of Cranberry Island; forest zone, Sphagnum bog Island No. 2.

T. recognitum or delicatulum. On the ground underneath the trees and in small pools, wooded zone, Cranberry Island.

T. paludosum Sulliv. Rau and Hervey. On ground, wooded border of Cranberry Island.

Hypnaceae.

Amblystegium varium (L.) Hedw. On ground, wooded zone, Cranberry Island.

A. riparium (Hedw.) B. S. Margin of small pools in wooded border of Cranberry Island.

A. kochii B. S. On ground, forest zone, northeast side of Cranberry Island.

Brachytheciaceae.

Brachythecium plumosum (Sw.) On the ground, wooded zone Cranberry Island; and Nelumbo-Polygonum society, Orchard Island.

PTERIDOPHYTA

Filices

Osmundaceae.

Osmunda regalis L. Generally distributed throughout the thicket and forest zones, also quite frequent in the bog-meadow, Cranberry Island. Occurs also on two smaller islands towards the northeast.

O. cinnamomea L. Generally distributed throughout Cranberry and the two small similar islands. The largest and most abundant fern.

Polypodiaceae.

Adiantum pedatum L. Forest, Rabbit Island. Not abundant.

Dryopteris thelypteris (L.) A. Gr. Generally distributed throughout the thicket and forest zones and frequent in the bog-meadow, covering appreciable areas in the southwestern portion. Cranberry Island and also other islands.

D. cristata (L.) A. Gr. Quite generally distributed throughout the thicket and forest zones, Cranberry and other islands.

D. spinulosa (Retz.) Kuntze. In well shaded situations of the forest zone, Cranberry Island.

Equisеteae

Equisitaceae.

Equisetum arvense L. Edge of marsh at foot of Baltimore and Ohio rail road embankment, east shore of Lake; ruderale society, Honey Creek.

ANGIOSPERMAE

Monocotylae

Typhaceae.

Typha latifolia L. Of general distribution in the shallow waters of the lake, at land margins and in the interior of many islands.

T. angustifolia L. Of general distribution in the lake, but less frequent than the former on shores and does not occur on the islands. Generally requires deeper water than the former species.

Sparganiaceae.

Sparganium eurycarpum Englm. Associated with Typha latifolia whenever the latter occurs abundantly.

Najadaceae.

Potamogeton natans L. Of general distribution in water 5½ and less feet deep.

P. lonchites Tuckm. Most abundant species and most widely distributed from water 5½ feet deep to stranded on the shore.

P. lucens L. Two plants east of and near Beech Island.

P. zosterifolius Schumacher. Generally distributed forming dense mats in shallow water in sheltered situations.

P. pusillus L. Not very abundant but generally distributed.

P. foliosus Raf. Marsh east of Custer's Point and near small islands north of Cranberry Island.

P. pectinatus L. Abundant and widely distributed in water from 5½ feet deep to stranded on low shores.

Juncaginaceae.

Scheuchzeria palustris L. Frequent and quite widely distributed in the bog-meadow, Cranberry Island.

Alismaceae.

Sagittaria latifolia Willd. Generally distributed in the marshes, and in southern portion of the bog-meadow.

Alisma plantago-aquatica L. Lewis Island; Polygonum-Scirpus society, Orchard Island.

Hydrocharitaceae.

Philotria canadensis (Mx.) Britt. In the shallow waters of the lake and ditches back of the levee.

Gramineae.

Panicum capillare L. Cranberry Island, eastern margin of bog-meadow, rare.

Echinochloa walteri (Pursh.) Nash. Abundant and widely distributed on low muddy shores.

Chaetochloa glauca L. Ulmus-Fraxinus society, Orchard Island; Cultivated ground, Lieb's Island; and along the lake shore.

Zizania palustris L. Marsh bordering east shore of lake.

Homalocenchrus oryzoides (L.) Poll. On the margin of Cranberry Island, very abundant on the mud flat at the mouth of Honey Creek and in the cove east of Summerland beach.

Syntherisma linearis (Krock.) Forest association of the majority of the islands.

S. sanguinalis (L.) Same distribution as the preceding.

Muhlenbergia diffusa Schreb. Of general distribution in open situations and also in the Hibiscus moscheutos societies, Orchard Island.

M. racemosa (Mx.) B. S. P. In the mud at the margin of the east side of Cranberry Island, and on the small island immediately north of Cranberry Island.

Phleum pratense L. Margin of wood bordering the lake.

Cinna arundinacea L. Swampy wooded margin of Lieb's Island.

Agrostis alba L. Quite common in fields and open borders.

A. perennans (Walt.) Tuckm. Ulmus-Fraxinus society, Orchard Island.

Calamagrostis canadensis (Mx.) Beauv. Northwest portion of wooded border and at the extreme margin of the southeast lobe of Cranberry Island.

Phragmites phragmites (L.) Karst. In the marsh at the foot of the Baltimore and Ohio railroad embankment on the east shore of the lake and south of Avondale. This is up to the present the southernmost station for this grass in Ohio.

Eragrostis hypnoides (Lam.) B. S. P. In the mud in the open spaces of a small island immediately to the north of Cranberry Island. Occurs also on recently exposed peat masses.

Poa pratensis L. Common on grassy shores and islands, as Lieb's and Lewis Islands.

Panicularia nervata (Willd.) Kuntze. At the water's edge of the extreme south lobe of Cranberry Island, and on the mud flat at the mouth of Honey Creek.

P. fluitans (L.) Kuntze. Abundant in the marsh bordering the north shore of the eastern portion of the lake and east of Custer's Point south shore.

Festuca elatior L. Mud flat at mouth of Honey Creek.

Cyperaceae.

Cyperus erythrorhizos Muhl. At water's edge of wooded zone in northeast part of Cranberry Island. On masses of peat in lake.

C. strigosus L. Widely distributed on low shores, masses of peat and Cranberry Island, often occurring as mat plants on mud flats.

Dulichium arundinaceum (L.) Britt. Abundant and generally distributed in the bog-meadow; less abundant in the thicket and forest zones of Cranberry Island.

Eleocharis obtusa (Willd.) Schultes. Generally distributed in low wet ground.

E. palustris (L.) R. & S. Occurs sparingly in forest zone, Cranberry Island.

E. palustris var. glaucescens (Willd.) Gray. Close to a small pool in southwest portion of bog-meadow, Cranberry Island.

E. acicularis (L.) R. & S. Copious and widely distributed on low muddy shores.

E. tenuis (Willd) Schultes. In the southeast portion of the bog-meadow, Cranberry Island.

Scirpus lacustris L. Quite generally distributed in shallow water and occurs on Cranberry Island at the margin of several pools.

S. fluviatilis (Torr.) Gray. Widely distributed and abundant in the marshes and bog.

S. atrovirens Muhl. Sedge zone, shore of Honey Creek.

S. cyperinus (L.) Bog-meadow, Cranberry Island.

Eriophorum polystachyon L. Cranberry Island, bog-meadow.

E. virginicum L. Generally but scatteringly distributed through the bog-meadow, Cranberry Island.

Rhynchospora alba (L.) Vahl. Abundant and generally distributed where the water level is high in the bog-meadow, Cranberry Island. At the margin of the forest, Orchard Island, and other wooded islands.

Carex asa-grayi Bailey. Swampy woods along the south shore of the lake.

C. lupulina Muhl. Generally distributed in the marshy borders of the lake.

C. tuckermanni Dewey. Swamp woods along the south shore of the lake.

C. lurida Wahl. Very common in the ditches and swampy wooded borders of the lake.

C. pseudo-cyperus L. In the swampy wooded borders of the lake, wooded islands and also at the margin of Cranberry Island.

C. comosa Boott. In the swampy borders of the lake, islands and Cranberry bog.

C. frankii Kunth. A very common sedge of the ditches and swampy borders of the lake.

C. squarrosa L. Low swampy woods at margin of lake.

C. typhinoides Schw. Low swampy woods at margin of like.

C. filiformis L. Bog-meadow, Cranberry Island where water level is high, but not near margin of island.

C. stricta Lam. Bog-meadow, at margin of thicket in southeastern portion of Cranberry Island.

C. aquatilis Wahl. Bog-meadow near pools in southern portion of Cranberry Island.

C. limosa L. Abundant in small pool in northern portion of bog-meadow and among the Sphagnum and Oxycoccus in the northeastern portion of the bog-meadow, Cranberry Island.

C. laxiflora blanda (Dewey) Boott. Charleston Island, drier portion.

C. leptalea Wahl. Bog-meadow near margin of a pool, eastern portion of Cranberry Island.

C. conjuncta Boott. Lewis and other wooded islands in eastern portion of lake.

C. stipata Muhl. A few plants at the western edge of the southern lobe of Cranberry Island.

C. decomposita Muhl. In two situations, at the base of a dead Alder at the water's edge of a small island bordering Cranberry Island on the east; and in the forest at the edge of a marginal pond on the east side of Cranberry Island. Reported for the state but no specimens in the State Herbarium up to the finding of the plant on Cranberry bog.

C. diandra Schranck. Near a small pool, eastern portion of bog-meadow, Cranberry Island.

C. diandra var. ramosa (Boott.) Same situation as the preceding.

C. vulpinoides Michx. At the water's edge of the long southern lobe of Cranberry Island and in wet woods at margin of lake and on wooded islands.

C. retroflexa Muhl. Thicket, Cranberry Island; and woods at margin of lake.

C. sparganioides Muhl. Woods at margin of lake.

C. interior Bailey. Abundant and widely distributed in the shrub and forest zones and at margin of bog-meadow, Cranberry Island, and other wooded islands.

C. tribuloides Wahl. A very common species in wet situations on the borders of the lake and islands.

C. alata Torr. Two situations on Cranberry Island, at the water's edge on the extreme southern lobe and at the edge of a pool in the thicket on the east side.

Araceae.

Peltandra virginica (L.) Kunth. In the marsh zone associated with Typha and Decodon of the shore and various islands and also alone or associated with Pontederia cordata or Bidens sp. in shallow water and on masses of peat.

Lemnaceae.

Spirodela polyrhiza (L.) Schleid. Widely distributed in the shallow waters of the lake and in ponds in the islands.

Lemna trisulca L. The most abundant and widely distributed floating macrophyte, often completely filling shallow depressions in Cranberry Island.

L. minor L. Associated with Lemna trisulca in the ponds of Cranberry Island and other shallow water.

Wollfia columbiana Karst. In several ponds in the thicket, Cranberry Island.

W. punctata Griseb. Associated with W. columbiana, Cranberry Island.

Wolffiella floridana (J. D. Sm.) Thomp. First discovered in 1906 in a small pool southeast side of bog-meadow at inner margin of thicket. Later in a larger marginal pool.

Pontederiaceae.

Pontederia cordata L. In shallow water north of Cranberry Island and in southern portion of lake.

Heteranthera dubia (Jacq.) MacM. In shallow water and on mud flats at margin of Orchard and State Journal Islands and north of Cranberry Island.

Juncaceae.

Juncus effusus L. Bog-meadow, occupying areas of high water level as in paths, Cranberry Island. Central portion of Lewis Island.

J. tenuis Willd. Common in grassy places on islands and the shore.

J. brachycephalus (Engelm.) Buch. In a wet depression in the southwestern portion of the Bog-meadow, Cranberry Island.

J. canadensis J. Gay. Associated with Carex limosa in a small pool of the bog-meadow, Cranberry Island.

Liliaceae.

Allium tricoccum Ait. Woods, Lewis and Rabbit Islands.

A. canadense L. Abundant at the edge of the wooded zone on north side of Lieb's Island along south shore of lake.

Erythronium americanum Ker. Very abundant in the rich woods north shore of Crane's pond.

E. albidum Nutt. Associated with but less abundant than E. americanum

Vagnera racemosa (L.) Morong. Common in woods at margin of lake, and on islands.

Salomonia biflora (Walt.) Britt. Wooded margins of the lake.

S. commutata (R. & S.) Britt. Shrub zone along eastern margin of lake.

Smilax rotundifolia L. Woods, Rabbit Island.

S. hispida Muhl. Woods, Rabbit Island and east shore of lake.

Dioscoraceae.

Dioscorea villosa L. In woods eastern margin of lake at Avondale.

Iridaceae

Iris versicolor L. Margin of forest zone at mouth of Honey creek and in swampy wood north of Lakeside.

Orchidaceae.

Habenaria clavellata (Mx.) Spreng. Common in forest of Cranberry Island and in the Sphagnum bog Island No. 2.

H. lacera (Michx.) R. Br. Frequent in wooded border Cranberry Island. In the center of Lewis Island the orchid was growing among Solidago.

H. leucophaea (Nutt.) Gray. Two plants found in thicket southeast side Cranberry Island.

Pogonia ophioglossoides (L.) Ker. Quite generally distributed in the thicket and in the Bog-meadow near margin of thicket, Cranberry Island.

Calopogon pulchellus (Sw.) R. Br. Abundant near the margin of the Bog-meadow, Cranberry Island.

Arethusa bulbosa L. Near the margin of the Bog-meadow, Cranberry Island.

Gyrostachys cernua (L.) Kuntze. Thicket southeast portion of Cranberry Island.

Dicotylae.

Salicaceae.

Populus deltoides Marsh. Buckeye Park, margin of Crane's pond and levee north and west shores of lake.

Salix nigra Marsh. The most widely distributed species at the margins of the islands and lake, along the canal and on the levee.

S. alba L. Next to *S. nigra* the most common and widely distributed Salix.

S. sericea Marsh. Margin of thicket, Cranberry Island.

S. petiolaris J. E. Smith. Margin of thicket, Cranberry Island, and other smaller islands more abundant than the preceding.

S. discolor Muhl. Most abundant and widely distributed shrub Salix. Shores and margins of islands.

Juglandaceae.

Juglans nigra L. An occasional tree on the levee, north shore of lake.

Hicoria minima (Marsh.) Britt. Forest zone, Orchard Island.

H. ovata (Mill.) Britt. Quite generally distributed along the borders of the lake and on the forested islands.

Betulaceae.

Carpinus carolinianus Walt. One tree on Rabbit Island.

Alnus rugosa (DuRoi) Spreng. One of the dominant shrubs of the forest and thicket of Cranberry and other swampy islands in the eastern portion of the lake. Occurring also as isolated, often half dead shrubs in the bog-meadow of Cranberry Island.

Fagaceae.

Fagus americana Sweet. A dominant tree of the forest north of Cranberry Island and of Rabbit Island and Buckeye Point.

Castanea dentata (Marsh.) Borkh. A lane of trees (planted) on Lieb's Island.

Quercus bicolor Willd. Sparingly on the levee, north side of lake.

Q. rubra L. Sparingly on the levee, north side of lake, and wood north of Cranberry Island.

Q. palustris Moench. The most abundant and widely distributed oak. Besides occurring everywhere along the shore and wooded islands it has also invaded the bog. One young tree and many seedlings are growing on Cranberry Island and also seedlings on the Sphagnum bog Island No. 2.

Q. imbricaria Mx. Not as abundant but quite as generally distributed as Q. palustris.

Ulmaceae.

Ulmus americana L. Abundant and widely distributed, the dominant tree in the forest zone of the lake shores and islands. Has not yet invaded the bog.

U. fulva Mx. Sparingly on the levee, Orchard and other wooded islands.

Celtis occidentalis L. A few trees on the levee along north shore of lake, in woods near Avondale, and one tree on Rabbit Island.

Moraceae.

Morus rubra L. Orchard Island.

Humulus lupulus L. One vine east shore of lake south of Avondale.

Urticaceae.

Urtica dioica L. A very common herb in the forest zone of the shore, Lewis and Charleston Islands.

Urtica gracilis Ait. Forest zone, islands and shore.

Adicea pumila (L.) Raf. Common in thicket at margins of pools Cranberry Island, swampy woods along the shore and on other islands.

Boehmeria cylindrica (L.) Willd. Common and very generally distributed in swampy woods and in the bog thicket of Cranberry Island.

Polygonaceae.

Rumex brittanica L. Common in marsh zone Cranberry Island.

R. crispus L. Rather common along the margin of the lake.

R. verticillatus L. At water's edge, Cranberry Island.

R. obtusifolius L. Orchard Island, forest zone. Lieb's Island, ruderale zone.

Polygonum hartwrightii A. Gray. Zone of ruderals north side of Lieb's Island.

P. emersum (Mx.) Britt. Abundant and widely distributed, grows in the lake at a depth of 5½ feet, forms large mats in shallower water, forms well defined zones along shores and grows also on exposed mud flats.

P. persicaria L. Zone of ruderals, Lieb's Island.

P. punctatum Ell. (*P. acre* H. B. K.) In shrub zone and at margins of pools Cranberry Island; on mud flats of other islands and the shore of lake.

P. hydropiperoides Michx. Thicket, Cranberry Island.

P. sagittatum L. Mud flat of cove east of Summerland beach.

P. arifolium L. In mud at water's edge of shrub zone and margin of pools in the south side of Cranberry Island.

Amaranthaceae.

Amaranthus hybridus L. Small island north of Cranberry Island, Polygonum-Scirpus society, Orchard Island.

Acnida tamariscina (Nutt.) Wood. On mud of small island north of Cranberry Island.

Portulacaceae.

Claytonia virginica L. Abundant in woods north of lake.

Portulaca oleracea L. Cultivated fields bordering the lake.

Nymphaeaceae.

Nymphaea advena Soland. Quite generally distributed in shallow sequestered portions of the lake, most abundant in the extreme northern and southern lobes; two small clumps stranded in Cranberry bog.

Castalia tuberosa (Paine) Greene. Abundant and widely distributed, often associated with Nelumbo lutea growing at a depth of 5 feet.

Nelumbo lutea (Willd.) Pers. The most conspicuous in point of numbers, size and attractiveness of plant, fixed aquatic in the lake. Covering large areas in water down to 5½ feet deep in all portions of the lake except the extreme northern lobe.

Ceratophyllaceae.

Ceratophyllum demersum L. Forms dense and extensive submerged mats in ponds in the bog, in more or less protected coves of the lake, and less copious along the shores of lake and islands.

Anonaceae.

Asimina triloba (L.) Dunal. Woods, Rabbit Island.

Ranunculaceae.

Caltha palustris L. Swamp woods south shore of lake.

Syndesmon thalictroides. (L.) Hoffmg. Woods, north border of lake.

Batrachium trichophyllum (Chaix.) Bossch. In a small pool southeast side of Cranberry Island, quite abundant south of the bridge in the extreme southeast lobe of lake west of Thornville station.

B. divaricatum (Schrank.) Wimm. (*Ranunculus circinatus.*) In shallow water in southern lobe of lake.

Berberidaceae.

Caulophyllum thalictroides (L.) Michx. Quite abundant in the woods on Rabbit Island and Buckeye Point.

Lauraceae.

Benzoin benzoin (L.) Coult. Rabbit Island.

Papaveraceae.

Bicuculla cucullaria (L.) Millsp. Woods bordering north shore of lake.

Cruciferae.

Lepidium campestre (L.) R. Br. Common in fields along shore of lake.

Roripa palustris (L.) Bess. Quite common near the water's edge of the shrub zone, Cranberry Island.

R. americana (A. Gr.) Britt. Shrub zone Cranberry Island.

Cardamine pennsylvanica Muhl. Marsh back of levee, Seller's Point.

C. bulbosa (Schreb.) B. S. P. Abundant in wet situations in the shrub zone, Cranberry Island.

Dentaria laciniata Muhl. Rich wet woods north of Crane pond.

Droseraceae.

Drosera rotundifolia L. Common and widely distributed in the bog-meadow, associated with Sphagnum, Cranberry Island and Cranberry Island No. 2.

Penthoraceae.

Penthorum sedoides L. Hibiscus zone, cove east of Summerland beach and also wooded islands and low shores.

Platanaceae.

Platanus occidentalis L. Occurs on the levee and on low shores. A frequent tree.

Rosaceae.

Rubus occidentalis L. Shrub zone Lieb's Island.

R. nigrobaccus Bailey. Common and very generally distributed along the lake shore and islands.

R. hispidus L. East end of small Sphagnum-bog island.

Comarum palustre L. Common in the shrub and forest zones of Cranberry Island.

Potentilla monspeliensis L. Ruderal zone, cove east of Summerland beach.

Geum canadense Jacq. Widely distributed on low ground of margin of lake and islands.

Rosa carolina L. Very abundant in the marsh zone of the cranberry bog, Orchard and other islands.

Malus malus (L.) An occasional tree planted on the levee and forming a lane of alternating Apple and Chestnut trees on Lieb's Island.

Aronia arbutifolia (L.) Medic. Generally distributed thru the thicket and forest zones of Cranberry Islands 1 and 2.

A. atropurpurea Britt. In thicket Cranberry Island, but less common than A. arbutifolia.

A. nigra (Willd.) Britt. Quite generally distributed in the shrub and forest zones of Cranberry Island.

Crataegus sp. One tree in wood north of Cranberry Island.

Prunus americana Marsh. East embankment of Southwest Feeder where it is abundant over a small area.

P. serotina Ehrh. Formerly one of the large and quite abundant forest trees in the vicinity of the lake. A fair number still remains. It has also invaded the Cranberry bog, on which in the forest of the east side is one young tree.

Amygdalus persica L. An occasional tree planted near cottages.

Leguminosae.

Gleditsia triacanthos L. Common along the levee and shores of the lake and the larger islands.

Meibomia viridiflora (L.) Kuntze. Forest, Orchard Island.

Lathyrus palustris var. linearifolius Ser. Sparingly at margins of pools in eastern and southeastern portions of Cranberry Islands.

Apios apios (L.) MacM. Quite abundant in the thicket, Cranberry Island.

Oxalidaceae.

Oxalis cymosa Small. Common in woods of shores and islands.

O. stricta L. Quite as common and generally distributed as O. cymosa, more common in drier situations.

Euphorbiaceae.

Euphorbia corollata L. Dry ground at edge of marsh west of the Baltimore and Ohio rail road tracks, south of Avondale.

Anacardiaceae.

Rhus glabra L. On Orchard, State Journal, Lewis and Lieb's islands and along the embankment of southwest feeder of the canal.

R. vernix L. The most abundant and widely distributed shrub on Cranberry and several smaller islands to the east. It finds optimum conditions in the wooded zone but numerous stunted, half dead shrubs are scattered thru the bog- meadow of Cranberry Island.

R. radicans L. The most common liane on the forested shores and islands.

Ilicaceae.

Ilex verticillata Ait. Quite abundant near the water's edge of the forest zone of Cranberry Island.

Celastraceae.

Celastrus scandens L. Copse east side of Lieb's Island and woods south shore of lake.

Aceraceae.

Acer saccharinum L. An occasional tree along the levee and in the park.

A. rubrum L. Of general distribution along the shores and on the islands, the only tree occurring abundantly on the bog island.

A. saccharum Marsh. Wood, shore of lake north of Cranberry Island.

A. negundo L. Woods north of Crane pond.

Balsaminaceae.

Impatiens biflora Walt. Very common and abundant in the marsh along shores of lake and islands.

Rhamnaceae.

Rhamnus lanceolata Pursh. East embankment of Southwest Feeder.

Vitaceae.

Vitis labrusca L. Quite common in forest along shores and on islands.

V. aestivalis Mx. Same situations as V. labrusca.

Parthenocissus quinquefolia (L.) Planch. Forest, Orchard Island.

Malvaceae.

Malva rotundilfolia L. Along the levee, door yards of cottages and in fields.

Hibiscus moscheutos L. A common and conspicuous plant in the marsh.

Hypericaceae.

Hypericum perforatum L. Transition zone between marsh and ruderales cove east of Summerland beach.

H. multilum L. North shore of Orchard Island in the Polygonum-Scirpus society.

Triadenum virginicum (L.) Raf. An abundant plant in the marsh and thicket of Cranberry Island and the Sphagnum-bog Island No. 2.

Violaceae.

Viola papilionacea Pursh. Woods along the shore.

V. blanda Willd. In the thicket generally at margins of pools, sparingly at margins of pools in open zone, Cranberry Island and Sphagnum-bog Island No. 2.

Lythraceae.

Decodon verticillatus (L.) Ell. A common and widespread marsh shrub.

Onagraceae.

Epilobium strictum Muhl. Scatteringly at margins of the island and of pools, south and east sides of Cranberry Island. In Hibiscus-Typha society on south side of Orchard Island.

Onagra biennis (L.) Scop. A common ruderal of lake shores and the drier open portions of some islands as Crawford's. In 1910 two plants were found in the bog beside a fallen maple on the cleared southern lobe of Cranberry Island.

Haloragidaceae.

Proserpinaca palustris L. Two plants were found in 1910 in the shallow water at western margin of southern lobe of Cranberry Island.

Myriophyllum spicatum L. In shallow water near the north, west and extreme southern portions of the lake.

Umbelliferae.

Sanicula canadensis L. Lewis Island.

Cicuta bulbifera L. Marsh of Cranberry and Orchard Islands.

Sium cicutaefolium Gmel. Thicket, southern lobe of Cranberry Island, and small swampy islands to the southeast.

Angelica atropurpurea L. Abundant in willow zone, mouth of Honey creek.

Cornaceae.

Cornus florida L. Rattlesnake Island and wooded hills, east shore of lake.

C. stolonifera Michx. A common shrub at the water's edge of Cranberry Island; forming the beginning of a shrub zone on other islands and along the shores of lake and bank of canal.

Nyssa sylvatica Marsh. One tree found on wooded hill, east shore of lake.

Vacciniaceae.

Gaylussacia resinosa (Ait.) T. & G. A few small areas on north side of Cranberry Island forming a low shrub or heath zone.

Oxycoccus macrocarpus (Ait.) Pers. A dominant plant of the bog-meadow, Cranberry Islands I and II.

Primulaceae.

Samolus floribundus H. B. K. Marsh, Lewis Island.

Lysimachia nummularia L. Margin of wood, east shore of lake, south of Avondale.

Naumbergia thyrsiflora (L.) Duby. Quite abundant in the forest zone of Cranberry Island.

Oleaceae.

Fraxinus americana L. Of general distribution on wooded shores and larger islands.

F. nigra Marsh. In situations similar to that in which F. Americana occurs but not so abundant.

Gentianaceae.

Bartonia virginica (L.) B. S. P. Very abundant in and characteristic of the bog thicket and forest of Cranberry and Sphagnum-bog Islands.

Menyanthaceae.

Menyanthes trifoliata L. Abundantly distributed thru the thicket and places of high water level in bog-meadow of Cranberry and Sphagnum-bog Islands.

Apocynaceae.

Apocynum cannabinum L. Marsh border of forest zone, Lewis Island.

Asclepiadaceae.

Asclepias incarnata L. General in swamp woods of the shores, forested and bog islands.

A. syriaca L. Ruderal zone Lieb's Island.

Convolvulaceae.

Convolvulus sepium L. Common and generally distributed, abundant in open margin of Cranberry Island.

Cuscutaceae.

Cuscuta gronovii Willd. Abundant and widely distributed on Impatiens biflora, Decodon verticillatus and other hosts at the margin of many of the swamp islands.

Polemoniaceae.

Phlox paniculata L. Roadside, Shell beach.

P. divaricata L. General in woods of shores and several of the islands.

Verbenaceae.

Verbena urticifolia L. Forest, Orchard Island; ruderal society cove east of Summerland beach.

V. hastata L. Ruderal society; Charleston Island.

Lippia lanceolata Michx. Common on dry shores and drier portions of islands.

Labiatae.

Teucrium canadense L. Generally distributed in copses and thickets of the shore and islands.

Scutellaria lateriflora L. Very common in open margins of thickets adjacent to pools, Cranberry Island; and at edge of marsh, east shore of lake south of Avondale.

S. incana Muhl. Roadside, Shell Beach.

Nepeta cataria L. Edges of fields and roadsides.

Glechoma hederacea L. Abundant as ground cover in the forest zone, south shore of lake.

Stachys aspera Michx. Low ground south shore of lake.

Hedeoma pulegioides (L.) Pers. Forest zone, Orchard Island and other open woods.

Lycopus virginicus L. In thicket at edge of pools southeast side of Cranberry Island.

Lycopus americanus Muhl. Common on low shores and islands.

Mentha spicata L. Abundant in the willow zone, shore of Honey creek.

M. piperita L. Associated with M. spicata, shore of Honey creek.

M. canadensis L. (*M. arvensis* var *canadensis*) Quite abundant in the thicket of the southern part of Cranberry Island.

Solanaceae.

Solanum nigrum L. Lewis Island and in the fields along the shore of the lake.

S. dulcamara L. Very abundant climbing on the shrubs at the outer margin of most of the islands and also quite common along shore.

Datura stramonium L. Among the weeds, center of Charleston Island.

Scrophulariaceae.

Verbascum blattaria L. Ruderal zone, edge of cultivated field, Lieb's Island.

Chelone glabra L. Two plants were found (1910) at the margin of the Cranberry bog. Shore north of Cranberry Island.

Gratiola virginiana L. Marsh north of Seller's Point.

Ilysanthes gratioloides Benth. (*I. dubia* (L.) Barnhart) Nelumbo-Polygonum society south shore Orchard Island.

Veronica peregrina L. Ruderal-zone north side of Lieb's Island.

Afzelia macrophylla (Nutt.) Kuntze. Quite common along the embankments of the east and northeast shores of the lake.

Gerardia paupercula (A. Gr.) Britt. Quite frequent in margins of thickets bordering pools on the south and southeast sides of Cranberry Island.

Lentibulariaceae.

Utricularia vulgaris L. Forms dense mats in small, shallow pools of the bog-meadow. Occurs also in the marsh of the southern lobe of the lake at Thornville Station.

U. minor L. Occurs frequently associated with Spirodela and Lemna in several small, shallow pools in the souther portion of the bog-meadow, Cranberry Island.

Orobanchaceae.

Leptamnium virginianum (L.) Raf. On Beech roots, Rabbit Island.

Acanthaceae.

Dianthera americana L. Forms a rather dense growth over a small area at the western margin of the southern lobe of Cranberry Island, also quite abundant on Elm and smaller islands to the southeast of Cranberry Island.

Plantaginaceae.

Plantago rugelii Dec. Ruderal-zone north side of Lieb's Island. Common on the lawns of Summerland Beach, the Park, and other places.

Rubiaceae.

Cephalanthus occidentalis L. A common swamp shrub, very generally distributed.

Galium circaezans Michx. Center of Lewis Island.

G. trifidum L. Generally distributed on low, wet shores and in the Cranberry bog in the southern part where there are many pools.

G. concinnum T. & G. Lewis Island.

G. asprellum Michx. Thicket among the pools southern portion of Cranberry Island.

Caprifoliaceae.

Sambucus canadensis L. In the forest and shrub zones of Cranberry Island and other islands and lake shore, common and widely distributed.

Valerianaceae.

Valerianella chenopodifolia (Pursh.) DC. Ruderal-zone north side of Lieb's Island.

Dipsacaceae.

Dipsacus sylvestris Huds. A common and conspicuous member of the ruderal societies on Lieb's Island, cove east of Summerland beach, shore of Honey creek and also where the woods of the shores border on the fields.

Cucurbitaceae.

Micrampeles lobata (Michx.) Greene. Shrub zone, Orchard Island.

Campanulaceae.

Campanula aparinoides Pursh. Associated with Galium trifidum in the more open thickets at the edges of pools in the southern part of Cranberry Island.

Specularia perfoliata (L.) A. DC. Edge of forest border south of Avondale on margin of lake.

Cichoriaceae.

Taraxacum taraxacum (L.) Karst. Door yards of cottages and in meadows.

Lactuca scariola L. Margin in levee north and west shores of lake.

Canadensis L. Baltimore and Ohio railroad embankment at edge of marsh east side of lake.

Ambrosiaceae.

Ambrosia trifida L. Very abundant at inner margin of forest zone where it abuts on the cultivated field, Lieb's Island. A common weed in other ruderal societies.

A. artemisiaefolia L. Very common and generally distributed in drier situations as railroad embankments, the levee, and door yards.

Xanthium spinosum L. Western portion of Charleston Island.

Compositae.

Vernonia noveboracensis (L.) Willd. Ruderal-zone western portion of Charleston Island.

Eupatorium perfoliatum L. Common on low, wet, open ground. Not a bog plant but was found in 1910 on the extreme southern lobe of the bog.

E. ageratoides Lf. Quite common in the forest zone of the shores and islands and has also invaded the southeastern portion of Cranberry-bog.

Solidago uliginosa Nutt. Of frequent occurrence in the shrub and forest zones of Cranberry Island and the other bog islands.

S. patula Muhl. Sphagnum bog Island No. 2.

S. canadensis L. In the Scirpus zone of Lieb's Island; abundant on Lewis and other islands and also on low, wet ground along shore.

Aster puniceus L. Of frequent occurrence in the inner margin of the wooded belt of Cranberry Island; also on the Sphagnum bog Island No. 2.

A. puniceus var. lucidulus Gray. One specimen collected by Walter Fischer on Cranberry Island.

A. paniculatus Lam. Quite generally distributed in the thicket and in the open bog on the south and southeast sides of Cranberry Island.

A. ericoides L. Ruderal zone west side of Charleston Island.

Erigeron canadensis L. Common at edges of fields and drier situations in forest zones. It has also invaded the eastern border of the southern portion of the bog.

Polymnia canadensis L. Quite abundant in forest of Rabbit Island.

Eclipta alba (L.) Hassk. Growing in the mud of a small marginal island north of the Cranberry bog.

Helianthus tuberosa L. Edge of marsh, east shore of lake south of Avondale.

Verbesina alternifolia (L.) Britt. Ruderal zone west side of Charleston Island.

Bidens cernua L. Abundant and widely distributed in the marsh areas, wherever masses of exposed peat are carpeted with vegetation. Occurs also on floating rotten logs and exposed root masses.

B. comosa (A. Gr.) Wiegand. Western margin of southern lobe of Cranberry Island.

B. discoidea (T. & G.) Britt. Very abundant on exposed peat shelves at the margin of Cranberry Island; on floating logs and also on the stalks and exposed masses of Typha and

Hibiscus; also on masses of exposed peat in the lake. This species with B. cernua and B. frondosa forms a veritable golden carpet over masses of peat which come to the surface in the lake. The Bidens is successful even before the surface of the peat is wholly exposed They are generally associated with Echinochloa walteri.

B. frondosa L. Near outer margin of marsh of the southern lobe of Cranberry Island and on exposed masses of peat in the lake.

B. trichosperma (Mx.) Britt. Common in the shrub zone of the southeastern border of Cranberry Island.

B. trichosperma tenuiloba (A. Gr.) Britt. Local. At the margin of a pool in the southeastern side of Cranberry Island.

Achillea millefolium L. Generally distributed in edge of forest zones and fields and on the levee.

Erechtites hieracifolia (L.) Raf. Two plants found in the thicket north side of Cranberry Island. Quite common along the shore north of the island; also on Orchard Island.

Arctium minus Schk. A common and widely distributed ruderal.

Carduus lanceolatus L. Occurs sparingly in the forest zone Orchard Island.

The following is a list of plants which I have not found, nor are there specimens of them in the State herbarium, but they have been reported for Buckeye Lake by Herbert L. Jones in his catalogue of Phanerogams and Ferns of Licking County.

Aquilegia canadensis L. Rare. Reservoir and on the islands.

Rosa setigera Michx. Borders of swamp. Reservoir.

Cornus amonum Mill. (*C. sericea.*) Along the banks of the Reservoir.

Viburnum lentago L. Common in the swamps.

Helenium autumnale. Not common.

Gerardia tenuifolia Vahl. Cranberry Marsh.

Alnus incana (L.) Willd. Cranberry Marsh.

Valisneria spiralis L. Abundant in Licking Reservoir.

Juncus nodosus var. megacephalus M. A. Curtis. Licking Reservoir.

Cyperus inflexus Muhl. (C. *aristatus* Boeckl.) Licking Reservoir.

Rhynchospora glomerata (L.) Vahl. Licking Reservoir.

Poa flava L. (*P. serotina* Ehrh.) Abundant at Licking Reservoir.

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