IND
3392

506 In2
891-93
ege
York

HARVARD UNIVERSITY

Library of the
Museum of
Comparative Zoology

y.

SCIENCE COLLECTION

PROCEEDINGS

OF THE

Indiana Academy of Science,

1893.

W. A. NOYES,
C. A. WALDO,
W. W. NORMAN,
} Editors.

A. W. BUTLER,
C. H. EIGENMANN,
V. F. MARSTERS,
L. M. UNDERWOOD,
F. M. WEBSTER,
} Asst Editors.

BROOKVILLE, IND.:
PUBLISHED BY THE ACADEMY.
AUGUST, 1894.

TERRE HAUTE, IND.
MOORE & LANHAM, PRINTERS,
1894.

TABLE OF CONTENTS

	PAGE
Officers 1893–94	4
Committees 1893–94	5
Complete List of Officers	6
Constitution	7
By-Laws	8
List of Members	9
Biological Survey	13
Botany	14
Bibliography of Botany	20
List of Plants	30
Zoology	67
Bibliography of Fishes	71
List of Fishes	76
Ornithology: Bibliography	108
Notes on Indiana Birds	116
Bibliography of Mammals	120
List of Mammals	124
Mollusca	140
Bibliography of Mollusca	142
List of Mollusca	145
Geology: Bibliography	156
Suggestions for the Biological Survey	191
Phanerogamic Flora	193
Relation of High Schools to the Survey	199
Proceedings of the Winter Meeting, 1893	205
President's Address	205
Geology	219
Biology	224
Physics and Chemistry	262
Index	275

ILLUSTRATION.

Crowley's Ridge 224

OFFICERS, 1893–94.

PRESIDENT,
W. A. NOYES.

VICE-PRESIDENT,
A. W. BUTLER.

SECRETARY,
C. A. WALDO.

ASSISTANT SECRETARY,
W. W. NORMAN.

TREASURER,
W. P. SHANNON.

EXECUTIVE COMMITTEE.

W. A. NOYES,
W. W. NORMAN,
J. P. D. JOHN,
D. S. JORDAN,
AMOS W. BUTLER,
W. P. SHANNON,
T. C. MENDENHALL,
J. L. CAMPBELL,
J. C. ARTHUR.
C. A. WALDO,
JOHN M. COULTER,
O. P. HAY,
J. C. BRANNER,

CURATORS.

Botany	JOHN M. COULTER.
Ichthyology	CARL H. EIGENMANN.
Ornithology	AMOS W. BUTLER.
Herpetology	O. P. HAY.
Entomology	F. M. WEBSTER.
Mammalogy	E. R. QUICK.

COMMITTEES, 1893–94.

PROGRAMME.

J. C. Arthur. D. W. Dennis.

MEMBERSHIP.

C. H. Eigenmann, M. B. Thomas, P. S. Baker.

NOMINATIONS.

Stanley Coulter, V. F. Marsters, R. W. McBride.

AUDITING.

M. C. Stevees, C. H. Eigenmann.

STATE LIBRARY.

C. A. Waldo, W. A. Noyes, A. W. Butler,
J. S. Wright, A. W. Duff.

LEGISLATION FOR THE RESTRICTION OF WEEDS.

J. C. Arthur, J. M. Coulter, J. S. Wright.

EDITORS.

W. A. Noyes, C. A. Waldo, W. W. Norman.

PRESERVATION OF ABORIGINAL EARTHWORKS NEAR ANDERSON.

J. M. Coulter, J. P. D. John, O. J. Craig,
D. W. Dennis, F. A. Walker.

BIOLOGICAL SURVEY.

L. M. Underwood, A. W. Butler, J. M. Coulter.

DIRECTORS BIOLOGICAL SURVEY.

L. M. Underwood, C. H. Eigenmann, V. F. Marsters.

RELATIONS OF THE ACADEMY TO THE STATE.

C. A. Waldo, L. M. Underwood, A. W. Butler.

FINANCE.

C. H. Eigenmann, Stanley Coulter, Alex. Smith.

OFFICERS OF THE INDIANA ACADEMY OF SCIENCE.

	President.	Secretary.	Asst. Secretary.	Treasurer.
1885–6	David S. Jordan.	Amos W. Butler.	. . . . .	O. P. Jenkins.
1886–7	John M. Coulter.	Amos W. Butler.	. . . . .	O. P. Jenkins.
1887–8	J. P. D. John.	Amos W. Butler.	. . . . .	O. P. Jenkins.
1888–9	John C. Branner.	Amos W. Butler.	. . . . .	O. P. Jenkins.
1889–90	T. C. Mendenhall,	Amos W. Butler.	. . . . .	O. P. Jenkins.
1890–1	O. P. Hay.	Amos W. Butler.	. . . . .	O. P. Jenkins.
1891–2	J. L. Campbell.	Amos W. Butler.	. . . . .	C. A. Waldo.
1892–3	J. C. Arthur.	Amos W. Butler.	Stanley Coulter. W. W. Norman.	C. A. Waldo.
1893–4	W. A. Noyes.	C. A. Waldo.	W. W. Norman.	W. P. Shannon.

CONSTITUTION.

ARTICLE I.

SECTION 1. This Association shall be called the Indiana Academy of Science.

SEC. 2. The objects of this Academy shall be scientific research and the diffusion of knowledge concerning the various departments of science.

ARTICLE II.

SECTION 1. Members of this Academy shall be honorary fellows, fellows, non-resident members or active members.

SEC. 2. Any person engaged in any department of scientific work, or in original research in any department of science, shall be eligible to active membership. Active members may be annual or life members. Annual members may be elected at any meeting of the Academy; they shall sign the constitution, pay an admission fee of two dollars, and thereafter, an annual fee of one dollar. Any person who shall at one time contribute fifty dollars to the funds of this Academy, may be elected a life member of the Academy, free of assessment. Non-resident members may be elected from those who have been active members but who have removed from the state. In any case, a three-fourths vote of the members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on application for membership, who shall consider such application and report to the Academy before the election.

SEC. 3. The members who are actively engaged in scientific work, who have recognized standing as scientific men and who have been members of the Academy at least one year may be recommended for nomination for election as fellows by three fellows or members personally acquainted with their work and character. Of Members so nominated a number not exceeding five in one year may, on recommendation of the Executive Committee be elected as fellows. At the meeting at which this is adopted the members of the Executive Committee for 1894 and fifteen others shall be elected fellows and those now honorary members shall become honorary fellows. Honorary fellows may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case a three-fourths vote of the members present shall elect.

ARTICLE III.

SECTION 1. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall hold office one year. They shall consist of a president, vice president, secretary, assistant secretary, and treasurer, who shall perform the duties usually pertaining to their respective offices, and in addition, with the ex-presidents of the Academy, shall constitute an executive committee. The president shall, at each annual meeting, appoint two members to be a committee which shall prepare the programmes and have charge of the arrangements for all meetings for one year.

SEC. 2. The annual meeting of this Academy shall be held in the city of Indianapolis, within the week following Christmas of each year, unless otherwise ordered by the executive committee. There shall also be a summer meeting at such time and place as may be decided upon by the executive committee. Other meetings may be called at the discretion of the executive committee.

SEC. 3. This constitution may be altered or amended at any annual meeting by a threee-fourths majority of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

BY-LAWS.

1. On motion, any special department of science shall be assigned to a curator, whose duty it shall be, with the assistance of the other members interested in the same department, to endeavor to advance knowledge in that particular department. Each curator shall report at such time and place as the Academy shall direct. These reports shall include a brief summary of the progress of the department during the year preceding the presentation of the report.

2. The president shall deliver a public address on the evening of one of the days of the meeting at the expiration of his term of office.

3. No special meeting of the Academy shall be held without a notice of the same having been sent to the address of each member at least fifteen days before such meeting.

4. No bill against the Academy shall be paid without an order signed by the president and countersigned by the secretary.

5. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the treasurer, shall have their names stricken from the roll.

6. Ten members shall constitute a quorum for the transaction of business.

MEMBERS.

HONORARY FELLOW.

Daniel Kirkwood . . . . . Riverside, Cal.

FELLOWS.

J. C Arthur . . . . . Lafayette.
P. S. Baker . . . . . Greencastle.
W. S. Blatchley . . . . . Terre Haute.
J. C. Branner . . . . . Palo Alto, Cal.
A. W. Butler . . . . . Brookville.
J. L. Campbell . . . . . Crawfordsville.
John M. Coulter . . . . . Lake Forest, Ill.
Stanley Coulter . . . . . Lafayette.
H. T. Eddy . . . . . Terre Haute.
C. H. Eigenmann . . . . . Bloomington.
W. F. M. Goss . . . . . Lafayette.
Thos. Gray . . . . . Terre Haute.
O. P. Hay . . . . . Chicago, Ill.
H. A. Huston . . . . . Lafayette.
J. P. D. John . . . . . Greencastle.
D. S. Jordan . . . . . Palo Alto, Cal.
V. F. Marsters . . . . . Bloomington.
T. C. Mendenhall . . . . . Washington, D. C.
D. M. Mottier . . . . . Bloomington.
W. W. Norman . . . . . Greencastle.
W. A. Noyes . . . . . Terre Haute.
W. P. Shannon . . . . . Greensburg.
Alex. Smith . . . . . Crawfordsville.
W. E. Stone . . . . . Lafayette.
M. B. Thomas . . . . . Crawfordsville.
L. M. Underwood . . . . . Greencastle.
T. C. Van Nuys . . . . . Bloomington.
C. A. Waldo . . . . . Greencastle.

NON-RESIDENT MEMBERS.

D. H. Campbell	Palo Alto, Cal.
B. W. Evermann	Washington, D. C.
Charles H. Gilbert	Palo Alto, Cal.
C. W. Green	Palo Alto, Cal.
C. W. Hargitt	Syracuse, N. Y.
Edward Hughes	Palo Alto, Cal.
O. P. Jenkins	Palo Alto, Cal.
J. S. Kingsley	Tufts College, Mass.
Alfred Springer	Cincinnati, Ohio.
Robert B. Warder	Washington, D. C.

ACTIVE MEMBERS.

J. Alex. Adair	Hanover.
R. J. Aley	Bloomington.
Harry F. Bain	Des Moines, Iowa.
Timothy H. Ball	Crown Point.
H. H. Ballard	Terre Haute.
George W. Benton	Indianapolis.
A. W. Bitting	Lafayette.
Alexander Black	Greencastle.
Henry L. Bolley	Fargo, N. D.
M. A. Brannon	Ft. Wayne.
Chas. C. Brown	Indianapolis.
W. V. Brown	Greencastle.
H. L. Bruner	Irvington.
Wm. Lowe Bryan	Bloomigton.
J. B. Burris	Cloverdale.
Noble C. Butler	Indianapolis.
R. Ellsworth Call	Louisville, Ky.
J. L. Campbell	Crawfordsville.
J. T. Campbell	Rockville.
J. Fred Clearwaters	Greencastle.
U. O. Cox	Mankato, Minn.
M. E. Crowell	Indianapolis.
Will Cumback	Greensburg.
George L. Curtiss	Greencastle.
B. M. Davis	Irvington.
D. W. Dennis	Richmond.
Chas. R. Dryer	Terre Haute.
A. Wilmer Duff	Lafayette.
Joseph Eastman	Indianapolis.
E. S. Elder	Indianapolis.
Samuel G. Evans	Evansville.

E. M. Fisher . . . . . Urmeyville.
J. J. Flather . . . . . Lafayette.
Robert G. Gillum . . . . . Terre Haute.
U. F. Glick . . . . . Newbern.
Katherine E. Golden . . . . . Lafayette.
Michael Golden . . . . . Lafayette.
C. F. Goodwin . . . . . Brookville.
S. S. Gorby . . . . . Indianapolis.
Vernon Gould . . . . . Rochester.
Edwin Stanton Hallett . . . . . Corydon.
A. S. Hathaway . . . . . Terre Haute.
Wm. Perry Hay . . . . . Irvington.
Franklin W. Hayes . . . . . Indianapolis.
Robert Hessler . . . . . Indianapolis.
T. H. Hibben . . . . . Indianapolis.
Geo. C. Hubbard . . . . . Moore's Hill.
J. W. Hubbard . . . . . Bloomington.
Thomas M. Iden . . . . . Irvington.
Alex. Jameson . . . . . Indianapolis.
A. E. Jessup . . . . . Carmel.
Sylvester Johnson . . . . . Irvington.
W. B. Johnson . . . . . Franklin.
E. M. Kindle . . . . . Bloomington.
J. G. Kingsbury . . . . . Irvington.
W. H. Kirchner . . . . . Minneapolis, Minn.
Ph. Kirsch . . . . . Columbia City.
Daniel Layman . . . . . Indianapolis.
W. S. Lemen . . . . . Indianapolis.
Robert E. Lyons . . . . . Bloomington.
Herbert W. McBride . . . . . Chicago, Ill.
Robert Wesley McBride . . . . . Indianapolis.
Kate McCarthy . . . . . Wabash.
D. T. McDougal . . . . . Minneapolis, Minn.
F. M. McFarland . . . . . Palo Alto, Cal.
J. W. Marsee . . . . . Indianapolis.
C. Leo Mees . . . . . Terre Haute.
W. J. Moenkhaus . . . . . Bloomington.
G. T. Moore . . . . . Crawfordsville.
Joseph Moore . . . . . Richmond.
Warren K. Moorehead . . . . . Xenia, Ohio.
J. P. Naylor . . . . . Greencastle.
Charles E. Newlin . . . . . Indianapolis.
E. W. Olive . . . . . Crawfordsville.
J. H. Oliver . . . . . Indianapolis.
D. A. Owen . . . . . Franklin.

Elwood Pleas	Dunrieth.
Ryland Ratliff	Fairmount.
Thomas B. Redding	New Castle.
D. C. Ridgley	Delphi.
George L. Roberts	Greensburg.
L. J. Rettger	Terre Haute.
John F. Schnaible	Lafayette.
J. T. Scovell	Terre Haute.
C. E. Schafer	Huntington.
G. W. Sloan	Indianapolis.
Harold B. Smith	Lafayette.
M. C. Stevens	Lafayette.
Joseph Swain	Bloomington.
A. E. Swann	Indianapolis.
Geo. A. Talbert	Laporte.
Frank B Taylor	Ft. Wayne.
Erastus Test	Lafayette.
F. C. Test	Washington, D. C.
Wm. M. Thrasher	Irvington.
A. L. Treadwell	Oxford, Ohio.
Joseph H. Tudor	Baltimore, Md.
E. B. Uline	Lake Forest, Ill.
A. B. Ulrey	Bloomington.
F. A. Walker	Anderson.
W. O. Wallace	Wabash.
F. M. Webster	Wooster, Ohio.
M. W. Wells	Indianapolis.
J. R. Wiest	Richmond.
H. W. Wiley	Washington, D. C.
A. J. Woolman	Duluth, Minn.
J. S. Wright	Indianapolis.

Honorary fellow	1
Fellows	28
Non-resident members	10
Members	107
Total	146

REPORT OF THE BOTANICAL DIVISION OF THE INDIANA STATE BIOLOGICAL SURVEY.

LUCIEN M. UNDERWOOD, DIRECTOR.

The Indiana Academy of Science at its spring meeting originated the State Biological Survey by the appointment of three directors who were instructed to organize the survey and prepare for the winter meeting a Bibliography that would show the present status of the knowledge of the state flora and fauna, recording in accessible form what had been already written concerning them. It was further thought desirable to outline certain features of new work that could be reasonably attempted during the season of 1893. In order to make known the purposes of the survey the following general statement was published and somewhat widely distributed through the state in July last:

BIOLOGICAL SURVEY OF INDIANA.

CIRCULAR NO. 1.

At the last meeting of the Indiana Academy of Science, at Terre Haute, a Biological Survey was established for the State of Indiana, and the undersigned were appointed Directors to organize the survey and outline the preliminary work ordered by the Academy.

It is the purpose of the survey:—(1) To ascertain what has already been accomplished in the direction of making known the character and extent of the life of the state, and to this end to prepare a complete bibliography of materials bearing on the botany, zoology and palæontology of Indiana, to be published by the Academy. (2) To associate the various workers throughout the state, and so correlate their labors that all will work together towards a definite end, and ultimately accomplish the main purpose of the survey, namely,—the making known of the entire fauna and flora of Indiana, its extent, its distribution, its biological relations, and its economic importance. (3) To stimulate the teachers of biology throughout the state to encourage in their pupils the accumulation of material, which shall make known the local extent and distribution of life-forms, and thus contribute facts that will be useful in the survey and at the same time develop acute observers for continuing the study of the natural resources of the state. It is thus intended that the colleges and secondary schools will form with the survey a mutually helpful relation. (4) Ultimately to secure for the Academy a collection that will illustrate the biology of the

state. Until such collection can be otherwise provided for, the Academy will designate certain public or private collections where accumulated material may be deposited temporarily. Material sent to the directors will be thus held for the future disposition of the Academy.

It is earnestly requested that all persons interested in any department of biological work will place themselves in relation with the directors of the survey at once, in order that their work may be made to contribute the most effectively to the public good, and in order that the directors may know on whom they may depend for gaining information from various portions of the state. All contributions from persons interested will be properly credited in the reports of the survey. Correspondence is solicited with the director of the particular branch in which any one is interested, and such directions in regard to collecting and sending material will be given on application. By the assistance of the Smithsonian Institution, the directors are able to send printed directions for collecting to such as apply for them. (In ordering these it will be necessary to specify in what particular branch information is desired.)

Lucien M. Underwood, Greencastle, Ind.,
Division of Botany.
Carl H. Eigenmann, Bloomington, Ind.,
Division of Zoology.
Vernon F. Marsters, Bloomington, Ind.,
Division of Paleontology.

1 July 1893. *Directors of the Biological Survey of Indiana.*

In addition to the above the following was sent out by the Botanical Division:

SPECIAL ANNOUNCEMENT OF THE DIVISION OF BOTANY.

It is the purpose of this Division during the present year to make such additions and corrections to the published "Catalogue of the Plants of Indiana" as are possible, and to secure definite information regarding the distribution of such rare forms as are there published. Specimens illustrating the distribution or occurrence of any plant within the limits of the state must be deposited with the survey before any notice of their belonging to the state flora can be published. This will insure the ability to verify in future any fact published by the survey. In sending such material it is desirable that notes on the station, habitat, range and abundance of the plant be noted, together with any other information that will be of value.

In addition to the flowering plants and ferns covered in the above, it is the intention of the Division to commence the study of the distribution of the lower cryptogams, concerning which almost nothing has been published from Indiana. While collections will be made of all forms, special attention will be given at present to the study of (1) Mosses, (2) Hepaticæ, and (3) Parasitic Fungi. Specimens are earnestly desired of all species,

even those that are most common, from all portions of the state. It is desirable to state with each species the data indicated above, with particular reference to the habitat. In the case of parastic fungi, it is necessary to indicate the host, and to include sufficient quantity of the host plant, that doubtful determinations may be verified. The director has been promised the assistance of specialists in the study of material accumulated.

LUCIEN M. UNDERWOOD, Director,
Greencastle, Ind.

The Bibliography called for by the Academy has been prepared and is presented with this report as Appendix A. It has involved the actual page to page examination of large files of journals and while doubtless incomplete will when published serve as a basis for periodical additions.

As far as possible, personal collections have been made; but with the demands of a full laboratory upon the director there has been little time for either extensive field work or opportunity to fully determine the material collected. The season also was especially unfavorable from the long drought that lasted from June to September. In addition to the spring excursion to Vigo county I made a second trip to the same region in late October. One trip was made to Lake Maxinkuckee and the tamarack swamps in the vicinity of Kewanna, Fulton county. Another was made to Brown county in May. Two trips were made to Eel River Falls in Owen county, one in May and the other in October. Some collecting was done in the vicinity of Crawfordsville but the greater amount has been accomplished in the vicinity of Greencastle in Putnam county. While all groups of cryptogams have been collected, special attention has been given to those mentioned in the circular. Of the parasitic fungi the fullest collections were made in the Erysipheæ. Of these we have doubtless an almost complete collection and a few comparisons with the flora of adjoining states may be to the point. In Illinois, the report by Burrill and Earle* includes 27 species. Of these all but one have been found in Indiana (*Sphærotheca pruinosa* C. & P., on *Rhus glabra*). In Ohio the report of Selby† includes 24 species. Of these all have been found in Indiana except the unique *Uncinula Columbiana* on *Scutellaria lateriflora*. The entire number found in Indiana is 33 which exceeds the Illinois list by 6 species and the Ohio list by 9 species. Of other groups, the Uredineæ have been most abundantly collected. So far, the Ustilagineæ and Peronosporeæ have not been found abundant.

*Burrill and Earle, Parasitic Fungi of Illinois. Part II. Bull. Illinois State Lab. Nat. Hist. 2: 387–432, 1887.

†Selby. The Ohio Erysipheæ. Bull. Ohio Agric. Exp. Sta. 1: 213–224. Ap. 1893.

In addition to the personal collections above noted, there has been a reasonable amount of willingness expressed on the part of botanists elsewhere in the state to co-operate in making known the cryptogamic flora of their respective localities. The most serviceable aid in this direction has been rendered by Professor M. B. Thomas, and his assistant, Mr. E. W. Olive. During the past autumn they have collected and identified 120 species of parasitic fungi from the vicinity of Crawfordsville. It is likely that during the present winter season and especially during the coming summer we may hope for much local work of this character. So long as the survey is conducted on a purely voluntary basis this local work is a necessity and it is to be hoped that by this means much will be accomplished in the direction of determining the extent and range of our flora. One great lack among local workers is the lack of literature. So far as the colleges are concerned only three, perhaps, offer more than minimum opportunities in this direction. So far as I am aware there is only one copy of Saccardo's *Sylloge Fungorum* in any library in the state, and other literature is almost equally lacking, even in libraries where more is expected. There has also been a seeming fear on the part of some that work in systematic botany would prove an injury if attempted in connection with a course of botanical study, and that anything short of work in cytology was undignified in a botanical laboratory. It is certain that the swing of the pendulum has reached its outward limit in this direction and that systematic botany, particularly that of the cryptogams is likely to demand more serious and general work than it has hitherto been accorded in America. So far as the laboratory with which the director is concerned, we will say that the fullest opportunities will be given to any local workers who may wish to use its library *and collections.

In order to make representative species more accessible to local workers, the survey has planned the issue of a series of exsiccatæ of Indiana cryptogams for distribution among public and private collections, where they may become serviceable. The conditions of this gratuitous distribution will be given privately, though it may be here stated that sets will be placed in at least four of the colleges of the state that maintain a permanent herbarium. Of course the labor involved in preparing these sets

*Ample works are here accessible for ordinary systematic reference in the fungi, hepaticæ and musci. The literature of the algæ and lichens though considerable is not so extensive. The same is even more true of the collections, as may be seen in the note below.

makes the number to be issued very limited. The first two fascicles of Parasitic Fungi (100 species) are nearly ready for distribution. If the matter receives sufficient encouragement, succeeding fascicles will illustrate the Musci, Hepaticæ, Hymenomycetes, Pyrenomycetes and Lichenes, respectively.

Turning now to the higher plants, we find them, of course, better known but their local distribution is a matter of great interest and one on which little definite information is at hand. In the only published state flora* 1,475 species are recorded. Many additions have been made to this list by more or less reliable collectors, and the thorough examination of the unexplored portions of the state will doubtless reveal many others. The accompanying map will show how much of Indiana is yet a *terra incognita* botanically.† As an illustration of how common plants may be passed by, I will cite the case of the common cockle-bur. In the state flora *Xanthium strumarium* and *X. spinosum* are recorded. Growing with the former in Putnam county though less common is the allied *X. Canadense* and we have also found it in the vicinity of Crawfordsville. The two, quite similar in appearance, though common weeds, have evidently been confused together though both are doubtless more or less widely distributed, especially in the northern portions of the state.

The revision of the higher flora we have placed in the hands of Professor Stanley Coulter to whom all material will hereafter be referred. Professor Coulter has at our request prepared a paper on the present status of the Phaneroganic Flora of the state. It is desired in this connection (1) To ascertain what plants have been added to the flora since the catalogue was published, by securing either from those who originally reported them or otherwise a set or sets of these plants that may be placed in some herbaria for future reference. A list of these will be published later but it is the intention of the survey to admit no empty names to the list; until the plants themselves accompany the name as a voucher, they will be rigorously excluded. (2) To verify the plants of the catalogue itself either by material now in some existing collection or by the collection of new material in the original or other localities. It is thus intended to have some-

*Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Indiana. By editors of the Botanical Gazette and Prof. Charles R. Barnes, Crawfordsville, Indiana, 1881. Supplement I. April, 1882.

†The map presented with this report is not reproduced here. It showed that less than one-third of the counties had been entered by a field botanist, and that not over a dozen could be said to have been botanically explored.

where an accessible set of the plants of the entire state which may serve as the basis of a complete catalogue.

In regard to the assistance that local and amateur botanists can render the survey we will say that their work can be made of inestimable value if properly directed. The publication of county lists with nothing back of them except the opinions of persons whose general acquaintance with the flora of the country is slight, is not to be encouraged. Back of every note and every local list there ought to be a well kept collection, and in the case of rare plants there should be duplicates placed in some one of the larger public collections so that the identity of the plant in question can be placed beyond the danger of being lost as soon as the novelty of the first collection wears off. The colleges at least where botany is made a subject of some importance ought to have a collection of state plants for constant reference. In some of the larger high schools also the collection of the local flora can be made a useful adjunct of the year's study of botany and the town high school can thus serve as a local centre of botanical interest that will keep alive the local development of the subject among many who would otherwise drift away from botany into something else. Nor should this interest be confined to "manual" plants. Mosses, lichens, fungi and algæ should also form a rational part of the field study even in the high school period.

Finally we invite a thorough co-operation of all the workers of the state to assist in placing the definite record of the Indiana flora in safe keeping, and develop as widely as possible the knowledge of the extent and distribution of the plants of the state.

It is deemed advisable to present as complete a list as possible of the Indiana cryptogams that have been collected already in order that it may serve as the starting point for further work. In this list nothing is admitted unless accessible specimens exist in some collection that is likely to become permanent.* We include therefore the following material:

* Most of the specimens herein named are deposited in the Underwood Herbarium as probably the largest cryptogamic collection in the state. This collection so far as the plants below the Pteridophytes are concerned contains the various groups as follows:

Musci—About 900 species represented by about 3,000 specimens.

Hepaticæ—About 1,300 species represented by about 7,000 specimens.

Fungi—About 3,500 species represented by about 9,000 specimens.

Lichenes—About 300 species represented by about 800 specimens.

Algæ—About 200 species represented by about 300 specimens.

With the Pteridophytes of the collection the herbarium contains nearly 8,000 species represented by some 25,000 specimens. Except the ferns, this collection has been accumulated mainly since 1887 and contains numerous rare exsiccatæ.

1. Material collected mostly about Lafayette by Dr. J. C. Arthur and H. L. Bolley. This is preserved in their own private collections and in most cases duplicates have been been placed at my disposal.

2. Some mosses collected by W. S. Blatchley in Monroe and Vigo counties.

3. Material collected by E. M. Fisher mostly in Montgomery and Johnson counties and deposited in the herbarium of the Department of Agriculture (Division of Vegetable Pathology).

4. Material collected by M. A. Brannon illustrating a paper on "Some Mildews of Indiana," read before the Academy 1889. Duplicates of most of this material have also been placed at my disposal.

5. Material collected in the vicinity of Crawfordsville in 1893 mainly by E. W. Olive. Duplicates of this material have been contributed to the survey.

6. Material collected by the writer in various counties of the state, 1891-1893, including that collected since the organization of the survey.

7. Occasional miscellaneous species collected by various individuals and in our possession.

The above represents all the cryptogamic material that is known to belong to the state flora that is accessible at present. Some few additional lists have been published but as they are not represented by accessible specimens they are not considered here.

Thanks are due to the following who have identified certain materials in the line of their specialties: Prof. D. C. Eaton, Prof. R. Thaxter, Prof. G. F. Atkinson, Prof. C. E. Cummings, Prof. C. R. Barnes, Charles H. Peck, J. B. Ellis, E. W. D. Holway. Much assistance has been rendered by various students in my laboratory in the preliminary determination of material.

Thanks are also due to the managers of the Vandalia road for various favors that have made more extensive collections possible.

LUCIEN M. UNDERWOOD.

Greencastle, Indiana, December 5, 1893.

APPENDIX A.

BIBLIOGRAPHY OF INDIANA BOTANY.

Comparatively little material is at hand to record the early botanical work done within the limits of the present state of Indiana, though it is doubtless a fact that could the history be correctly told it would present many features of interest. The first recorded item of the history dates back just a century for we know that Michaux came to Louisville, Kentucky, in July 1793, and collected plants in that vicinity, and that later (1795), he ascended the Wabash as far as Vincennes. Thomas Nuttall botanized along the Ohio river to its mouth in 1818. A little later the erratic Rafinesque, who was professor of natural science in the University of Lexington, Ky., 1819-1826, collected in states to the north and south of his home and was an occasional visitor in our state. The establishment of the communistic society at New Harmony made that place a rendezvous for all the visiting naturalists and when the full history of that enterprise is written, there will be much of interest connected with these visits. Among them Maximilian, Prince of Neuwied, spent a winter there (1832-3) and published a list of the trees of the vicinity in 1839. During this period also, Riddell and Short were botanizing along the southern borders of the state, and Lapham of Wisconsin, occasionally collected grasses and other plants in the northern parts. In 1835 Dr. Clapp of New Albany made considerable collections in that vicinity, a part of which is still preserved in the herbarium of Wabash College. Alphonso Wood once resided at Terre Haute and made considerable collections in the state.

The commencement of the series of county floras was made by Professor A. H. Young for Jefferson county in 1871, soon followed by one for the lower Wabash Valley by Dr. Schneck of Mt. Carmel, Ill. Two additional lists of Jefferson county plants have been made, the second by John M. Coulter and the third by Charles R. Barnes. Other similar lists have followed: for Noble county by Van Gorder, Steuben by Bradner, East Central Indiana by Phinney, Franklin by Meynke, Dearborn by Collins, and Clark by Baird and Taylor. In addition to these several have been prepared, but not published: Putnam by MacDougal, Monroe and Vigo by Blatchley, Henry by Mrs. Mikels, and Knox by Spillman. The unfortunate feature about most of these publications is the fact that nothing exists but the original list. In many cases not a single specimen stands behind the list, so

that verification of doubtful plants will be impossible until additional material is collected.

Probably the greatest impetus to the study of Botany in Indiana was given by the founding of the Botanical Bulletin in November 1875, soon changed to the Botanical Gazette. Its original form was quite unlike its present magnitude—a four page sheet without cover in place of its present 40 page issue. Its contents also were as unlike the present as can be well imagined and the file of this journal may well be taken to represent the splendid progress made in the science of Botany in America during the past two decades. The first numbers were largely filled with local notes and the entire journal during the first few years of its existence shows its strictly provincial character. In 1881 this journal published a catalogue of the state flora including nearly 1,500 plants stopping with the ferns. In the preparation of this flora, much assistance was received from Rev. E. J. Hill regarding the flora of the northern counties of the state and he has since contributed many notes regarding the rarer plants of that region. This portion of the state has further received some attention from Messrs. Higley and Raddin in their flora of Chicago and vicinity.

The story of the study of the cryptogamic flora of the state is soon told. *Uromyces lespedezæ* seems to have been the first of the lower cryptogams to be reported in 1876 by John M. Coulter. Sixty-nine species of mosses were reported from Southern Indiana by A. H. Young in 1876, and a number of Mosses and Lichens were reported from Wayne county by Mrs. Haines. Both these collections are in existence but they are not accessible for reference at the present time. H. L. Bolley and Dr. J. C. Arthur have collected some material from the vicinity of Lafayette; among that collected by Mr. Bolley were several interesting Uredineæ on Carex and other Cyperads. Those collected by Dr. Arthur were mostly species of economic interest. In 1890 E. M. Fisher, under appointment of the Department of Agriculture at Washington, collected a considerable number of parasitic fungi mostly in Montgomery and Johnson counties. J. N. Rose and M. A. Brannon have each had a brief struggle with the powdery mildews and W. H. Evans at one time made some collection of the lichens, but the material does not seem to be in existence at present. Dr. Julius Röll made extensive collections of mosses in America and a considerable number of species from Hobart, Indiana are included in his list. This sums up in brief, the history of botanical collection and local workers in Botany to the time of the organization of the Biological Survey.

The following papers have been published to date which bear more or less directly on the state flora. Many additional data concerning Indiana plants are given in the various manuals of botany which have not been included in this enumeration:

Arthur, Joseph Charles. Spotting of Peaches and Cucumbers. Bull. Ag. Exp. Sta., Indiana, No. 19. (Jan. 1889.)
Account of *Cladosporium carpophilum* and *C. cucumerinum*.

———Smut of Wheat and Oats. Bull. Ag. Exp. Sta., No. 28. (Sept. 1889.)
Account of *Tilletia foetens* and *Ustilago avenæ*.

———Treatment of Smut in Wheat. Bull. Ag. Exp. Sta., No. 32. (July, 1890.)
Methods of controlling stinking smut of wheat (*Tilletia foetens*).

———The Loose Smut of Oats. Bull. Ag. Exp. Sta., No. 35. (Mar. 1891.)
Account of treatment of *Ustilago avenæ*.

———Treatment of Powdery Mildew and Black Rot. Bull. Ag. Exp. Sta., No. 38. (March, 1892.)
Brief account of treatment of *Uncinula ampelopsidis* and *Læstadia Bidwellii*.

Arthur, J. C., and Golden, Katherine. Diseases of the Sugar Beet Root. Bull. Ag. Exp. Sta., No. 39. (April, 1892.)
Account of "Beet Scab," attributing it to a bacterial disease.

Bailey, Liberty Hyde. Limits of Michigan Plants. Bot. Gazette, 7: 105–108. (Sept. 1882.)
Notes on some Indiana plants.

Baird, John F., and Taylor, John L. The Flora of Clark county, Ind. Manual of the Pub. Schools of Clark county, Ind., for 1878–9, 45–65.

Barnes, Charles Reid. Notes [on various plants]. Bot. Gazette, 2: 120–121. (July, 1877.)

———Addenda [to flora of Jefferson county]. Bot. Gazette, 3: 13. (February, 1878.)
Adds three species to previous lists.

———Catalogue of Phænogamous and Vascular Cryptogamous Plants found growing wild in Jefferson county, Indiana, to which is added a list of plants growing in Clark county, but not found in Jefferson, by John F. Baird. 8 vo.: pp. 9. (?)

Barnes, C. R., Brotherus, Dr., Venturi, Dr. v., Renauld, F., Cardot, J., Röll, J., Stephani, F. Nord-Amerikanische Laubmoose, Torfmoose und Lebermoose gesammelt von Dr. Julius Röll in Darmstadt. Hedwigia, 32: 181–203, 260–309, 334–402. (1893.)
Includes species collected at Hobart, Indiana: 49 Musci, 9 Sphagnaceæ, 5 Hepaticæ, with several new varieties.

Benedict, A. C., and Elrod, M. N. A partial list of the Flora of Wabash and Cass counties, with notes. 17th Ann. Rept. Geol. Survey, 260–272. (1892.)
List of 92 plants.

Blatchley, W. S. On Weeds in general, and our worst weeds in particular. Indiana Farmer. (8 March, 1890.)
Includes list of 20 worst weeds of Indiana, and some account of their origin in the state.

———The Ironweed. Indiana Farmer. (4 October, 1890.)
Discusses habits and general character as a weed.

Bolley, H. L. The Heteroecismal Pucciniæ. Am. Month. Micros. Jour., 10: 169–180, plate. (1889.)
Illustrates *Puccinia Bolleyana* and gives account of the change of host plants for several species.

———Sub-epidermal Rusts. Bot. Gazette, 14: 139–145. Pl. 15. (June, 1889.)
Notes on various Indiana species of *Puccinia*.

———Wheat Rust. Bull. Ag. Exp. Sta., No. 26. (July, 1889.)
Account of *Puccinia graminis, P. coronata, P. rubigo-vera*.

Botanical Gazette. Some Big Trees of Indiana. Bot. Gazette, 5: 69–70. (May, 1880.)
Quotes notes from Case's Botanical Index.

———Notice of Catalogue of the Flora of Indiana. Bot. Gazette, 6: 179. (Jan. 1881.)
Note to effect that work through Compositæ was done by C. R. Barnes, and that remaining work was to be done by editors.

———Flora of Indiana. Supplement I. (April, 1882), pp. 1–4.
List of 43 additions, bringing the number of vascular plants of Indiana to 1,475.

———New Indiana Plants. Bot. Gazette, 8: 285. (Aug. 1883.)
Notes four additions to the state flora.

Bowers, Homer. A contribution to the life history of Hydrastis Canadensis. Bot. Gazette, 16: 73–82. Pl. 8. (March, 1891.)
Notes on life history and probable extinction of the species in Indiana.

Bradner, E. A partial Catalogue of the Flora of Steuben county. 17th Ann. Rept. Geol. Survey, 135–159. (1892.)
List of 729 species.

Collins, S. H. A partial flora of Dearborn county, Indiana, and vicinity. 16th Ann. Rept. Dept. of Geology and Natural History, 376–382. (1889.)
List of 248 species.

Copeland, Herbert E. Cyclostoma platyphyllum Moquin. Bot. Bulletin (now Bot. Gazette), 1: 6. (Dec. 1875.)

Notes this plant as established on Fall creek. Also, *Nasturtium sessiliflorum* and *Dactyloctenium Egyptiacum* in Indianapolis.

Coulter, John Merle. Sullivantia Ohionis. Amer. Nat., 9: 572. (1874.)

Its occurrence near Hanover, with some account of its habitat.

———Partial list of the flora of Jefferson county. 6th Ann. Rept. Geol. Survey, 229–277. (1875.)

List of 722 species.

———Aster Novæ-Angliæ. Bot. Bulletin (now Bot. Gazette), 1: 2. (Nov. 1875.)

Notes on habits of plants growing in vicinity of Hanover.

———Querci near Hanover, Ind. Bot. Bull., 1: 2. (Nov. 1875.)

Mentions nine species in vicinity.

———Diarrhena Americana Beauv. Bot. Bull., 1: 6. (Dec. 1875.)

Notes occurrence of this plant in Clifty Ravine.

———Dentaria laciniata Muhl. Bot. Bull., 1: 8. (Dec. 1875.)

Notes variations of this plant in vicinity; suggest union of several species of Dentaria under one name.

———An interesting herbarium. Bot. Bull., 1: 9–10. (Jan. 1876.)

Account of the collection of Dr. Clapp, who collected in vicinity of New Albany, 1835–6, then preserved by the Natural History Society of that place.

———Some effects of the unusual season. Bot. Bull., 1: 11–12. (Jan. 1876.)

Notes blossoming of various plants in December, 1875, in various parts of state.

———Some plants noted in Carroll county, Indiana. Bot. Bull., 1: 12. (Jan. 1876.)

Notes richness of flora of Wabash valley.

———Some early plants. Bot. Bull., 1: 15. (Feb. 1876.)

Notes early blossoming of plants, January, 1876.

———Uromyces lespedezæ (Schw.) Bot. Bull., 1: 20. (March, 1876.)

Notes occurrence of this rust as plentiful on *L. violacea*. Quotes letter from C. H. Peck, naming the fungus, which seems to have been the first collected in the state of which we have any definite record.

———Some plants new to the Flora of Jefferson county. Bot. Bull., 1: 34–35. (June, 1876.)

Notes on the occurrence of numerous plants not included in the two lists of the Geol. survey.

———Plants new to Jefferson county. Bot. Bull., 1: 38. (July, 1876.)

Additional list collected by A. H. Young.

———Some Carices near Hanover, Ind. Bot. Bull., 1: 38–40. (July, 1876.)

List of 24 species, with notes.

———The "Knobs" of Southern Indiana. Bot. Bull., 1: 41–42. (August, 1876.)

Brief account of the flora of this region in Clark and Floyd counties.

———Magnolia acuminata L. Bot. Bull., 1: 44. (August, 1876.)
Notes on this species near Hanover, Ind.

———Conobea multifida Benth. Bot. Bull., 1: 47. (Sept. 1876.)
Notes on this species from Kirkville, Ind.

———Some river bank flowers. Bot. Bull., 1: 51–52. (Oct. 1876.)
Notes on plants growing in the alluvium of the Ohio river near Hanover, Ind.

———Aster oblongifolius Nutt. Bot. Gazette, 2: 65–66. (Dec. 1876.)
Notes occurrence in Jefferson county.

———Natural grafting. Bot. Gazette, 2: 137. (Sept. 1877.)
Notes *Carpinus* growing on trunk of *Fagus* near Hanover.

———Spermacoce glabra Michx. Bot. Gazette, 2: 137–138. (Sept. 1877.)
Note of station near Hanover.

———The "Barrens" of Southern Indiana. Bot. Gazette, 2: 145–146. (Oct. 1877.)
Brief account of the flora of these regions, located in Clark, Floyd, Washington and Harrison counties.

———Some new stations. Bot. Gazette, 3: 24. (March, 1878.)
Notes on rare plants of Clark county.

———The Flora of Northern Indiana. Bot. Gazette, 4: 109–113. (Jan. 1879.)
Notes based largely on a botanizing trip along the L. S. & M. S. R. R.

———A natural Botanic Garden. Bot. Gazette, 5: 70. (May, 1880.)
Notes on flora of Wabash College campus.

———A comparative view of the Flora of Indiana. Bot. Gazette, 6: 301–302. (Dec. 1881.)
Gives comparative statistics of the flora of Indiana, Washington, D. C., and eastern United States.

———Some Notes on Physostegia Virginiana. Bot. Gazette, 7: 111–112. (Sept. 1882.)
Notes the flowers as cataleptic.

Coulter, J. M., Coulter, M. S., and **Barnes, C. R.** Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Indiana. 8 vo. pp. 38. Crawfordsville (1881.)
List of 1,432 species.

Coulter, John M., and **Thompson, Harvey.** Origin of the Indiana Flora. 15th Ann. Rept. Geol. Survey, 253–282. (1886.)

Coulter, [M.] Stanley. On the size of forest trees in Jefferson county, Ind. Bot. Bull. 1: 10. (Jan., 1876.)
Notes large trees, especially *Platanus occidentalis, Fagus ferruginea* and *Liriodendron Tulipifera.*

———The numerical relations existing among the forest trees of Jefferson county, Ind. Bot. Bull., 1: 15. (Feb. 1876.)
Gives relative abundance in per cents: *Fagus ferruginea* leads with 35 per cent.

———The forest trees of Cass County, Ind. Bot. Bull., 1: 42–43. (Aug. 1876.)
Notes on relative abundance; the *Querci* forming 50 per cent.

———Note on Euphorbia marginata. Bot. Gazette, 2: 63. (Dec. 1876.)
Note on naturalization of this plant on Eel river.

———The Forest Trees of Indiana, their distribution and economic value. Trans. Indiana Horticultural Society, 1891, 157–192 (1892.) Also, separate pp. 36.
List of 108 species, with notes on distribution and economic characters.

Curtiss, George L. Diatoms of the waters of Indiana. 12th Ann. Rept. Geol. Survey, 377–384, Pl. 33–38. (1883.)
Figures numerous species of Diatoms: a few of the figures named.

Elliott, Thomas B. The trees of Indiana. Trans. Indianapolis Acad. Science, 72–86. (1872.)
[Not seen; inserted on authority of Dr. N. L. Britton's State and Local Floras.]

Geddes, W. N. Some great ragweeds. Bot. Bull., 1: 14–15. (Feb. 1876.)
Notes *Ambrosia trifida* 12 to 18 feet high near Hanover.

Gorby, S. S. Geology of Miami county. 16th Ann. Rept. Dept. of Geology and Natural History, 165–188. (1889.)
Includes list of trees and shrubs, pp. 168–170.

Grahn, E. G. Microscopical Notes. Bull. Brookville Soc. Nat. Hist., No. I., 39–41. (1885.)
List of 46 Diatomaceæ and 2 Desmidiaceæ from vicinity of Brookville.

Haines, Mary P. List of Ferns, Mosses, Hepaticæ and Lichens collected in Wayne county. 8th, 9th and 10th Ann. Rept. Geol. Survey, 235–239. (1879.)

Higley, William K. and Radden, Charles S. The flora of Cook county, Illinois, and a part of Lake county, Indiana. Bull. Chicago Acad. Sci. II: i—xxiii, 1—168, with map.
Phanerogams and Pteridophytes of Lake county north of the Little Calumet river.

Hill, E. J. Botanical Notes. Bot. Gazette, 6: 259–263. (Sept. 1881.)
Localities for various plants in Northern Indiana.

———Eleocharis dispar n. sp. Bot. Gazette, 7: 3. (Jan. 1882.)
From Lake county: referred by Gray's Manual to E. capitata R. Br.

———Notes on Indiana Plants. Bot. Gazette, 7: 187–188. (March, 1882.)
Gives stations of new plants from Lake county.

———Notes on Indiana Plants, 1883. Bot. Gazette, 9: 45–48. (March, 1884.)
Various Lake county stations.

———Some Indiana Plants. Bot. Gazette, 10: 262–263. (April, 1885.)
Stations in Lake and Porter counties.

———Some Indiana Plants. Bot. Gazette, 13: 323. (Dec. 1888.)
Notes on certain plants of the northern counties.

———Notes on the Flora of Chicago and vicinity. Bot. Gazette, 17: 246–252. (August, 1892.)
Notes on a few Lake county species.

Hussey, John. Regular flower in Pedicularis Canadensis. Bot. Gazette, 4: 166–167. (June, 1879.)
Note on form, from near Lafayette.

Lapham, Increase A. The Grasses of Wisconsin and the adjacent states of Iowa, Illinois, Indiana, Ohio and Michigan, and the territory of Minnesota and the region about Lake Superior. Trans. Wis. State Ag. Soc., 3: 397–488. (1853.)

Maximilian, Alexander Philip (Prince of Neuwied). [List of trees in vicinity of New Harmony.] Reise in das innere Nord-Amerika, 1: 209, (Coblenz, 1839.)
Includes list of 60 species of trees.

Meyncke, O. M. A large red-bud. Bot. Gazette, 7: 36. (March, 1882.)
Tree 14 inches in diameter near Brookville.

———The Flora of Franklin county. Bull. Brookville Soc. Nat. Hist., No. 1: 13–38 (1885); No. 2: 45–49 (1886).

Phinney, A. J. Catalogue of the Flora of Central Eastern Indiana. (Alpine or elevated district of the State.) 12th Ann. Rept. Geol. Survey, vey, 196–243. (1883.)
Mainly from Delaware and Wayne counties.

Riddell, John L. Synopsis of the Flora of the Western States. Western Journ. of Med. and Phys. Sciences, 7: 329–374 (Jan. 1835); 489–556 (April, 1835.)
Intended to cover Ohio, Indiana, Illinois, West Tennessee, Missouri and Northwest Territories.
List of 1,802 species, including mosses, hepaticæ and lichens.

Ridgway, Robert. Notes on the Native Trees of the Lower Wabash and White river valleys in Illinois and Indiana. Proc. U. S. Nat. Mus., –: 49–88. (1882.)
Valuable notes on 92 species of trees.

———Additions and corrections to the list of native trees of the Lower Wabash. Bot. Gazette, 8: 345–352. (Dec. 1883.)

Rose, Joseph N. Nostoc and Penicillium in Na C_2 H_3 O_2. Bot. Gazette, 10: 280. (May, 1885.)
Note on occurrences of these plants in a four per cent. solution of sodium acetate.

———Notes on the conjugation of Spirogyra. Bot. Gazette, 10: 304–306, Pl. 7. (July, 1885.)
Diverse methods of conjugation studied at Wabash College.

———Mildews of Indiana. Bot. Gazette, 11: 60–63. (March, 1886.)
Enumerates 12 species of Erysiphei.

———Selinum Canadense in Indiana. Bot. Gazette, 11: 338. (Dec. 1886.)
Notes discovery of station of this plant near Crawfordsville.

Schneck, J. Flora of the Lower Wabash valley, below the mouth of the White river. 7th Ann. Rept. Geol. Survey, 504–579. (1876.)
List of 867 species, some of which belong to the flora of Illinois.

———Some plants of the Lower Wabash. Bot. Gazette, 2: 83. (Feb. 1877.)
26 plants added to his previous list.

Thompson, Maurice. Geographical Botany. 15th Ann. Rept. Geol. Survey, 242–252. (1886.)
Introduction to paper by Coulter and Thompson.

———Preliminary sketch of the characteristic plants of the Kankakee region. 16th Ann. Rept. Dept. of Geol. and Nat. Hist., 155–161. (1889.)
Brief list of a few common plants.

———Geological and Natural History Report of Carroll county. 17th Ann. Rept. Geol. Survey, 171–191. (1892.)
Contains a partial list of plants, pp. 188–190.

Thompson, Harvey. Origin of the Flora of Indiana. Bot. Gazette, 11: 88–90. (April, 1886.)
Resumé of longer article, by Coulter and Thompson.

Troop, J. Grasses of Indiana. Bull. Ag. Exp. Sta., No. 29. (Dec. 1889.)
Descriptions of 128 grasses known to inhabit Indiana, with figures of several.

Underwood, Lucien Marcus. Some Additions to the state Flora from Putnam county. Proc. Ind. Acad. Sci., 1891, 89–91. (1892.)
Notes on *Eustichia Norvegica*, *Fossombronia cristata*, *Trametes ambigua*, *Hydnum stratosum*, *Cordyceps capitata*, *Phallus Ravenelii*.

———Edible Fungi.—A great waste of vegetable food in Indiana. Trans. Indiana Hort. Soc., 1893, 62–67. (1894.)
Popular account of the most common edible species, with plate.

Van Gorder, W. B. Catalogue of the Flora of Noble county, Indiana. Pp. 52. Kendallville, Ind. (1885.)
List of 693 species, 25 of which are not in state catalogue of 1881.

Young, A. Harvey. Manual of the Botany of Jefferson county. 2nd Ann. Rept. Geol. Survey, 253–292. (1871.)
List of 609 species.

———Notes on certain species of the genus Asplenium. Bot. Bull., 1: 2–3. (Nov. 1875.)

Notes on four species of Southern Indiana.

———Notes on some interesting plants found in Jefferson county. Bot. Bull., 1: 6–8. (Dec. 1875.)

Notes occurrence and stations of several rare plants.

———Notes upon some Gramineæ. Bot. Bull., 1: 18–20. (March, 1876.)

Notes based on collections in Jefferson county.

———Ferns near Hanover, Ind. Bot. Bull., 1: 22–23, 27. (April, May, 1876.)

Notes on habitat of twenty species of ferns.

———Bryological Notes. Bot. Gazette, 2: 61–62. (Dec. 1876.)

Includes list of 69 species from Southern Indiana, chiefly near Hanover.

———Jeffersonia diphylla Pers. Bot. Gazette, 2: 136–137. (Sept. 1877.)

Notes on variations.

———Habenaria peramœna Gray. Bot. Gazette, 2: 137. (Sept. 1877.)

Notes abundance near Hanover.

———Monotropa uniflora. Bot. Gazette, 3: 37–38. (April, 1878.)

Notes station in Jefferson county, and poisonous effect; *cf.* Bot. Gazette, 3: 54–55 and 79, on latter point.

UNPUBLISHED PAPERS READ BEFORE THE ACADEMY.

Blatchley, W. S. List of the plants of Monroe county, Ind. (Read, 1888.)

Paper accessible; many of the plants are in the herbarium of DePauw University.

———The Compositæ of Vigo county, Ind. (Read, 1889.)

Paper accessible.

———On some plants new to the state list. (Read, 1889.)

Paper accessible; many of the plants are in the herbarium of DePauw University.

Brannon, M. A. Some Indiana Mildews. (Read, 1889.)

Paper in the hands of the survey, also duplicates of many of the specimens.

Evans, Walter H. Lichens of Indiana. (Read, 1887.)

Paper not accessible; specimens ought to be at Wabash College, but cannot be found.

Fisher, E. M. Parasitic Fungi of Indiana. (Read, 1890.)

Paper not accessible; plants were collected for Div. of Veg. Pathology, U. S. Dept. Agriculture. Through the kindness of Prof. B. T. Galloway, a list of species collected is in possession of the survey.

Hubbard, G. C. Additions to the Flora of Indiana. (Read, 1886 and 1887.)

Papers not accessible as read; a complete list of plants collected by Mr. Hubbard in Indiana is in the possession of the survey.

MacDougal, Daniel T. The plants of Putnam county. (Read, 1889.)
Paper in the hands of the survey; most of the plants it represents are in the herbarium of DePauw University.

Meyncke, O. M. Notes on the White-spored Agarics of Franklin county, Ind. (Read, 1887.)
Paper not accessible; plants represented by the notes not preserved.

Mikels, Rosa Redding. Preliminary paper on the flora of Henry county, Ind. (Read, 1891.)
Paper accessible; few plants to represent the flora preserved.

Shannon, W. P. The Occurrence of Veratrum Woodii in Decatur county, Ind. (Read, 1890.)

Spillman, W. J. Preliminary list of Knox county plants. (Read, 1890.)
Paper not accessible; a list of Knox county plants in the herbarium of the writer is in the hands of the survey.

APPENDIX B.

LIST OF CRYPTOGAMS AT PRESENT KNOWN TO INHABIT THE STATE OF INDIANA.

In the following list specimens collected by various persons are duly credited; where no collector is named, the collection was made by the Director of the Survey. The plants collected by Mr. Fisher are in the U. S. Nat. herbarium; a few of these have not been collected by any one else. Unless a special statement is made, all species are represented in the Underwood herbarium; reference is made in brackets for those species not in our possession. A considerable amount of material including some interesting algæ has not been fully determined as yet, and some small collections have not been worked over.

MYXOMYCETES.

ARCYRIA CINEREA (Bull.) Schum. Vermillion, 7, 1889 (Arthur).

ARCYRIA PUNICEA Pers. Vermillion, 7, 1889 (Arthur); Putnam, 10, 1893

BADHAMIA UTRICULARIS (Bull.) Berk. Putnam, 10, 1893.

CERATIOMYXA MUCIDA (Pers.) Schröt. (*Ceratium hydnoides* Auct.) Vigo, 5, 1893.

COMATRICHA LONGA Pk. Putnam, 7, 1893.

DICTYDIUM LONGIPES Morg. Vermillion, 9, 1889 (Arthur).

DIDYMIUM FARINACEUM Schrad. Putnam, 5, 1892.

Didymium microcarpum (Fr.) Rost. Putnam, 3, 1894.

Fuligo septica (Link.) Gmel. Vermillion, 7, 1889 (Arthur); Putnam, 7, 1893.

Hemiarcyria clavata (Pers.) Rost. Putnam, 10, 1892.

Hemiarcyria plumosa Morg. Vermillion, 7, 1889 (Arthur).

Hemiarcyria rubiformis (Pers.) Rost. Vermillion, 7, 1889 (Arthur); Putnam, 10, 1892.

Lamproderma violaceum (Fr.) Rost. Putnam, 10, 1893.

Lycogala epidendrum Buxb. Putnam, 5, 1890 (Arthur); 10, 1891; 10, 1893.

Lycogala flavo-fuscum (Ehrenb.) Rost. Putnam, 11, 1893.

Stemonitis ferruginea Ehrh. Vermillion, 7, 1889 (Arthur). [Herb. Arthur.]

Stemonitis fusca Roth. Vermillion, 7, 1889 (Arthur).

Stemonitis nigrescens Rex. Putnam, 10, 1893.

Trichia scabra Rost. Tippecanoe, 2, 1892 (Arthur); Putnam, 10, 1892.

Trichia varia Pers. Putnam, 10, 1891; 10, 1892; 10, 1893.

Tubulina cylindrica (Bull.) D C. Vermillion, 7, 1889 (Arthur).

PHYCOMYCETES.

Synchitriaceæ

Synchitrium decipiens Farl.

On Amphicarpæa monoica, Putnam, 9, 1893; Johnson, 9, 1890, (Fisher).

Synchitrium fulgens Schröt.

On Œnothera biennis, Brown, 5, 1893.

Mucoraceæ.

Mucor stolonifer Ehrhenb.

On bread, Putnam, 1891.

Entomophthoraceæ.

Empusa Muscæ Cohn.

On flies, Putnam, 10, 1893.

Peronosporaceæ.

Albugo amaranthi (Schw.) Kuntze. (*Cystopus bliti*).

On Amarantus sp., Putnam, 10, 1892; Tippecanoe, 7, 1890 (Bolley).

On Amarantus chlorostachys hybridus, Johnson, 7, 1890 (Fisher).

On Amarantus retroflexus, Johnson, 7, 1890 (Fisher).

On Amarantus spinosus? Montgomery, 1893 (Olive).

Albugo candidus (Pers.) Kuntze. (*Cystopus candidus*).

On Sisymbrium officinale, Brown, 5, 1893; Putnam, 7, 1893.

On Capsella bursa-pastoris, Putnam, 4, 1892; Montgomery, 1893 (Olive).

On Radish, Putnam, 9, 1891; Johnson, 8, 1890 (Fisher).

On Sisymbrium canescens, Putnam, 5, 1893.

On Brassica nigra, Johnson, 7, 1890 (Fisher); Tippecanoe, 8, 1891 (Arthur).

On Brassica alba, Johnson, 7, 1890 (Fisher).

On Lepidium Virginicum, Montgomery, 1893 (Olive); Putnam, 4, 1894.

On Dentaria sp., Montgomery, 1893 (Olive).

Albugo ipomœæ-panduranæ (Schw.) Swingle.

On Ipomœa hederacea, Putnam, 9, 1893.

On Ipomœa pandurata, Johnson, 9, 1890 (Fisher).

Albugo portulacæ (D C.) Kuntze.

On Portulaca oleracea, Putnam, 6, 1893; Johnson, 8, 1890 (Fisher); Montgomery, 1893 (Olive); Tippecanoe 7, 1890 (Bolley).

Plasmopara australis (Speg.) Swingle.

On Sicyos angulatus, Johnson, 9, 1890 (Fisher). [Herb. U. S.]

Plasmopara geranii (Pk.) Berl. et De Toni.

On Geranium Carolinianum, Putnam, 5, 1892; Vigo, 5, 1893.

Plasmopara Halstedii (Farl.) Berl. et De Toni.

On Bidens connata, Johnson, 9, 1890 (Fisher).

On Bidens frondosa, Johnson, 8, 1890 (Fisher).

On Helianthus annuus, Montgomery, 1893 (Olive).

Plasmopara obducens Schröt.

On Impatiens sp., Putnam, 4, 1892.

On Impatiens pallida, Tippecanoe, 5, 1893 (Arthur).

Plasmopara viticola (B. and C.) Berl. et De Toni.

On Vitis cordifolia, Johnson, 7, 1890 (Fisher).

On Vitis (sp. cult.), Johnson, 9, 1890 (Fisher); Montgomery, 1893 (Olive). Putnam, 7, 1893; Crawford, 9, 1889 (Arthur).

Peronospora alta Fckl.

On Plantago major, Johnson, 7, 1890 (Fisher); Putnam, 5, 1894.

Peronospora corydalis De Bary.

On Dicentra Canadensis, Putnam, 4, 1892; 4, 1893.

On Dicentra cucullaria, Montgomery, 1893 (Olive).

Peronospora effusa (Grev.) Rabenh.

On Chenopodium sp., Putnam, 9, 1891.

On Chenopodium album, Johnson, 9, 1890 (Fisher).

Peronospora ficariæ Tul.

On Ranunculus sp., Putnam, 4, 1893.

On Ranunculus recurvatus, Montgomery, 1893 (Olive).

Peronospora rumicis Corda.

On Polygonum dumetorum scandens, Johnson, 7, 1890 (Fisher). [Herb. U. S.]

ASCOMYCETES.

Discomycetes.

Chlorosplenum aeruginosum (Oeder.) De Not. Putnam, 12, 1893.

Helotium citrinum (Hedw.) Fr. Putnam, 10, 1892; 7, 1893; 10, 1893.

Peziza coccinea Jacq. Putnam, 5, 1893.

Peziza occidentalis Schw. Vigo, 5, 1893; Bown, 5, 1893.

Peziza scutellata L. Putnam, 5, 1893.

Psilopezia nummularis Berk. Putnam, 10, 1893.

Urnula Craterium (Schw.) Fr. Tippecanoe, 4, 1892; Montgomery, 4, 1892; Putnam, 5, 1892; 5, 1893; Vigo, 5, 1893.

Rhytisma acerinum (Pers.) Fr.

On Acer saccharinum (A. dasycarpum) Putnam, 10, 1891; 10, 1893; Marshall, 10, 1893.

Rhytisma andromedæ (Pers.) Fr.

On Andromeda polifolia, Fulton, 10, 1893.

Rhytisma prini (Schw.) Fr.

On Ilex verticillata, Marshall, 10, 1893; Vigo, 10, 1893.

Gyromitra brunnea n. sp. A stout, fleshy, stipitate plant, 8–13 cm. high, bearing a broad, much contorted, brown ascoma; stem 2–5 cm. thick, more or less enlarged and spongy-solid at the base, hollow below, rarely slightly fluted, clear white; receptacle 5–12 cm. across in the widest direction, the two diameters usually considerably unequal, irregularly lobed and plicate, in places faintly marked into areas by indistinct anastomosing ridges, closely cohering with the stem in various parts, rich chocolate brown or somewhat lighter if much covered with the leaves among which it grows, whitish underneath; asci 8-spored; spores oval, 28–30 mic. long by about 14 wide, hyaline, somewhat roughened-tuberculate, usually nucleate, the highly refractive nucleus spherical or oval, 11 mic. or if oval 14 by 11 mic. in diameter; paraphyses slender, enlarged at the apex, faintly septate. In rich woods, mostly in beech leaf mould; Putnam county, May 1892, 1893 and 1894, first found by Dr. W. V. Brown. The plant is esculent, tender and possesses a fine flavor. Often as many as 8 or 10 plants would be found in one small area but the plant appears to be local

and never very abundant. Some single plants would weigh nearly half a pound.

Morchella esculenta (L.) Pers. Putnam, 4, 1892; 5, 1893.

Morchella rimosipes D C. Putnam, 4, 1892.

Morchella hybrida (Sow.) Pers. (*M. semilibera* D C.) Putnam, 4, 1892.

Morchella conica Pers. Putnam, 5, 1893.

Gymnoascee.

Exoascus deformans (Berk.) Fckl.

On peach leaves, Putnam, 5, 1892; Vigo, 5, 1893; Monroe, 5, 1893; Montgomery, 1893 (Olive); Tippecanoe 6, 1890 (Bolley).

Exoascus potentillæ Farl.

On Potentilla Canadensis, Vigo 5, 1893; Putnam, 5, 1893.

Exoascus pruni (Tul.) Fckl.

On Prunus Americana, Monroe, 5, 1893.

Exoascus sp.

On Ostrya Virginica, Putnam, 5, 1893; Vigo, 5, 1893.

Lichenes.

Arthonia spectabilis Fl. Putnam, 5, 1893,

Buellia parasina (Ach.) Th. Fr. Putnam, 5, 1893.

Cladonia cæspiticia (Pers.) Fl. Putnam, 5, 1893.

Cladonia fimbriata (L.) Fr. Putnam, 5, 1893.

Cladonia furcata (Hud.) Fr. Putnam, 5, 1893.

Cladonia mitrula Tuck. Putnam, 5, 1893.

Cladonia pyxidata (L.) Fr. Putnam, 4, 1893.

Cladonia symphycarpa Fr. Putnam, 4, 1893.

Endocarpon miniatum Fr. Owen, 5, 1893; 10, 1893.

Graphis scripta Fr. Putnam, 10, 1891.

Lecanora pallida (Schreb.) Schær. Putnam, 5, 1893.

Lecanora subfusca (L.) Ach. Putnam, 5, 1893.

Lecanora tartarea (L.) Ach. Putnam, 5, 1893.

Lecidea albocærulescens (Wulf.) Schoen. Putnam, 5, 1893.

Nephroma Helveticum Ach. Putnam, 5, 1893.

Nephroma levigatum Ach. Putnam, 5, 1893.

Parmelia caperata (L.) Ach. Putnam 4, 1893.

Parmelia colpodes (Ach.) Nyl. Putnam, 5, 1893.

Parmelia perforata (Jacq.) Ach. Putnam, 5, 1893.

Parmelia saxatilis (L.) Fr. Putnam, 4, 1893.

Parmelia tiliacea (Hoffm.) Floerk. Putnam, 5, 1893.

Peltigera canina (L.) Hoffm. Putnam, 5, 1893.

Pertusaria commune D C. Putnam, 5, 1893.

Pertusaria velata (Turn.) Nyl. Putnam, 5, 1893.

Physcia stellaris (L.) Tuck. Putnam, 10, 1891.

Ramalina calicaris (L.) Fr. Putnam, 4, 1892.

Sticta amplissima (Scop.) Mass. Putnam, 5, 1893.

Sticta pulmonaria (L.) Ach. Putnam, 10, 1891; Owen, 10, 1893.

Theloschistes concolor (Dicks.) Tuck. Putnam 10, 1891.

Usnea barbata (L.) Fr. Putnam, 5, 1893; Brown, 5, 1893; Owen, 5, 1893; Marshall, 10, 1893.

Perisporiaceæ.

Erysiphe cichoracearum D C.

On Actinomeris squarrosa, Johnson, 10, 1890 (Fisher).

On Ambrosia artemisiæfolia, Johnson, 8, 1890 (Fisher); Marshall, 10, 1893; Montgomery, 1893 (Olive).

On Ambrosia trifida, Johnson, 8, 1890 (Fisher); Montgomery (Brannon, Olive); Putnam, 10, 1891.

On Aster cordifolius, Johnson, 10, 1890 (Fisher).

On Aster Novæ-Angliæ, Johnson, 9, 1890 (Fisher).

On Aster paniculatus, Johnson, 10, 1890 (Fisher); Montgomery, 1893 (Olive).

On Aster puniceus, Johnson, 11, 1890 (Fisher).

On Aster Tradescanti, Johnson, 10, 1890 (Fisher).

On Aster ericoides, Montgomery, 1893 (Olive).

On Aster azureus, Montgomery, 1893 (Olive).

On Aster (sp.), Montgomery (Brannon).

On Cnicus altissimus, Montgomery, 10, 1890 (Fisher).

On Eupatorium perfoliatum, Fulton, 10, 1893; Johnson, 10, 1890 (Fisher); Montgomery, 1893 (Olive).

On Eupatorium purpureum, Johnson, 8, 1890 (Fisher).

On Helianthus annuus, Putnam, 11, 1892.

On Helianthus decapetalus, Montgomery, 10, 1890 (Fisher).

On Helianthus parviflorus, Tippecanoe, 10, 1892 (Arthur).

On Helianthus tuberosus, Montgomery, 10, 1890 (Fisher).

On Hydrophyllum appendiculatum, Montgomery, 10, 1890 (Fisher); 1893 (Olive).

On Hydrophyllum Virginicum, Montgomery, 10, 1893; 1893 (Olive).

On Hydrophyllum macrophyllum, Putnam, 7, 1893; Montgomery, 1893 (Olive).

On Parietaria Canadensis, Montgomery, 7, 1890 (Fisher).

On Phlox paniculata, Montgomery 10, 1890 (Fisher).

On Solidago Canadensis, Montgomery, 10, 1890 (Fisher); 1893 (Olive); Johnson, 9, 1890 (Fisher).

On Solidago serotina, Johnson, 10, 1890 (Fisher).

On Solidago latifolia, Montgomery, 1893 (Olive).

On Verbena hastata, Marshall, 10, 1893.

On Verbena stricta, Johnson, 7, 1890 (Fisher); Montgomery, 10, 1893 Tippecanoe, 9, 1888 (Bolley).

On Verbena urticaefolia, Johnson, 11, 1890 (Fisher); Putnam, 10, 1891 Montgomery, 1893 (Olive).

On Vernonia fasciculata, Putnam, 10, 1891; Montgomery 10, 1893.

On Vernonia Noveboracensis, Johnson, 8, 1890 (Fisher).

On Xanthium strumarium, Johnson, 10, 1890 (Fisher); Putnam, 9, 1891; Montgomery 1893 (Olive).

On Zinnia elegans, Putnam, 10, 1891.

On Pilea pumila, Montgomery, 1893 (Olive).

Erysiphe communis (Wallr.) Fr.

On Amphicarpæa monoica, Johnson, 9, 1890 (Fisher); Putnam, 9, 1893; Vigo, 10, 1893.

On Apios tuberosa? Johnson, 9, 1890 (Fisher).

On Aquilegia Canadensis, Owen, 10, 1893.

On Clematis Virginiana, Putnam, 10, 1891; Johnson, 9, 1890 (Fisher); Montgomery, 9, 1889 (Brannon).

On Geranium maculatum, Johnson, 8, 1890 (Fisher).

On Heuchera Americana, Putnam, 10, 1891.

On Ranunculus abortivus, Johnson, 7, 1890 (Fisher); Putnam, 7, 1893 10, 1891; Montgomery, 1893 (Olive).

On Lathyrus palustris, Marshall, 10, 1893.

On Thalictrum polygamum, Johnson 10, 1890 (Fisher).

On Ranunculus recurvatus, Montgomery, 1893 (Olive).

Erysiphe galeopsidis, D C.

On Chelone glabra, Johnson, 10, 1890 (Fisher).

On Scutellaria lateriflora, Johnson, 10, 1890 (Fisher); Marshall, 10, 1893 Putnam, 10, 1891; Montgomery, 1893 (Olive).

On Scutellaria pilosa, Johnson, 10, 1890 (Fisher).

On Stachys aspera, Johnson, 10, 1890 (Fisher); Fulton, 10, 1893.

Erysiphe graminis D C.

On Poa pratensis, Johnson, 11, 1890 (Fisher); Montgomery, 1893 (Olive).

On lawn grass, Putnam, 9, 1891; 11, 1891.

Erysiphe liriodendri Schw.

On Liriodendron tulipifera, Putnam, 10, 1891; 10, 1893; Montgomery, 10, 1893; Wabash, 10, 1891 (Miller).

Microsphæra alni (D C.) Wint.

On Betula pumila, Fulton, 10, 1893 (Fisher).

On Carpinus Caroliniana, Johnson, 9, 1890 (Fisher); Montgomery (Brannon).

On Fagus ferruginea, Johnson, 9, 1890 (Fisher).

On Ilex verticillata, Marshall, 10, 1893.

On Hicoria sulcata, Johnson, 9, 1890 (Fisher); Marshall, 10, 1893.

On Euonymus atropurpureus, Johnson, 10, 1890 (Fisher).

On Juglans nigra, Johnson, 9, 1890 (Fisher); Putnam, 10, 1893.

On Platanus occidentalis, Johnson, 9, 1890 (Fisher); Putnam, 10, 1891; Montgomery, 1893 (Olive).

On Syringa vulgaris, Johnson, 10, 1890 (Fisher); Putnam, 7, 1893; Tippecanoe, 10, 1893 (Arthur); Montgomery, 1893 (Olive).

On Ostrya Virginiana, Johnson, 10, 1890 (Fisher).

On Tecoma radicans, Putnam, 10, 1893.

On Viburnum acerifolium, Putnam, 10, 1891.

On Viburnum dentatum, Johnson, 10, 1891 (Fisher).

On Viburnum prunifolium, Johnson, 9, 1890 (Fisher).

On Viburnum pubescens, Putnam, 10, 1891.

Microsphæra diffusa C. and P.

On Lespedeza sp., Marshall, 10, 1893.

Microsphæra elevata Burrill.

On Catalpa, Putnam, 10, 1891; 10, 1893; Owen, 10, 1893; Tippecanoe, 9, 1890 (Bolley).

Microsphæra erineophila Pk.

On Erineum of Fagus ferruginea, Marion, 8, 1890 (Tracy); Putnam, 10, 1891; 10, 1893.

Microsphæra euphorbiæ (Pk.) B. and C.

On Euphorbia corollata, Steuben, 1892 (Martin Canse); Tippecanoe, 9, 1888 (Bolley).

Microsphæra grossulariæ (Wallr.) Lev.

On Sambucus Canadensis, Johnson, 9, 1890 (Fisher); Montgomery, 10, 1893.

MICROSPHÆRA QUERCINA (Schw.) Burrill.

On Quercus alba, Putnam, 10, 1891.

On Quercus bicolor, Johnson, 9, 1890 (Fisher); Vigo, 10, 1893.

On Quercus lyrata, Johnson, 9, 1890 (Fisher).

On Quercus macrocarpa, Johnson, 9, 1890 (Fisher).

On Quercus Muhlenbergii, Johnson, 9, 1890 (Fisher); Putnam, 10, 1893.

On Quercus rubra, Johnson, 9, 1890 (Fisher); Marshall, 10, 1893; Putnam, 10, 1893; Vigo, 10, 1893.

On Quercus sp., Montgomery (Brannon).

MICROSPHÆRA RAVENELII Berk.

On Gleditschia triacanthos, Johnson, 8, 1890 (Fisher); Vigo, 10, 1893; Montgomery (Brannon); Putnam, 10, 1893; Owen, 10, 1893.

MICROSPHÆRA RUSSELLII Clinton.

On Oxalis stricta, Johnson, 7, 1890 (Fisher); Putnam, 10, 1891; Montgomery, 10, 1893; 1893 (Olive).

MICROSPHÆRA SEMITOSTA B. and C.

On Cephalanthus occidentalis, Johnson, 9, 1890 (Fisher); Vigo, 10, 1893.

MICROSPHÆRA SYMPHORICARPI Howe.

On Symphoricarpus vulgaris, Putnam, 10, 1891; 11, 1892; 10, 1893.

MICROSPHÆRA VACCINII (Schw.) C. and P.

On Vaccinium sp., Marshall, 10, 1893.

PHYLLACTINIA SUFFULTA (Reb.) Sacc.

On Carpinus Caroliniana, Putnam, 10, 1891; Montgomery, 10, 1890 (Fisher).

On Celastrus scandens, Montgomery, 10, 1890 (Fisher).

On Cornus florida, Putnam, 10, 1891; 10, 1892.

On Corylus Americana, Montgomery, 10, 1890 (Fisher); Marshall, 10, 1893.

On Fraxinus Americana, Johnson, 9, 1890 (Fisher); Montgomery, 10, 1893; 1893 (Olive); Putnam, 10, 1893.

On Fraxinus pubescens, Johnson, 9, 1890 (Fisher).

On Fraxinus quadrangulata, Johnson, 10, 1890 (Fisher).

On Fraxinus sambucifolia, Johnson, 10, 1890 (Fisher).

On Liriodendron tulipifera, Johnson, 9, 1890 (Fisher); Montgomery, 1893 (Olive).

On Ostrya Virginica, Montgomery, 10, 1890 (Fisher); Putnam, 10, 1891; 10, 1893.

On Quercus coccinea, Johnson, 9, 1890 (Fisher); Montgomery, 10, 1890 (Fisher).

On Quercus palustris, Shelby, 11, 1890 (Fisher); Vigo, 10, 1893.

On Quercus rubra, Vigo, 10, 1893.

On Catalpa bignoniodes, Montgomery, 1893 (Olive).

On Xanthoxylum Americana, Montgomery, 1893 (Olive).

PODOSPHÆRA BIUNCINATA C. & P.

On Hamamelis Virginiana, Putnam, 9, 1893; 10, 1893.

PODOSPHÆRA OXYACANTHÆ (D C.) DeBary.

On Cratægus crus-galli, Johnson, 7, 1890 (Fisher).

On Cratægus spathulata, Johnson, 7, 1890 (Fisher).

On Cratægus tomentosa, Johnson, 7, 1890 (Fisher).

On Cydonia vulgaris, Johnson, 8, 1890 (Fisher).

On Prunus Americana, Johnson, 10, 1890 (Fisher).

On Prunus cerasus, Johnson, 7, 1890 (Fisher); Putnam, 10, 1891; 7, 1893; Tippecanoe, 8, 1890 (Bolley).

On Spiræa tomentosa, Marshall, 10, 1893.

On Cratægus sp., Owen, 10, 1893.

SPHÆROTHECA CASTAGNEI Lev.

On Bidens chrysanthemoides, Johnson, 9, 1890 (Fisher); Montgomery, 1893 (Olive).

On Bidens connata, Johnson, 8, 1890 (Fisher); Montgomery, 10, 1893.

On Bidens frondosa, Johnson, 7, 1890 (Fisher); Putnam, 10, 1891; 7, 1893; Montgomery, 10, 1893.

On Brunella vulgaris, Johnson, 9, 1890 (Fisher); Marshall, 10, 1893.

On Coreopsis trichosperma, Johnson, 9, 1890 (Fisher).

On Erechtites hieracifolia, Johnson, 8, 1890 (Fisher); Marshall, 10, 1893; Montgomery, 1893 (Olive).

On Erigeron Canadense, Johnson, 10, 1890 (Fisher).

On Erigeron (Sp.), Montgomery (Brannon).

On Pedicularis lanceolata, Johnson, 8, 1890; 11, 1890 (Fisher).

On Taraxacum officinale, Montgomery (Brannon, Olive); Putnam, 10, 1891; Tippecane, 6, 1890 (Bolley).

SPHÆROTHECA HUMULI (D C.) Burrill.

On Agrimonia Eupatoria, Montgomery, 10, 1890 (Fisher); Putnam, 11, 1891; 10, 1893; Marshall, 10, 1893.

On Potentilla palustris, Marshall, 10, 1893.

SPHÆROTHECA MORS-UVÆ (Schw.) B. & C.

On Ribes cynosbati, Montgomery, 6, 1893 (Hughart).

Sphaerotheca pannosa (Wallr.)

On Geum album, Johnson, 8, 1890 (Fisher).

On Rosa lucida, Johnson, 8, 1890 (Fisher).

On Rosa (sp. cult.) Putnam, 9, 1893.

Sphaerotheca phytoptophila Kell. & Swingle.

On Phytoptus fascicles of Celtis occidentalis, Putnam, 5, 1890 (Arthur); 10, 1891; 11, 1893; Montgomery, 1893 (Olive); Tippecanoe, 12, 1893 (Arthur).

Uncinula circinata C. & P.

On Acer dasycarpum, Montgomery (Brannon); Marshall, 10, 1893.

On Acer rubrum, Johnson, 1890 (Fisher).

On Acer saccharum, Johnson, 9, 1890 (Fisher); Putnam, 10, 1893; Montgomery, 1893 (Olive).

Uncinula Clintonii Pk.

On Tilia Americana, Montgomery, 10, 1890 (Fisher); Putnam, 10, 1893.

Uncinula flexuosa Pk.

On Æsculus glabra, Johnson, 7, 1890 (Fisher); Montgomery (Brannon, Olive).

On Æsculus Hippocastanum, Putnam, 10, 1893.

Uncinula geniculta Gerard.

On Morus rubra, Johnson, 9, 1890 (Fisher); Montgomery, 10, 1890 (Fisher); 10, 1893.

Uncinula macrospora Pk.

On Ulmus Americana, Putnam, 10, 1891; 10, 1892; Owen, 10, 1893; Montgomery, 1893 (Olive); Wabash, 10, 1891 (Miller).

On Ulmus fulva, Johnson, 8, 1890 (Fisher); Montgomery, 1893 (Olive).

Uncinula necator (Schw.) Burrill.

On Ampelopsis quinquefolia, Johnson, 9, 1890 (Fisher); Montgomery (Brannon, Olive); Putnam, 10, 1891.

On Vitis cordifolia, Johnson, 9, 1890 (Fisher).

On Vitis (cult. sp.) Johnson, 9, 1890 (Fisher); Montgomery (Brannon, Olive); Putnam, 10, 1891; 10, 1893.

Uncinula parvula C. & P.

On Celtis occidentalis, Johnson, 9, 1890 (Fisher); Marion, 1890 (Tracy); Putnam, 10, 1893.

Uncinula salicis (D C.) Wint.

On Salix nigra, Johnson, 8, 1890 (Fisher).

On Salix sericea, Montgomery, 10, 1890 (Fisher).

On Salix cordata, Montgomery, 1893 (Olive).

On Salix sp. Montgomery (Brannon); Putnam, 9, 1894; Marshall, 10, 1893.

On Populus tremuloides, Marshall, 10, 1893.

HYPOCREACEÆ.

CLAVICEPS PURPUREA (Fr.) Tul.

Sclerotia on Rye, Putnam, 7, 1893; Tippecanoe (Arthur).

Sclerotia on Elymus Virginicus, Montgomery, 10, 1893.

CORDYCEPS OPHIOGLOSOIDES (Ehrh.) Sacc., Putnam, 11, 1891.

EPICHLOE TYPHINA (Pers.) Tul.

On Festuca nutans, Tippecanoe, 7, 1890 (Arthur).

On grass (sp. ig.), Vigo, 5, 1893; Putnam, 6, 1894.

HYPOCREA CITRINA (Pers.) Fr., Putnam, 11, 1891; 10, 1893.

HYPOCREA GELATINOSA (Tode.) Fr., Putnam, 10, 1891.

HYPOCREA RUFA (Pers.) Fr. (Trichoderma viride.)

Conidial stage, Putnam, 11, 1893.

SPHÆRIACEÆ.

DALDINIA CONCENTRICA (Bolt.) Ces. and DeNot.

On Acer sp., Putnam, 10, 1891.

DIATRYPE ALBOPRUINOSA (Schw.) Cooke. Vigo, 10, 1893.

DIATRYPE VIRESCENS (Schw.) E. and E. Putnam, 9, 1893.

DICHÆNA FAGINEA (Pers.) Fr.

On Fagus ferruginea, Tippecanoe, 4, 1892 (Arthur); Putnam, 4, 1893.

EUTYPA SPINOSA (Pers.) Tul. Putnam, 11, 1892; 10, 1893.

GNOMONIA ULMEA (Schw.) Thüm.

On Ulmus fulva, Montgomery, 10, 1890 (Fisher); Johnson, 9, 1890 (Fisher). [Herb. U. S.]

HYPOXYLON ANNULATUM (Schw.) Mont. Putnam, 4, 1893.

HYPOXYLON ATROPUNCTATUM (Schw.) Cooke. Putnam, 4, 1893.

HYPOXYLON COCCINEUM Bull. Putnam, 12, 1891; 10, 1891.

HYPOXYLON COHÆRENS (Pers.) Fr.

On Fagus ferruginea, Putnam, 10, 1891.

HYPOXYLON MARGINATUM (Schw.) Berk., Putnam, 5, 1893.

HYPOXYLON PERFORATUM (Schw.) Sacc., Putnam, 10, 1891; 2, 1893.

HYPOXYLON RUBIGINOSUM (Pers.) Fr., Putnam, 10, 1891; 5, 1893.

LESTADIA BIDWELLII (Ell.) Viala et Rav.

On Vitis cordifolia, Johnson, 8, 1890 (Fisher); Putnam, 10, 1891.

On Vitis (cult.), Putnam, 7, 1893.

On Ampelopsis quinquefolia, Owen, 10, 1893.

Melanomma sporadicum E. & E., Putnam, 4, 1893.

Nummularia Bulliardi Tul., Putnam, 10, 1891.

Otthia morbosa (Schw.) E. & E.

On Prunus sp., Floyd, 6, 1890 (Arthur); Putnam, 4, 1894.

Rosellinia aquila (Fr.) DeNot, Putnam, 10, 1891.

Scorias spongiosa (Schw.) Fr.

On honey-dew dropped by Aphidæ on and under beech twigs, Putnam, 10, 1891; 4, 1893; Owen, 5, 1893.

Sphærella fragariæ Tul. (*Ramularia fragariæ*).

Conidia on Fragaria vesca, Putnam, 5, 1892.

Conidia on Fragaria elatior, Johnson, 8, 1890 (Fisher).

Sphærella fraxinicola (Schw.) Cooke.

On Fraxinus Americana, Johnson, 9, 1890 (Fisher). [Herb. U. S.]

Sphæria iridis Schw.

On Iris versicolor, Montgomery, 1893 (Olive). [Herb. Wabash Coll.]

Tryblidium minor Cooke.

On Salix sp., Putnam, 5, 1892.

Ustulina vulgaris Tul.

On Quercus sp., Montgomery, 4, 1892; Putnam, 10, 1891; 5, 1893.

Valsaria exasperans (Ger.) E. and E. Putnam, 12, 1891.

Valsaria quadrata (Schw.) Sacc. (*Diatrype obesa* B. and C.)

On Fagus ferruginea, Putnam, 10, 1891.

Xylaria polymorpha (Pers.) Grev. Putnam, 11, 1891; Tippecanoe, 1892 (Arthur).

Xylaria corniformis Fr. Putnam, 10, 1891; 10, 1892; 10, 1893.

Xylaria hypoxylon (L.) Grev. Putnam, 11, 1893.

Dothideaceæ.

Phyllochora lespedezæ (Schw.) Cooke.

On Lespedeza sp., Marshall, 10, 1893.

Dothidiella ulmi (Duv.) Wint.

On Ulmus Americana, Montgomery, 1893 (Olive). [Herb. Wabash Coll.]

Phyllachora graminis (Pers.) Fckl.

On Panicum latifolium, Tippecanoe, 9, 1888 (Bolley); Putnam, 10, 1892.

On Muhlenbergia sp., Putnam, 10, 1892.

On Asprella hystrix, Montgomery, 10, 1893.

On Muhlenbergia Mexicana, Johnson, 11, 1890 (Fisher).

On Elymus Canadensis, Montgomery, 11, 1890 (Fisher).

On Elymus sp., Putnam, 10, 1892.

Phyllachora trifolii (Pers.) Fckl.

On Trifolium pratense, Johnson, 11, 1890 (Fisher). [Herb. U. S.]

FUNGI IMPERFECTI.

Sphæropsideæ.

Actinonema rosæ Fr. (*Asteroma rosæ Lib.*).

On Rosa sp. in greenhouse, Tippecanoe, 1, 1887 (Barnes); 10, 1892 (Arthur).

Cincinnobolus Cesatii DeBary.

On Mycelium of Erysiphei on Helianthus sp., Tippecanoe, 1888 (Bolley).

On Mycelium of Erysiphei on Taraxacum officinale and Solidago Canadensis, Johnson, 7, 1890 (Fisher).

On Mycelium of Erysiphei on Solidago arguta, S. latifolia, Aster Shortii, Rudbeckia triloba, Hydrophyllum Virginicum, Montgomery, 10, 1890 (Fisher).

On Sphærotheca Castagnei on Taraxacum, Montgomery, 1893 (Olive).

On Phyllactinia suffulta on Liriodendron, Montgomery, 1893 (Olive).

On Erysiphe sp. on Erigeron, Montgomery, 1893 (Olive).

Darluca filum (Riv.) Cast.

On Uredo on Carex sp., Johnson, 7, 1890 (Fisher). [Herb. U. S.]

Leptostroma hypophyllum B. & Rav.

On Gleditschia triacanthos, Marion, 8, 1890 (Arthur); Tippecanoe, 9, 1892 (Arthur); Putnam, 9, 1893.

Melasmia ? Galii E. & E.

On Galium trifidum latifolium, Johnson, 9, 1890 (Fisher). [Herb. U. S.]

Phleospora aceris (Lib.) Sacc.

On Acer rubrum, Johnson, 7, 1890 (Fisher). [Herb. U. S.]

Phleöspora ulmi (Fr.) Wallr.

On Ulmus fulva, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Phyllosticta asiminæ E. & K.

On Asimina triloba, Johnson, 8, 1890 (Fisher); Putnam, 7, 1893.

Phyllosticta celtidis E. & K.

On Celtis occidentalis, Montgomery, 10, 1890 (Fisher). [Herb. U. S.]

Phyllosticta Commonsii E. & E.

On Paeonia (cult.), Montgomery, 1893 (Olive). [Herb. Wabash Coll.]

Phyllosticta cruenta Kickx.

On Smilacina racemosa, Montgomery, 1893 (Olive).

Phylosticta pavle Desm. (P. sphæropsoidea E. & E.)

On Aesculus glabra, Montgomery, 7, 1890 (Fisher); 1893 (Olive); Johnson, 8, 1890 (Fisher); Brown, 5, 1893.

PHYLLOSTICTA QUERCUS Sacc & Speg.

On Quercus macrocarpa Montgomery, 1893 (Olive). [Herb. Wabash Coll.]

PHYLLOSTICTA SANGUINARIÆ Wint.

On Sanguinaria Canadensis, Brown, 5, 1893, immature.

PHYLLOSTICTA SASSAFRAS Cooke.

On Sassafras, Montgomery, 7, 1890 (Fisher). [Herb. U. S.]

SEPTORIA ASCLEPIADICOLA E. & E.

On Asclepias incarnata, Johnson, 10, 1890 (Fisher). [Herb. U. S.]

SEPTORIA CACALIÆ E. & K.

On Cacalia atriplicifolia, Owen, 10, 1893; Montgomery, 1893 (Olive).

SEPTORIA CANNABINA West. ?

On Cannabis sativa, Montgomery, 7, 1890 (Fisher). [Herb. U. S.]

SEPTORIA CONSPICUA E. & M.

On Steironema ciliatum, Johnson, 7, 1890; 10, 1890 (Fisher). [Herb. U. S.]

SEPTORIA CRATÆGI Kickx.

On Crataegus sp., Owen, 10, 1893.

SEPTORIA DENTARIÆ Pk.

On Dentaria laciniata, Montgomery, 1893 (Olive).

SEPTORIA FLAGELLARIS E. and E.

On Convolvulus sepium, Monroe, 5, 1893.

SEPTORIA HELIANTHI E. and K.

On Heliopsis lævis, Montgomery, 7, 1890 (Fisher).

On Helianthus annuus, Montgomery, 1893 (Olive).

SEPTORIA LACTUCÆ Pass.

On Lactuca sativa, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

SEPTORIA LAPPARUM Sacc.

On Arctium lappa, Montgomery, 1893 (Olive).

SEPTORIA LEUCOSTOMA E. and E.

On Fraxinus Americana, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

SEPTORIA MICROSPORA E. and E.

On Asprella hystrix, Mongomery, 7, 1890 (Fisher). [Herb. U. S.]

SEPTORIA ŒNOTHERÆ B. and C.

On Œnothera biennis, Vigo, 5, 1893.

SEPTORIA PODOPHYLLINA Pk.

On Podophyllum peltatum, Monroe, 5, 1893; Putnam, 5, 1893 (Melia Ellis); Montgomery, 1893 (Olive).

Septoria polygonorum Desm.

On Polygonum sp., Putnam, 9, 1893; 10, 1893.

Septoria psilostega E. & M.

On Galium circæzans, Johnson, 7, 1890 (Fisher). [Herb. U. S.]

Septoria rubi Westd.

On Rubus (blackberry), Vigo, 5, 1893.

On Rubus villosus, Montgomery, 1893 (Olive).

Septoria sisymbrii Ell.

On Dentaria laciniata, Vigo, 5, 1893.

Septoria trillii Pk.

On Trillium grandiflorum, Montgomery, 1893 (Olive).

On Trillium sessile, Montgomery, 1893 (Olive).

On Trillium recurvatum, Montgomery, 1893 (Olive).

Septoria violæ Westd.

On Viola palmata cucullata, 1893 (Olive).

Septoria sp.

On Cicuta maculata, Johnson, 11, 1890 (Fisher). ["Not S. Sii." Herb. U. S.]

Sphærographium fraxini Pk. Putnam, 4, 1892.

Stagnospora collapsa (C. & E.) Sacc.

On Acer dasycarpum, Putnam, 3, 1893.

Vermicularia herbarum Westd. (*V. dianthi* Westd.)

On carnations in greenhouse, Tippecanoe, 3, 1889 (Arthur).

Hyphomycetes.

Ceratophorum uncinatum (Cl. and Pk.) Sacc.

On Quercus macrocarpa, Johnson, 9, 1890 (Fisher). [Herb. U. S.]

Cercospora ampelopsidis Pk.

On Ampelopsis quinquefolia, Johnson, 7, 1890 (Fisher). [Herb. U. S.]

Cercospora apii Fres.

On Pastinaca sativa, Putnam, 9, 1893.

Cercospora cercidicola Ell.

On Cercis Canadensis, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Cercospora chionea E. and E.

On Cercis Canadensis, Montgomery, 1893 (Olive).

Cercospora dianthera E. and K.

On Dianthera Americana, Montgomery, 1893 (Olive).

Cercospora dubia (Russ.) Wint.

On Chenopodium album, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Cercospora echinocystis E. and M.

On Echinocystis lobata, Montgomery, 1893 (Olive).

Cercospora effusa (B. and C.) E. and E.

On Lobelia syphilitica, Putnam, 10, 1892; 9, 1893.

Cercospora elongata Pk.

On Dipsacus sylvestris, Montgomery, 1893 (Olive).

Cercospora eupatorii Pk.

On Eupatorium perfoliatum, Montgomery, 1893 (Olive).

Cercospora flagellaris E. & M.

On Phytolacca decandra, Montgomery, 1893 (Olive).

Cercospora granuliformis Ell. & Hol.

On Viola palmata cucullata, Montgomery 7, 1890; 10, 1890 (Fisher). [Herb. U. S.]

Cercospora hydropiperis (Thüm.) Speg.

On Polygonum hydropiper, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Cercospora lippiæ E. & E.

On Lippia lanceolata, Montgomery, 1893 (Olive).

Cercospora oculata E. & K.

On Vernonia Noveboracensis, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Cercospora penstemonis E. & K.

On Penstemon lævigatus digitalis, Montgomery, 1893 (Olive).

Cercospore prenanthis, E. & K.

On Prenanthes alba, Montgomery, 1893 (Olive).

Cercospora ptelea Wint.

On Ptelea trifoliata, Johnson, 11, 1890 (Fisher); Montgomery, 1893 (Olive). [Herb. U. S. and Wabash Coll.]

Cercospora rhoina C. & E.

On Rhus glabra, Montgomery, 7, 1890 (Fisher). [Herb. U. S.]

Cercospora rosicola Pass.

On Rosa setigera, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Cercospora saururi C. & E.

On Saururus, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Cercospora sedoides E. & E.

On Penthorum sedoides, Johnson, 8, 1890; 10, 1890 (Fisher). [Herb U. S.]

Cercospora simulata E. & E.

On Cassia Marilandica, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Cercospora xanthoxyli Cke.

On Xanthoxylum Americanum, Montgomery, 1893 (Olive).

Cercosporella cana Sacc.

On Erigeron annuus, Johnson, 7, 1890; 10, 1890 (Fisher). [Herb. U. S.]

Cercosporella clavata (Ger.) Pk.

On Asclepias incarnata, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Cercosporella racemosa E. & M.

On Teucrium Canadense, Johnson, 7, 1890 (Fisher). [Herb. U. S.]

Cercosporella teucrii E. & K.

On Teucrium Canadense, Johnson, 11, 1890 (Fisher). [Herb. U. S.]

Didymaria ungeri Cda.

On Ranunculus septentrionalis, Johnson, 10, 1890 (Fisher). [Herb. U. S.]

Fusarium miniatum (B. & C.) Sacc.

On trunk of Ostrya injured by woodpeckers, Putnam, 5, 1892.

On old wood, Putnam, 5, 1893.

Fusarium rimosum (Pk.) Sacc.

On cut ends of corn stalks. Putnam, 10, 1893.

Fusicladium dendriticum (Wallr.) Fckl.

On Pirus malus, Johnson, 7, 1890 (Fisher). [Herb. U. S.]

Heterosporium gracile (Wallr.) Sacc.

On Iris versicolor, Montgomery, 1893 (Olive). [Herb. Wabash Coll.]

Monilia aureo-fulva (Link) Gmel.

On decaying wood, Putnam, 10, 1893.

Oidium lactis Fres.

On surface of milk, Tippecanoe, 3, 1891 (Arthur). [Herb. Arthur.]

Oospora Scabies Thax.

On potatoes producing deep scab, Tippecanoe, 2, 1892 (Arthur).

On sugar beet producing scab, Tippecanoe, 3, 1891 (Arthur).

Polythrincium trifolii Kze.

On Trifolium repens, Putnam, 6, 1893; Johnson, 11, 1890 (Fisher).

Ramularia armoraceæ Fckl.

On Nasturtium armoracia, Montgomery, 1893 (Olive).

Ramularia plantaginis E. & M.

On Plantago major, Johnson, 8, 1890; 10, 1890 (Fisher). [Herb. U. S.]

Ramularia rufo-maculata Pk.

On Polygonum acre, Johnson, 1890 (Fisher). [Herb. U. S.]

Rhinotrichum Curtisii Berk., Putnam, 10, 1891.

Scolecotrichum graminis Fckl.

On Phleum pratense, Johnson, 11, 1890 (Fisher).

On Poa nemoralis, Johnson, 11, 1890 (Fisher).

On Poa pratensis, Johnson, 11, 1890 (Fisher). [Herb. U. S.]

Streptothrix atra B. & C., Tippecanoe, 10, 1888 (Bolley); Putnam, 11, 1891.

Melanconieæ.

Cylindrosporium iridis Ell. and Hals.

On Iris versicolor, Montgomery, 1893 (Olive).

Gloeosporium apocyni Pk.

On Apocynum cannabinum, Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Gloeosporium Lindemuthianum Sacc. and Magn.

On cultivated beans, Tippecanoe, 5, 1890 (Arthur); Putnam, 9, 1893.

Gloeosporium septorioides Sacc.

On Quercus sp., Montgomery, 7, 1890 (Fisher). [Herb. U. S.]

Marsonia Martini Sacc. and Ell.

On Quercus alba, Montgomery, 10, 1890 (Fisher).

On Quercus rubra, Montgomery, 10, 1890 (Fisher).

On Quercus Muhlenbergii, Montgomery, 10, 1890 (Fisher).

On Quercus bicolor, Montgomery, 10, 1890 (Fisher). [Herb. U. S.]

Myxosporium nitidum B. and C.

On Cornus, Tippecanoe, 4, 1892 (Arthur).

BASIDIOMYCETES.

Ustilagineæ.

Entyloma compositarum Farl.

On Ambrosia artemisiæfolia, Tippecanoe, 7, 1889 (Arthur).

Entyloma physalidis (K. and C.) Wint.

On Physalis pubescens, Johnson, 11, 1890 (Fisher); Putnam, 9, 1893.

On Physalis Philadelphica, Johnson, 11, 1890 (Fisher).

Tilletia striæformis (Westend.) Wint.

On Phleum pratense, Putnam, 5, 1892; 5, 1893; Tippecanoe, 5, 1889 (Bolley).

Urocystis anemones (Pers.) Wint.

On Hepatica acutiloba, Tippecanoe, 5, 1893 (Arthur).

Ustilago anomala J. Kunze.

On Polygonum dumetorum scandens, Putnam, 9, 1893.

Ustilago avenæ (Pers.) Jensen.

On Avena sativa, Montgomery, 1893 (Olive); Tippecanoe, 1891 (Arthur).

USTILAGO HORDEI.

On Barley, Dearborn 6, 1888 (Bolley). [Herb. Arthur.]

USTILAGO PANICI-GLAUCI [Wallr.) Wint. (*U. neglecta* Niessl.)

On Setaria glauca, Montgomery, 1893 (Olive).

USTILAGO RABENHORSTIANA Kuhn.

On Panicum capillare, Putnam 10, 1892.

USTILAGO SYNTHERISMÆ (Schw.) Pk.

On Cenchrus tribuloides, Putnam, 10, 1892.

USTILAGO TRITICI (Pers.) Jensen.

On Triticum vulgare, Brown, 5, 1893; Putnam, 6, 1893; Montgomery, 1893 (Olive); Wabash, 6, 1888 (Miller); Tippecanoe, 1893 (Arthur).

USTILAGO UTRICULOSA (Nees) Wint.

On Polygonum amphibium, Wabash, 10, 1890 (Miller).

USTILAGO ZEÆ MAYS (D C.) Wint.

On Zea mays, Putnam, 9, 1892; 9, 1893; Johnson, 10, 1890 (Fisher.)

UREDINEÆ.

ÆCIDIUM AQUILEGIÆ Pers.

On Aquilegia sp., Tippecanoe, 6, 1889 (Bolley).

ÆCIDIUM ASTERUM Schw.

On Aster cordifolius, Montgomery, 1893 (Olive).

On Aster sagittifolius, Montgomery, 1893 (Olive).

On Aster sp., Vigo, 5, 1893; Tippecanoe, 5, 1893 (Arthur).

On Solidago latifolia, Putnam, 7, 1893.

On Solidago Canadensis, Laporte, 6, 1893 (Arthur).

On Solidago cæsia, Montgomery, 1893 (Olive).

On Solidago sp., Vigo, 5, 1893.

ÆCIDIUM BERBERIDIS Pers.

On Berberis vulgaris, Lagrange, 7, 1889 (Arthur). [Herb. Arthur.]

ÆCIDIUM DICENTRÆ Trelease.

On Dicentra cucullaria, Montgomery, 1893 (Olive).

ÆCIDIUM EUPHORBIÆ Gmel.

On Euphorbia corollata, Johnson, 7, 1890 (Fisher).

On Euphorbia dentata, Putnam, 9, 1891.

On Euphorbia Preslii, Johnson, 7, 1890 (Fisher); Fulton, 10, 1893.

On Euphorbia maculata? Montgomery (Rose).

On Euphorbia sp., Putnam, 10, 1892; Tippecanoe 7, 1890 (Bolley).

ÆCIDIUM GERANII D C.

On Geranium maculatum, Vigo, 5, 1893.

Æcidium grossulariæ D C.

On Ribes rotundifolium, Putnam, 5, 1893.

On Ribes cynosbati, Putnam, 5, 1892; Montgomery, 1893 (Olive).

Æcidium hepaticatum Schw.

On Hepatica acutiloba, Montgomery, 4, 1892; 5, 1893 (Thomas).

Æcidium hydnoideum B. & C.

On Dirca palustris, Johnson, 7, 1890 (Fisher); Montgomery, 1893 (Olive) Wabash, 7, 1887 (Miller).

Æcidium impatientis Schw.

On Impatiens fulva, Johnson, 7, 1890 (Fisher); Putnam, 7, 1893; Montgomery (Rose).

Æcidium lycopi Gerard.

On Lycopus sp., Vigo, 5, 1893.

Æcidium Marie-Wilsoni Peck.

On Viola palmata cucullata, Putnam, 5, 1893.

Æcidium œnotheræ Pk.

On Oenothera biennis, Vigo, 5, 1893.

Æcidium onobrychidis Burrill.

On Psoralea Onobrychis, Vigo, 5, 1893.

Æcidium pteleæ B. & C.

On Ptelea trifoliata, Montgomery, 1893 (Olive).

Æcidium pustulatum Curt.

On Comandra umbellata, Vigo, 5, 1893; Montgomery, 1893 (Olive).

Æcidium ranunculi Schw.

On Ranunculus abortivus, Decatur, 5, 1889 (Arthur); Putnam, 4, 1892; 5, 1893; Brown, 5, 1893.

Æcidium sambuci Schw.

On Sambucus Canadensis, Johnson, 7, 1890 (Fisher); Putnam, 5, 1892; 5, 1893; Brown, 5, 1893; Vigo, 5, 1893; Montgomery, 1893 (Olive).

Cæoma agrimoniæ Schw.

On Agrimonia eupatoria, Johnson, 7, 1890 (Fisher); Putnam, 9, 1891; Owen, 10, 1893; Montgomery (Rose).

On Agrimonia parviflora, Putnam, 9, 1893; Marshall, 10, 1893.

Coleosporium rubi Ell. and Hals.

On Rubus cuneifolius, Johnson, 9, 1890 (Fisher).

On Rubus villosus, Johnson, 9, 1890 (Fisher). [Herb. U. S.]

Coleosporium sonchi-arvensis (Pers.) Lev.

On Aster cordifolius, Montgomery, 10, 1890 (Fisher).

On Aster azureus, Montgomery, 10, 1890 (Fisher); 1893 (Olive).

On Aster Novæ-angliæ, Montgomery, Johnson, 8, 1890 (Fisher); Montgomery, 10, 1890 (Fisher).

On Aster paniculatus, Montgomery, 10, 1890 (Fisher).

On Aster puniceus, Johnson, 10, 1890 (Fisher).

On Aster saggittæfolius, Johnson, 8, 1890 (Fisher).

On Aster salicifolius, Johnsoh, 11, 1890 (Fisher).

On Aster Shortii, Montgomery, 10, 1890 (Fisher).

On Aster Tradescanti, Johnson, 7, 1890 (Fisher).

On Solidago arguta, Montgomery, 10, 1890 (Fisher).

On Solidago cæsia, Montgomery, 7, 1890 (Fisher); Johnson, 11, 1890 (Fisher).

On Solidago Canadensis, Johnson, 7, 1890 (Fisher); Montgomery, 10, 1890 (Fisher); Wabash, 10, 1890 (Miller).

On Solidago latifolia, Montgomery, 10, 1890 (Fisher); 1893 (Olive); Owen, 10, 1893.

On Solidago patula, Montgomery, 10, 1890 (Fisher).

On Solidago rugosa, Johnson, 11, 1890 (Fisher).

On Solidago serotina, Johnson, 10, 1890 (Fisher); Owen, 10, 1893.

On Vernonia fasciculata, Putnam, 10, 1891; Montgomery, 1893 (Olive).

On Vernonia Noveboracensis, Johnson, 8, 1890 (Fisher).

On Hieracium sp., Vigo, 5, 1893.

GYMNOSPORANGIUM GLOBOSUM Farl.

On Juniperus Virginiana, Putnam, 4, 1892; 5, 1893; Owen, 5, 1893.

GYMNOSPORANGIUM MACROPUS Link.

On Juniperus Virginiana, Putnam 3, 1892; 4, 1892; 5, 1893; Owen, 5, 1893; Montgomery, 1893 (Olive); Tippecanoe, 3, 1889 (Bolley).

MELAMPSORA POPULINA (Jacq.) Lev.

On Populus balsamifera, Montgomery, 10, 1890 (Fisher).

On Populus grandidentata, Montgomery, 10, 1890 (Fisher); Putnam, 10, 1893.

On Populus monilifera, Johnson, 7, 1890 (Fisher); Putnam, 9, 1891; 10, 1893; Montgomery, 1893 (Olive); Tippecanoe, 9, 1888 (Bolley).

On Populus tremuloides, Marshall, 10, 1893.

MELAMPSORA SALICINA Lev.

On Salix cordata, Montgomery, 1893 (Olive.)

On Salix nigra, Johnson, 10, 1890 (Fisher).

On Salix discolor, Montgomery, 10, 1890 (Fisher).

On Salix longifolia, Johnson, 10, 1890 (Fisher); Montgomery, 1893 (Olive).

On Salix sp., Johnson 7, 1890 (Fisher); Putnam, 10, 1892; 10, 1893.

PHRAGMIDIUM FRAGARIÆ (D C.) Rossm.

On Potentilla Canadensis, Johnson, 9, 1890 (Fisher); Marshall, 10, 1893; Owen 10, 1893; Vigo, 10, 1893; 5, 1893 (Uredo); Tippecanoe, 9, 1889 (Bolley).

PHRAGMIDIUM SUBCORTICIUM (Schrank) Wint.

On Rosa lucida, Johnson, 9, 1890 (Fisher).

On Rosa setigera, Johnson, 7, 1890 (Fisher).

On Rosa Carolina, Putnam, 9, 1893.

On Rosa (sp. cult.), Putnam, 10, 1891; 11, 1892; 9, 1893; Dearborn, 9, 1888 (Bolley).

On Rosa (sp.) Vigo 5, 1893; Brown, 5, 1893 (Uredo).

PUCCINIA ANDROPOGI Schw.

On Andropogon sp., Vigo, 10, 1893.

PUCCINIA ANGUSTATA Pk.

On Scirpus atrovirens, Johnson, 11, 1890 (Fisher); Putnam, 9, 1891; Tippecanoe, 9, 1889 (Bolley).

On Eriophorum cyperinum, Putnam, 10, 1891; Fulton, 10, 1893.

PUCCINIA APOCRYPTA Ell & Tracy.

On Asprella hystrix, Johnson 11, 1890 (Fisher). [Herb. U. S.]

PUCCINIA ARGENTATA (Schultz.) Wint.

II., On Impatiens flava, Johnson, 9, 1890, (Fisher). [Herb. U. S.]

PUCCINIA ASTERIS Duby.

On Aster cordifolius, Montgomery, 10, 1890 (Fisher).

On Aster paniculatus, Montgomery, 10, 1890 (Fisher).

On Aster sp., W. Lafayette, 10, 1889 (Bolley).

PUCCINIA BOLLEYANA DeToni.

On Carex sp., Tippecanoe, 11, 1888 (Bolley).

PUCCINIA CARICIS (Schum.) Reb.

On Carex bullata, Johnson, 9, 1890 (Fisher).

On Carex fœnea, Montgomery, 11, 1890 (Fisher).

On Carex lurida, Montgomery, 11, 1890 (Fisher).

On Carex straminea, Johnson, 11, 1890 (Fisher).

On Carex virescens, Montgomery, 11, 1890 (Fisher).

On Carex sp., Johnson 11, 1890 (Fisher); Putnam, 10, 1891; 10, 1893; Fulton, 10, 1893; Montgomery, 1893 (Olive); Boone, 3, 1891 (Arthur).

On Dulichium spathaceum, Marshall, 10, 1893.

Puccinia circeæ Pers.

On Circæa Lutetiana, Johnson, 7, 1890 (Fisher); Putnam, 10, 1893; Wabash 7, 1886 (Miller).

Puccinia convolvuli (Pers.) Cast.

On Convolvulus sepium, Putnam, 9, 1891; 9, 1893.

Pucinia coronata Corda.

On Calamagrostis Canadensis, Tippecanoe, 11, 1888 (Bolley).

Puccinia cyperi Arthur.

On Cyperus sp., Putnam, 10, 1893.

Puccinia Davi Clinton.

On Steironema ciliatum, Johnson, 8, 1890 (Fisher); Putnam, 10, 1893.

Puccinia dochmia B. and C.

On Muhlenbergia diffusa, Johnson, 11, 1890 (Fisher). [Herb. U. S.]

Puccinia eleocharidis Arthur.

On Eleocharis palustris, Tippecanoe, 11, 1888 (Bolley).

Puccinia emaculata Schw.

On Panicum capillare, Putnam, 10, 1892; 9, 1893; Montgomery, 1893 (Olive).

Puccinia flosculosorum (A. and S.) Roehl.

On Cnicus lanceolatus, 7, 1890;* 9, 1890† (Fisher); Marion, 8, 1890; (Bolley); Marshall, 10, 1893; Putnam, 9, 1893.

On Taraxacum officinale, Johnson, 8, 1890‡ (Fisher); Putnam, 5, 1893; Montgomery, 1893 (Olive); Tippecanoe, 9, 1888 (Bolley).

Puccinia galii (Pers.) Wint.

On Galium asprellum, Johnson, 11, 1890 (Fisher).

On Galium concinnum, Johnson, 7, 1890 (Fisher); Montgomery, 1893 (Olive).

On Galium triflorum, Putnam, 11, 1891; 10, 1893; Montgomery, 10, 1893.

Puccinia graminis Pers.

On Agrostis sp., Putnam, 10, 1893.

II. On Avena sativa, Putnam, 7, 1893; (III.) Montgomery, 1893 (Olive); Tippecanoe, 10, 1888 (Bolley).

On Poa pratensis, Montgomery, 11, 1890 (Fisher); Marshall, 10, 1893; Putnam, 10, 1893.

On Poa compressa, Montgomery, 11, 1890 (Fisher).

*In Coll. U. S. as P. cirsii-lanceolati.
†In Coll. U. S. as P. suaveolens.
‡In Coll. U. S. as P. hieracii.

On Triticum vulgare, Johnson, 7, 1890 (Fisher); Putnam, 9, 1893; Tippecanoe, 6, 1890 (Arthur).

Puccinia heliopsidis Schw.

On Heliopsis scabra, Johnson, 9, 1890 (Fisher). [Herb. U. S.]

Puccinia industata Dietel & Holway *ined.*

On Cyperus strigosus, Putnam, 9, 1893; 10, 1893.

On Cyperus sp., Tippecanoe, 9, 1888 (Bolley).

Puccinia interstitialis (Schl.) Tranzschel. (Uredo=Caeoma nitens Schw.)

II. On Rubus (blackberry), Putnam, 5, 1892; 5, 1893; Vigo, 5, 1893.

II. On Rubus villosus, Montgomery, 1893 (Olive).

II. On Rubus occidentalis, Montgomery, 1893 (Olive); Marshall, 5, 1889 (Parks in Herb. Arthur).

Puccinia Kuhnle Schw.

On Kuhnia eupatorioides, Tippecanoe, 9, 1888 (Bolley).

Puccinia lateripes B. & Rav.

On Ruellia strepens, Johnson, 7, 1890 (Fisher); Owen, 10, 1893; Wabash, 7, 1887 (Miller).

Puccinia lobelle Gerard.

On Lobelia syphilitica, Johnson, 7, 1890 (Fisher); Putnam, 10, 1892; 9, 1893; Fulton, 10, 1893; Tippecanoe, 9, 1883 (Arthur); Vermillion, 7, 1889 (Arthur).

Puccinia maydis Carr.

On Zea mays, Putnam, 10, 1891; 9, 1893; Montgomery, 1893 (Olive); Dearborn, 8, 1889 (Bolley).

Puccinia mentle Pers.

On Blephilia hirsuta, Johnson, 9, 1890 (Fisher); Montgomery, 11, 1890 (Fisher).

On Cunila Mariana, Monroe, 9, 1886 (Blatchley).

On Mentha Canadensis, Johnson, 8, 1890 (Fisher); Marshall, 10, 1893; Tippecanoe, 9, 1893 (Arthur).

On Monarda fistulosa, Montgomery, 10, 1890 (Fisher); Marshall, 10, 1893; Vigo, 10, 1893.

On Monarda? sp., Owen, 10, 1893.

On Pycnanthemum lanceolatum, Marshall, 10, 1893.

On Pycnanthemum muticum, Vigo, 10, 1893.

Puccinia podophylli Schw.

On Podophyllum peltatum, Johnson, 7, 1890 (Fisher); Monroe, 5, 1893; Brown, 5, 1893; Owen, 5, 1893; Vigo, 5, 1893; Putnam, 5, 1892; Mont-

gomery, 1893 (Olive); Wabash, 6, 1890 (Miller); Dearborn, 1889 (Bolley).

Puccinia polygoni-amphibii Pers.

On Polygonum acre, Johnson, 10, 1890 (Fisher); Putnam, 10, 1891; 10, 1893.

On Polygonum Muhlenbergii, Fulton, 10, 1893; Wabash, 5, 1890 (Miller).

Puccinia prenanthis (Pers.) Fckl.

I. III. On Prenanthes sp., Vigo, 5, 1893.

On Prenanthes alba, Putnam, 5, 1890 (Arthur).

Puccinia ranunculi Seymour.

On Ranunculus repens, Montgomery, 1893 (Olive).

Puccinia rubigo-vera (D C.) Wint.

On Elymus Virginicus, Tippecanoe, 10, 1888 (Bolley).

On Avena sativa, Johnson, 7, 1890 (Fisher).

On Muhlenbergia diffusa, 7, 1890 (Fisher).

Puccinia sanicul.e Grev.

On Sanicula Canadensis, Montgomery (Rose).

Puccinia schroeteriana Plowr. & Magnus

On Carex stenolepis, Johnson, 11, 1890 (Fisher). [Herb. U. S.]

Puccinia silphii Schw.

On Silphium sp., Putnam, 10, 1891.

Puccinia tanaceti D C.

On Helianthus annuus, Johnson, 9, 1890 (Fisher); Putnam, 10, 1891; 11, 1892; Montgomery, 1893 (Olive).

On Hilanthus divaricatus, Montgomery, 10, 1890 (Fisher).

On Helianthus strumosus, Johnson, 8, 1890 (Fisher); Tippecanoe, 9, 1888 (Bolley).

On Helianthus tracheliifolius, Montgomery, 10, 1890 (Fisher); Shelby, 11, 1890 (Fisher).

On Helianthus grosse-serratus, Montgomery, 1893 (Olive).

On Helianthus sp., Putnam 10, 1893; Vigo, 10, 1893.

Puccinia tenuis Burrill.

On Eupatorium ageratoides, Putnam, 9, 1893.

Puccinia thalictri Chev.

II., III. On Thalictrum dioicum, Montgomery, 6, 1893 (Olive).

Puccinia Vernoni.e Schw.

On dead stems Vernonia fasciculata, Putnam, 12, 1892.

On Vernonia fasciculata, Putnam, 10, 1893.

Puccinia violæ (Schum.) D C.

On Viola palmata cucullata, Johnson, 8, 1890 (Fisher); Montgomery, 1893 (Olive).

On Viola striata, Montgomery, 10, 1890 (Fisher); Owen, 10, 1893; Putnam, 10, 1893.

I. On Viola sp., Vigo, 5, 1893; Putnam, 5, 1893.

Puccinia vulpinoides Diet. & Holway *ined.*

On Carex vulpinoides, Tippecanoe, 11, 1888 (Bolley).

Puccinia xanthii Schw.

On Ambrosia trifida, Dearborn, 8, 1890 (Bolley).

On Xanthium Canadense, Montgomery, 10, 1890 (Fisher); 10, 1893; Putnam, 9, 1893.

On Xanthium strumarium, Johnson, 7, 1890 (Fisher); Putnam, 9, 1891; 7, 1893; Montgomery, 1893 (Olive); Tippecanoe, 8, 1890 (Arthur).

Roestelia lacerata (Sow.) Fr.

On Crataegus coccinea, Montgomery, 1893 (Olive).

On Crataegus punctata, Montgomery, 1893 (Olive); Putnam, 9, 1893.

Roestelia pyrata Thax.

On Pyrus communis, Wabash, 9, 1887 (Miller).

On Pyrus coronaria, Wabash, 8, 1891 (Miller).

Uredo hydrangeæ B. & C.

On Hydrangea arborescens, Marion, 8, 1890 (Tracy); Montgomery, 8, 1890, 10, 1890 (Fisher); Putnam; 10, 1891.

Uredo polypodii (Pers.) D C.

On Cystopteris fragilis, Putnam, 7, 1893.

Uromyces appendiculata (Pers.) Lev.

On Phaseolus (sp.) Montgomery, 10, 1890 (Fisher); 1893 (Olive); Putnam, 10, 1892; 7, 1893.

On Strophostyles angulosa, Montgomery, 1893 (Olive.)

Uromyces caladii (Schw.) Farl.

I. On Arisæma dracontium, Vigo, 5, 1893; Brown 5, 1893; (III) Montgomery 1893 (Olive).

I. On Arisæma triphyllum, Putnam, 5, 1892; Monroe, 5, 1893; Owen, 5, 1893; Vigo, 5, 1893.

III. On Arisæma triphyllum, Johnson, 7, 1890 (Fisher); Putnam, 7, 1893; Montgomery 1893 (Olive).

Uromyces caryophyllinus (Schr.) Schröt.

On Carnations, Marion, 1892 (Arthur).

Uromyces dactyloides Otth.

II. On Poa pratensis, Johnson, 11, 1890 (Fisher). [Herb. U. S.]

Uromyces euphorbiæ, C. & P.

On Euphorbia dentata, Putnam, 9, 1891.

On Euphorbia Preslii, Johnson, 7, 1890 (Fisher); Fulton, 10, 1893.

On Euphorbia hypericifolia, Putnam, 10, 1891; Tippecanoe, 9, 1888 (Bolley).

Uromyces graminicola Burrill.

II. III. On some grass (Triodia? or Glyceria?), Johnson, 8, 1890 (Fisher). [Herb. U. S.]

Uromyces hedysari-paniculati (Schw.) Farl.

On Desmodium canescens, Johnson, 7, 1890 (Fisher); Montgomery, 1893 (Olive).

On Desmodium lævigatum, Montgomery, 7, 1890 (Fisher).

On Desmodium paniculatum, Johnson, 7, 1890; 10, 1890 (Fisher).

On Desmodium viridiflorum, Putnam, 9, 1893.

On Desmodium Dillenii, Montgomery (Rose).

On Desmodium sp., Owen, 10, 1893; Vigo, 10, 1893; Marshall, 10, 1893; Montgomery, 10, 1893.

Uromyces Howei Pk.

On Asclepias cornuti, Johnson, 8, 1890 (Fisher); Montgomery, 7, 1890 (Fisher); 1893 (Olive); 10, 1893; Putnam, 10, 1891; 9, 1893; Wabash, 7, 1891 (Miller); Dearborn 9, 1888 (Bolley).

On Asclepias purpurascens, Montgomery, 10, 1890 (Fisher).

On Asclepias incarnata, Montgomery, 1893 (Olive).

Uromyces hyperici (Schw.) Curt.

On Elodes campanulata, Marshall, 10, 1893.

On Hypericum Canadense, Johnson, 8, 1890 (Fisher).

On Hypericum mutilum, Putnam, 10, 1891; Marshall, 10, 1893.

Uromyces lespedezæ (Schw.) Pk.

On Lespedeza procumbens, Montgomery, 10, 1890 (Fisher).

On Lespedeza reticulata, Montgomery, 10, 1890 (Fisher).

On Lespedeza sp., Owen, 10, 1893.

Uromyces perigynius Hals.

On Carex pubescens, Putnam, 5, 1890 (Arthur). Cf. Bot. Gaz., Aug. 1891.

Uromyces polygoni (Pers.) Fuckel.

On Polygonum acre, Johnson, 8, 1890 (Fisher).

On Polygonum aviculare, Putnam, 9, 1893; Montgomery, 1893 (Olive);

Tippecanoe, 9, 1888 (Bolley).

On Polygonum erectum, Johnson, 8, 1890 (Fisher); Putnam, 10, 1891; Tippecanoe, 9, 1888 (Bolley).

Uromyces terebinthi (D C.) Wint.

On Rhus toxicodendron, Montgomery, 10, 1890 (Fisher); Putnam, 9, 1893; 10, 1893; Owen, 10, 1893.

Uromyces trifolii (A. & S.) Wint.

On Trifolium medium, Johnson, 11, 1890 (Fisher).

On Trifolium pratense, Montgomery, 10, 1890 (Fisher); 1893 (Olive); Johnson, 11, 1890 (Fisher); Putnam, 9, 1891; Tippecanoe, 10, 1891 (Arthur); Wabash, 8, 1891 (Miller).

On Trifolium repens, Montgomery, 1893 (Olive); Tippecanoe, 10, 1888 (Bolley).

On Trifolium hybridum, Wabash, 10, 1886 (Miller).

Uromyces sp.

On Carex lupulina pedunculata, Johnson, 11, 1890 (Fisher). "n. sp." [Herb. U. S.]

Uropyxis amorphæ (Curt.) Schroet.

On Amorpha canescens, Marshall, 10, 1893.

Tremellini.

Auricularia sambucina Mart. Putnam, 12, 1891; 5, 1893; 10, 1893.

Exidia glandulosa Bull. Putnam, 12, 1891; 10, 1893.

Guepinia spathularia Schw. Putnam, 10, 1892; 9, 1893.

Tremella albida Huds. Putnam, 6, 1893 (M. T. Cook.)

Tremella foliacea Pers. Putnam, 10, 1893.

Tremella lutescens Pers. Putnam, 10, 1893.

HYMENOMYCETES.

Thelephorei.

Corticium incarnatum Fr.

On Hicoria sp, Putnam, 4, 1893.

Corticium mutatum Pk., Putnam, 10, 1891.

Craterellus cornucopioides L. Putnam, 7, 1893.

Stereum albobadium Schw., Putnam, 10, 1891 (H. E. Cole).

Stereum bicolor Pers? Putnam, 10, 1891.

Stereum complicatum Fr., Putnam, 10, 1891.

Stereum frustulosum Pers.

On Quercus sp., Putnam, 10, 1894; 10, 1892; 10, 1893.

Stereum purpureum Pers., Putnam, 3, 1892.

Stereum sericeum Schw., Putnam, 10, 1891.

Stereum versicolor Swartz, Putnam, 10, 1891; 10, 1892; 11, 1893.

Thelephora Schweinitzii Pk., Putnam, 7, 1893.

Clavariei.

Calocera cornea Batsch. Putnam, 11, 1892; 10, 1893.

Clavaria crispula Fr. Putnam, 7, 1893; 10, 1893.

Clavaria mucida Pers. Putnam, 10, 1893.

Clavaria pyxidata Pers. Putnam, 10, 1893; Marshall, 10, 1893.

Clavaria stricta Pers. Putnam, 10, 1893.

Hydnei.

Hydnum alboviride Morg. Putnam, 6, 1893 (Florence Young).

Hydnum alutaceum Fr. Putnam, 10, 1891.

Hydnum coralloides Scop. Putnam, 9, 1891; 12, 1891; 10, 1893 (Ellis and Wright); Tippecanoe, 9, 1893 (Arthur).

Hydnum erinaceum Bull. Putnam, 10, 1891; 10, 1893; Vermillion, 9, 1889 (Arthur).

Hydnum farinaceum Pers. Putnam, 10, 1891; 10, 1893.

Hydnum flabelliforme Berk. Putnam, 10, 1893.

Hydnum mucidum Fr. Putnam, 12, 1891.

Hydnum nudum B. and C. Putnam, 11, 1891.

Hydnum ochraceum P. Putnam, 10, 1891; 10, 1893; Vigo, 10, 1893.

Hydnum pithyophilum B. & C. ? Putnam, 10, 1893; plant bright yellow.

Hydnum pulcherrimum B. & C. Putnam, 10, 1891.

Hydnum septentrionale Fr.

On a fallen oak, Vigo, 10, 1893.

On a standing beech, Vigo, 10, 1893.

Hydnum stratosum Berk. Under side of a log, Putnam, 10, 1891.

Hydnum udum Fr. Putnam, 10, 1892; 10, 1893.

Irpex fuscescens Schw. Vigo 10, 1893; Putnam, 10, 1893.

Irpex obliquus Schrad. Vigo, 10, 1893.

Phlebia merismoides Fr. Putnam, 10, 1892; 10, 1893; Vigo, 10, 1893.

Polyporineæ.

Dædalea ambigua Berk. Putnam, 9, 1891; 10, 1893.

Dædalea confragosa Bolt. Putnam, 10, 1891; 9, 1893.

Dædalea unicolor Bull. Putnam, 10, 1893.

Favolus alveolarius (D C.) Fairman. (*F. Europæus, F. Canadensis.*) Putnam, 1, 1893; Marshall, 10, 1893.

Gloeoporus conchoides Mont. ? Vigo, 10, 1893; Tippecanoe, 4, 1892 (Arthur).

Lenzites betulina (L.) Fr. Putnam, 10, 1891; Vigo, 10, 1893; Tippecanoe, 4, 1892 (Arthur).

Lenzites vialis Pk. Putnam, 10, 1891; 10, 1893 (Including polyporoid forms.)

Merulius molluscus Fr. Putnam, 10, 1893.

Merulius rubellus Pk. Putnam, 9, 1891; 11, 1892; 10, 1893.

Merulius tremellosus Schrad. Putnam, 10, 1891; 5, 1893; 11, 1893; Vigo, 10, 1893.

Polyporus adustus Willd. Putnam, 10, 1891; 10, 1893; Vigo, 10, 1893.

Polyporus applanatus Pers. Putnam, 10, 1891; 10, 1892; 10, 1893; Tippecanoe, 4, 1890 (Arthur).

Polyporus arcularius Batsch.

On fallen branches, Putnam, 5, 1892; 5, 1893.

Polyporus conchatus (Pers.) Fr. Putnam, 10, 1893.

Polyporus conchifer Schw.

On branches of Ulmus Americana, Putnam, 10, 1891; 10, 1893.

Polyporus connatus Fr.

On cherry tree, Putnam, 3, 1893.

Polyporus fraxinophilus Pk.

On Fraxinus Americana, Putnam, 5, 1893.

Polyporus fuscocarneus Pers. Putnam, 10, 1893; 11, 1893.*

Polyporus gilvus Schw. Putnam, 10, 1891; Vigo, 10, 1893; Marshall, 10, 1893.

Polyporus hirsutus Wulf. Putnam, 10, 1891; 10, 1892; 10, 1893.

Polyporus obducens Pers. Putnam, 10, 1891.

Polyporus pergamenus Fr. Putnam, 10, 1891; 12, 1891; 10, 1892; Tippecanoe, 1889 (Arthur).

Polyporus picipes Fr. Putnam, 10, 1891.

Polyporus radicatus Schw. Putnam, 10, 1891.

Polyporus resinosus Schrad.

On Tilia Americana, Putnam, 5, 1892; 10, 1892.

Polyporus ribis (Schum.) Fr.

On currant bushes, Putnam, 5, 1893.

Polyporus rimosus Berk? Putnam, 10, 1891.

Polyporus sulphureus (Bull.) Fr. Putnam, 9, 1893.

*These forms are called by Peck var. *tenuis*.

Polyporus versicolor (L.) Fr. Tippecanoe, 11, 1889 (Arthur): Putnam, 10, 1891; Vigo, 10, 1893.

Polyporus vitellinus Schw. Putnam, 11, 1892.

Polyporus vitreus Pers? Vigo, 10, 1893.

Polyporus (Poria) xanthosporus n. sp. A resupinate plant with golden yellow spores, covering large areas of decaying wood; mycelium thin, dirty white, forming an almost inperceptible subiculum; pores at first whitish shallow folds of the subiculum, leaving scarcely any margin not occupied by the various stages of imperfectly formed pores, at length appearing yellowish from the abundant spores, finally yellowish brown or dark russet, slightly angular, small (0.25 mm.), becoming cristate at the mouth, 1 cm. or less long when fully mature, or with occasional longer masses of pores rising above the general surface, 2–2.5 cm. long; spores copious, brilliant golden yellow, oval, smooth, nucleate, 6x4 or 6x5 mic. "Goose pond" nine miles south of Terre Haute, Vigo county, October 1893. Forming large masses in cavities underneath the bark and wood of decaying poplar logs (*Populus heterophylla?*), its brilliant spores forming a dense covering in portions of the cavities not filled with the fungus. The color has persisted without appreciable fading after exposure to the light for nearly seven months.

Trametes cinnabarina (Jacq.) Fr. Putnam, 10, 1891; 10, 1893; Tippecanoe, 5, 1893 (Arthur); Vigo, 10, 1893: Marshall, 10, 1893.

Trametes scutellata Schw. (*T. Ohiensis* Berk.)
On oak rails, Putnam, 11, 1891.

Boletineæ.

Boletinus porosus (Berk.) Pk. Putnam, 10, 1893.

Boletus Americanus Pk. Putnam, 9, 1891.

Boletus Clintonianus Pk. In a tamarack swamp, Fulton, 10, 1893.

Boletus subluteus Pk. Putnam, 10, 1893.

Boletus subtomentosus L. Putnam, 7, 1893.

Agaricineæ.

Agaricus campestris L. Putnam, 10, 1891; 5, 1892; 9, 1893.

Agaricus sylvaticus Schæff. Putnam, 10, 1893.

Amanita muscaria L. Putnam, 7, 1893.

Amanita pantherina D. C. Putnam, 7, 1893.

Amanita phalloides Fr. Putnam, 9, 1893.

Amanita virosa Fr. In low, sandy woods, Vigo, 10, 1893.

Armillaria mellea Vahl. Putnam, 9, 1891; 9, 1893; 10, 1893.

Clitocybe illudens Schw. Putnam, 10, 1893.
Clitocybe laccata Scop. Putnam 9, 1891; Vigo, 10, 1893.
Clitocybe phyllophila Fr. Putnam, 10, 1893.
Collybia dryophila Bull. Putnam, 5, 1892.
Collybia longipes Bull. Putnam, 10, 1893.
Collybia platyphylla Fr. Putnam, 5, 1892.
Collybia radicata Relh. Putnam, 9, 1891; 10, 1893.
Collbia velutipes Curt. Putnam, 12, 1891; Tippecanoe, 4, 1892. (Arthur).
Crepidotus dorsalis Pk. Putnam, 10, 1891.
Crepidotus fulvotomentosus Pk. Putnam, 7, 1893; 10, 1893.
Galera tenera Schæff. Putnam. 10, 1893.
Hypholoma Candolleanum Fr.
On lawns, Putnam 6, 1893.
Hypholoma incertum Pk. Putnam, 5, 1892.
Hypholoma sublateritium Schaeff. Putnam, 10, 1891; 10, 1893.
Hypholoma velutinum Pers. Putnam, 10, 1893.
Lepiota Americana Pk. Putnam, 9, 1893.
Lepiota cristata A. and S. Putnam, 9, 1893.
Lepiota naucinoides Pk. Putnam, 10, 1893.
Lepiota procera Scop. Putnam, 10, 1893; Montgomery, 10, 1893.
Mycena corticola Schum.
On bark of living trees, Putnam, 11, 1891.
Mycena galericulata Scop. Putnam, 5, 1892; Vigo, 5, 1893.
Mycena Leaiana Berk. Putnam, 5, 1892; Vigo, 5, 1893.
Naucoria semiorbicularis (Bull).
On lawns, Putnam, 5, 1892.
Panæolus fimiputris Bull.
On dung in pastures, Putnam, 6, 1893.
Pholiota adiposa Fr. Putnam, 9, 1893; Vigo, 10, 1893.
Pholiota spectabilis Fr. Vigo, 10, 1893.
Pleurotus salignus Schrad.
On dead Salix, Putnam, 10, 1893.
Pleurotus serotinus Schrad. Putnam, 11, 1892.
Pluteus cervinus Schæff. Putnam, 5, 1892; 9, 1893.
Stropharia æruginosa Curt. Putnam, 10, 1893; Vigo, 10, 1893.
Stropharia semiglobata Batsch. Putnam, 10, 1893.
Tubaria furfuracea Pers. Putnam, 10, 1893.

Bolbitius tener Berk.

On lawns, Putnam 6, 1893.

Cantharellus cibarius Fr. Putnam, 7, 1893.

Cantharellus cinnabarinus. Putnam, 7, 1893.

Coprinus atramentarius (Bull.) Fr. Putnam, 4, 1892; 10, 1893.

Coprinus comatus Fr. Putnam, 10, 1893.

Coprinus micaceus (Bull.) Fr. Putnam 4, 1892.

Coprinus plicatilis (Curt.) Fr. Putnam, 6, 1893 (Melia Ellis).

Coprinus sterquilinus Fr. Putnam, 6, 1893 (Melia Ellis).

Lactarius trivialis Fr. Putnam, 7, 1893.

Lentinus lepideus Fr. Vigo, 10, 1893.

Lentinus strigosus Fr. Putnam, 10, 1891; 10, 1893.

Marasmius rotula (Scop.) Fr. Putnam, 5, 1893.

Panus stypticus (Bull.) Fr. Putnam, 10, 1891; 5, 1893; 10, 1893; Vigo, 10, 1893.

Schizophyllum commune Fr. Putnam, 10, 1891; 11, 1893; Montgomery, 10, 1893.

GASTROMYCETES.

Phalloideæ.

Mutinus caninus Huds. Putnam, 6, 1893; 7, 1893.

Phallus Dæmonum Rumph.? Putnam, 10, 1891.

Phallus duplicatus Bosc. Putnam, 10, 1891.

Phallus Ravenelii B. & C. Putnam 10, 1891.

Lycoperdaceæ.

Bovista minor Morg. Putnam, 4, 1894.

Bovista pila B & C. Putnam, 4, 1892; 10, 1893; Marshall, 10, 1893.

Bovista plumbea Pers. Vermillion, 9, 1889 (Arthur); Putnam, 6, 1892.

Calvatia Bovista (L.) (C. maxima Schæff., Lycoperdon gigantum Batch). Montgomery, 4, 1892 (Blair); Noble, 9, 1892 (Laura Beazell); Putnam, 11, 1893.

Calvatia cælata Bull. Putnam, 10, 1893.

Calvatia craniiformis Schw. Putnam, 10, 1893; Owen, 10, 1893.

Calvatia cyathiformis Bosc. Putnam 4, 1893; 10, 1893; 11, 1893; Vigo, 10, 1893; Vermillion (Arthur).

Catastoma circumscissum (B. & C.) Morg. Putnam 9, 1893.

Geaster capensis Thüm. Elkhart 6, 1892. (S. W. Baer).

Geaster limbatus Fr. Putnam, 12, 1892.

Geaster striatus D. C. Putnam, 4, 1892; 10, 1892.

Lycoperdon asterospermum D. & M. Vigo 10, 1893.*

Lycoperdon cepæforme Bull. Putnam 9, 1893.

Lycoperdon coloratum Pk. Putnam 4, 1894.

Lycoperdon excipuliforme Scop. Putnam, 10, 1893.*

Lycoperdon glabellum Pk. Putnam, 10, 1893.

Lycoperdon gemmatum Batsch. Putnam, 10, 1893.

Lycoperdon muscorum Morg. Vigo, 5, 1893 (a single specimen).

Lycoperdon Peckii Morg. Marshall, 10, 1893; Vigo, 10, 1893.

Lycoperdon pedicellatum Pk. Putnam, 10, 1893.

Lycoperdon pyriforme Schæff. Putnam, 10, 1893; Vigo, 10, 1893.

Lycoperdon rimulatum Pk. Vigo, 5, 1893 (one specimen only).

Lycoperdon separans Pk. Putnam, 10, 1893; Marshall, 10, 1893; Vigo, 10, 1893.

Lycoperdon Turneri E. and E. Marshall, 10, 1893.*

Secotium accuminatum (Mont.) Tul. (S. *Warnei.* Pk.) Putnam, 10, 1893; Tippecanoe, 9, 1893 (Arthur).

Tylostoma mammosum Mich. Putnam, 4, 1892; Vigo, 5, 1893.

Sclerodermaceæ.

Scleroderma vulgare Fr. Putnam, 9, 1893.

Nidulariaceæ.

Crucibulum vulgare Tul. Brown, 5, 1893; Putnam, 6, 1893; 9, 1893; Vigo, 10, 1893.

Cyathus striatus (Huds.) Hoffm. Putnam, 7, 1893.

Cyathus vernicosus (Bull.) D C. Vermillion, 9, 1889 (Arthur); Putnam, 6, 1893; 9, 1893.

BRYOPHYTA.

HEPATICÆ.

Ricciaceæ.

Riccia fluitans L. Marshall, 5, 1891 (Norman); St. Joseph, 7, 1893 (Uline); Vigo, 5, 1893.

Marchantiaceæ.

Asterella hemisphærica (L.) Beauv. Putnam, 5, 1891 (Campbell); 5, 1892; 10, 1892.

Conocephalus conicus (L.) Dumort. Putnam 10, 1892.

Fimbriaria texella Nees. Owen, 5, 1893; Brown, 5, 1893.

Marchantia polymorpha L. Putnam, 5, 1892; Owen, 5, 1893; Fulton, 10, 1893.

*Determined by A. P. Morgan.

ANTHOCEROTACEÆ.

ANTHOCEROS LEVIS L. Putnam, 10, 1892.

NOTHOTHYLAS ORBICULARIS (Schw.) Sulliv. Putnam, 11, 1892; Monroe, 1893 (Mottier).

JUNGERMANIACEÆ.

ANEURA PINGUIS (L.) Dumort. Putnam, 11, 1892 (one specimen only).

BAZZANIA TRILOBATA (L.) S. F. Gray. Putnam, 10, 1891.

CEPHALOZIA CURVIFOLIA (Dicks.) Dumort. Putnam, 3, 1892; 10, 1892.

CHILOSCYPHUS ASCENDENS H. and W. Putnam, 3, 1891.

DIPLOPHYLLUM TAXIFOLIUM (Wahl.) Dumort. Putnam, 10, 1892.

FOSSOMBRONIA CRISTATA Lindb. Putnam, 10, 1891.

FRULLANIA ÆOLOTIS Nees. Putnam, 10, 1891.

FRULLANIA EBORACENSIS Lehm. Putnam, 10, 1891.

FRULLANIA SQUARROSA Nees. Putnam, 10, 1891.

FRULLANIA VIRGINICA Lehm. Putnam, 10, 1891.

GEOCALYX GRAVEOLENS (Schrad.) Nees. Putnam, 10, 1892.

JUNGERMANIA SCHRADERI Mart. Montgomery, 4, 1892.

LEJEUNEA CALCAREA Lib. Putnam, 10, 1891. (On Camptosorus.)

LEPIDOZIA REPTANS (L.) Dumort. Putnam, 3, 1892; 10, 1892.

LOPHOCOLEA HETEROPHYLLA (Schrad.) Nees. Montgomery, 4, 1892.

LOPHOCOLEA BIDENTATA (L.) Dumort. Putnam, 10, 1892.

NARDIA CRENULATA (Sm.) S. F. Gray. Putnam, 10, 1893.

NARDIA HYALINA (Lyell) Carr. Putnam, 5, 1893.

PELLIA EPIPHYLLA (L.) Raddi. Putnam, 10, 1891; 10, 1892.

PORELLA PINNATA L. Vigo, 5, 1893.

PORELLA PLATYPHYLLA (L.) Lindb. Putnam, 10, 1891; Monroe, 5, 1893.

PLAGIOCHILA ASPLENOIDES (L.) Dumort. Putnam 10, 1892.

PTILIDIUM CILIARE (L.) Nees. Putnam, 10, 1891.

SCAPANIA NEMOROSA (L.) Dumort. Putnam, 9, 1891; 10, 1892.

TRICHOCOLEA TOMENTELLA (Ehrh.) Dumort. Putnam 4, 1892.

MUSCI.

ANOMODON ROSTRATUS (Hedw.) Schimp. Owen, 5, 1893; Montgomery (Barnes).

ATRICHUM ANGUSTATUM (Brid.) Bruch. & Schimp. Vigo, 10, 1893.

ATRICHUM UNDULATUM (L.) Bruch. & Schimp. Putnam, 9, 1891.

AULACOMNIUM HETEROSTICHUM (Beauv.) Bruch. & Schimp. Putnam, 5, 1893; Montgomery (Barnes).

Bartramia pomiformis (L.) Hedw. Putnam, 10, 1891.

Bryum argenteum L. Putnam, 2, 1892.

Bryum cespiticium L. Putnam, 5, 1892.

Bryum intermedium (Schwäg.) Brid. Owen, 5, 1893.

Bryum roseum Schreb. Putnam, 10, 1893.

Ceratodon purpureus (L.) Brid. Tippecanoe, 4, 1892; Owen, 5, 1893; Putnam, 4, 1894.

Climacium Americanum Brid. Putnam, 10, 1891; 10, 1892.

Conomitrium Julianum (Savi.) Mont. Monroe, 3, 1893 (Mottier).

Cylindrothecium cladorrhizans (Hedw.) Schimp. Putnam, 10, 1891; 5, 1893.

Dicranella heteromalla (L.) Schimp. Putnam, 10, 1891; Lake (Röll).

Dicranella rufescens (Turn.) Schimp. Putnam, 10, 1891.

Dicranella varia (Hedw.) Schimp. Putnam, 11, 1892.

Dicranum flagellare Hedw. Lake (Röll). [Herb. Barnes.]

Dicranum scoparium (L.) Hedw. Putnam, 10, 1891; 5, 1893.

Drummondia clavellata Hook. Tippecanoe, 4, 1892; Monroe (Blatchley).

Eustichia Norvegica Brid.

On sandstone rocks. Putnam, 10, 1891.

Fissidens incurvus (W. and M.) Schwäg. Putnam, 12, 1892.

Fissidens taxifolius (L.) Hedw. Putnam, 5, 1893.

Funaria hygrometrica (L.) Sibth. Putnam, 5, 1892.

Grimmia apocarpa (L.) Hedw. Putnam, 5, 1893.

Gymnostomum curvirostre Hedw. Owen, 5, 1893.

Hypnum (Thamnium) Alleghaniense Müll. Putnam, 4, 1892.

Hypnum arcuatum. Montgomery (Barnes). [Herb. Barnes.]

Hypnum (Eurhynchium) Boscii Schwäg. Putnam, 10, 1891; Monroe (Blatchley).

Hypnum (Euhypnum) cupressiforme L. Putnam, 10, 1891; 5, 1893.

Hypnum (Thuidium) delicatulum L. Putnam, 10, 1891.

Hypnum (Amblystegium) fluviatile, Swartz. Montgomery (Barnes); Putnam, 5, 1882.

Hypnum (Brachythecium) laetum Brid. Montgomery (Barnes); Putnam, 10, 1891.

Hypnum (Amblystegium) radicale Beauv. Montgomery (Barnes). [Herb. Barnes.]

Hypnum (Brachythecium) rutabulum L. Putnam, 10, 1891.

Hypnum (Rhynchostegium) serrulatum Hedw. Putnam, 9, 1891; 5, 1893.

HYPNUM (Amblystegium) SERPENS L. Putnam, 5, 1893.
LEPTOTRICHUM PALLIDUM (Herb.) Hampe. Vigo, 5, 1893.
LEPTOTRICHUM TORTILE (Schrad.) Müll. Lake (Roll). [Herb. Barnes.]
LEUCOBRYUM VULGARE Hampe. Fulton, 10, 1893; Putnam, 10, 1893.
LEUCODON JULACEUS (Hedw.) Sulliv. Monroe (Blatchley); Putnam, 10, 1891; 12, 1891.
MNIUM AFFINE Bland. Montgomery (Barnes). [Herb. Barnes.]
MNIUM CUSPIDATUM Hedw. Putnam, 5, 1892.
PHYSCOMITRIUM TURBINATUM (Michx.) Brid. Putnam, 5, 1892; 5, 1893; Tippecanoe, 4, 1892; Owen; 5, 1893.
POGONATUM BREVICAULE Beauv. Putnam, 10, 1892.
POLYTRICHUM FORMOSUM Hedw. Montgomery (Barnes). [Herb. Barnes.]
POLYTRICHUM OHIOENSE Ren. & Cardot. Marshall, 10, 1893.
POTTIA TRUNCATA (Hedw.) Fuern. Tippecanoe, 4, 1892.
TIMMIA MEGAPOLITANA Hedw. Montgomery (Barnes). [Herb. Barnes.]
WEISIA RIVIDULA Brid. Putnam, 4, 1892.

SPHAGNACEÆ.

SPHAGNUM CYMBIFOLIUM Ehrh. Fulton, 10, 1893.*
SPHAGNUM PAPILLOSUM LEVE Warnst. Fulton, 10, 1893.*
SPHAGNUM RECURVUM MUCRONATUM. Fulton, 10, 1893.*
SPHAGNUM RUFESCENS. Fulton, 10, 1893.*

* Determined by Prof. D. C. Eaton.

ZOOLOGY.

C. H. EIGENMANN, DIRECTOR.

In connection with the general circular of the Biological Survey of Indiana, the following special circular for the Zoological section was issued:

SPECIAL ANNOUNCEMENT OF THE DIVISION OF ZOOLOGY.

The leading aim of this division during the season will be the compilation of a complete bibliography of the vertebrates of Indiana and of as many invertebrates as can be provided for.

At the same time any material showing the distribution of animals in the state is especially desirable. To determine the distribution, complete collections of the vertebrates of as many localities as possible should be

made. Collections should always accompany notes, so that the observations may be verified by some specialist.

No opportunity should be neglected to observe the breeding habits and seasons, and the animal with young should, whenever possible, be preserved and forwarded to the Director, who will transmit it to the proper authority for record.

Another subject which should receive attention is the migration, or seasonal appearance and disappearance of mammals, birds, reptiles and fishes. The interesting results obtained in the observation of the migration of birds only suggest what may be done with the less conspicuous but no less interesting habits of other forms.

Carl H. Eigenmann, Director,
Bloomington, Indiana.

The chief aim of this division for the past season—the compilation of the bibliography of the vertebrates of Indiana—has been completed, and, wherever that has not been done before, preliminary lists of the Indiana species have been compiled and are ready for the printer. Where such lists had recently been published in accessible form they have not been reproduced.

I give here the titles of the lists of species and bibliographies with their place of publication:

A Catalogue of the Mammals of Indiana, with Bibliography.

A. W. Butler and B. W. Evermann. These proceedings.

A Catalogue of the Birds of Indiana.

Amos W. Butler. Proceedings of the Agricultural Society, 1890.

Bibliography of Indiana Ornithology.

A. W. Butler. These proceedings.

The Batrachians and Reptiles of the State of Indiana.

O. P. Hay. Seventeenth Report Indiana Geological and Natural History Survey.

Bibliography of the Batrachians and Reptiles of Indiana.

O. P. Hay. These proceedings.

A Catalogue of the Fishes of Indiana.

Carl H. Eigenmann and C. H. Beeson. These proceedings.

Bibliography of Indiana Ichthyology.

Carl H. Eigenmann. These proceedings.

The invertebrates have not been so well provided for, although some of the groups have received an equal share of attention.

No reports on the Protozoa, sponges, Plathelminthes and Vermes have been prepared.

A catalogue of the Mollusca with bibliography has been completed by Mr. R. Elsworth Call, and appears in these proceedings.

Several groups of the Arthropods have recently been dealt with.

In the Memorial Bulletin (No. 46, 1893) of the U. S. National Museum, the complete writings of our late associate, Harvey Bollman, have been reproduced. In this volume the Indiana Myriopoda are more fully treated than those of any other state. In the same volume, L. M. Underwood has given a complete bibliography of the American Myriopoda, and naturally, the Indiana bibliography is included.

A Catalogue of the Butterflies known to occur in Indiana.

W. S. Blatchley. Seventeenth Annual Report Indiana Geological and Natural History Survey.

The Gryllidæ of Indiana.

W. S. Blatchley. Proc. Indiana Academy I, 126.

The Locustidæ of Indiana.

W. S. Blatchley. Proc. Indiana Academy II, 92.

The Blattidæ of Indiana.

W. S. Blatchley. Proc. Indiana Academy II, 153.

A partial list of new species of parasitic Hymenoptera reared in Indiana.

F. M. Webster. Proc. Indiana Academy II, 89.

The Crustacea of Indiana have been considered by O. P. Hay in the proceedings of the Indiana Academy I, 147.

Hereafter all specimens coming into the hands of the Academy will be referred to the following specialists:

Mammals and Birds	A. W. Butler.
Batrachians and Reptiles	O. P. Hay.
Fishes	Carl H. Eigenmann.
Lepidoptera and Orthoptera	W. S. Blatchley.
Crustacea	W. P. Hay.
Animal Parasites	A. W. Bitting.
Arachnida	Dr. Henry C. McCook.

The field work for the past two seasons has been limited to private enterprise except as far as the explorations of the U. S. Fish Commission were concerned.

The specialists in the various branches will record the details of the progress in their respective departments.

The work in fishes has been as follows:

Mr. D. C. Ridgely has collected for the Indiana University in Trail creek, a small stream of La Porte county, emptying into Lake Michigan. Mr. W. O. Wallace has collected a good series of fishes in Wabash county. Messrs. Kirsch and Beeson on behalf of the U. S. Fish Commission have explored the Eel river along its entire length and made collections in various points of the Maumee basin.

Offers of assistance and co-operation have been received from various persons over the state who have not yet given any concrete assistance.

It is the intention of the director of the Zoological Survey to establish stations at various places in the state during successive summers to study the fauna in situ. The work during the coming summer will either be explorations along the Ohio river or on one of the lakes of northern Indiana. Next to the distribution of Indiana organisms their correlation in different localities, their geographical variations, migrations and breeding habits seem to be questions which should be studied.

The position and general features of Indiana are such that not a single animal need be expected to be restricted within its geographical boundaries. The same may be said of the four states surrounding it. Nor would they with Indiana form a geographical unit. For these reasons it seems to me that the advantages of co-operation with neighboring states may be overestimated. If the survey is to be restricted by geographical boundaries, the boundaries of Indiana will do about as well as the boundaries of the states surrounding us. While too great value can not be placed on the thorough exploration of neighboring states and of the states bordering on them for purposes of comparison, our best efforts, must for economic reasons, be devoted to our own bailiwick.

This leads me to say a word in favor of county surveys. The same interests that bind us together to conduct a survey of the state unite the teachers and others of the same county and through this common interest county surveys may be established and the survey of the state furthered. I am well aware that animals and plants do not respect county lines, but neither do they state lines. I would urge the formation of county science associations whose sole purpose it shall be to make a careful survey of the respective counties. Wabash county has such an association, and judging the work of this association from the part that has passed through my hands, this association may well form a model for other counties.

Teachers and others of this county formed an association similar to that of the Academy of Sciences. Some one interested in a particular branch was made curator of that branch and all specimens referred to him. As a result we have a very fair collection of the fishes of this county with exact locality labels, a complete set of the birds, including several not known to occur elswhere in the state, (*Dendroica kirtlandi*) and a similar list of the plants. Work as well done as this in every county of the state would rapidly advance our knowledge of the habits and distribution of the organisms in the state.

Those counties in which academies, colleges or universities are situated ought to lead in this respect. It is certainly the duty of the biological departments of such institutions to make a survey of the surrounding country and *display its fauna and flora*. While I deprecate the miscellaneous collections of odds and ends from nowhere and the ends of the world, a systematic collection of the organisms displayed with proper labels showing the geographical distribution would have a definite, scientific and educational value. The data for the geographical distribution of Indiana animals will be furnished in the reports of the survey.

BIBLIOGRAPHY OF INDIANA FISHES.

Indiana has had more than her share of American Ichthyologists; in fact, she has harbored at one time or another nearly as many as all the other states put together.

These have come in two widely separate periods. Rafinesque, the author of the Ichthyologia Ohiensis, and Le Sueur, both of whom were for a time at New Harmony, published between 1814 and 1820. While works of a general nature had an indirect bearing on the fishes of Indiana, nothing appeared on the fishes of Indiana between 1820 and 1875. All the more recent work has been due to the presence in Indiana of David Starr Jordan. It may be noted here that Jordan's first Ichthyological venture was the publication of a description of the Sisco of Lake Tippecanoe, in 1875, and his last Indiana effort the description of a new fish from the Tippecanoe river, 1890.

About Jordan there arose a group of his pupils, all of whom have added something to the knowledge of the fishes of the state.

The names of these which owed their inspiration directly or indirectly to Jordan are Copeland, Brayton, Gilbert, Hay, McKay, Rosa Smith

Swain, Evermann, Eigenmann, Fordice, Blatchley, Jenkins, Bollman Kirsch, Shannon and Woolman.

The following is a list of the papers which have appeared:

1814. **Rafinesque, Constantine Samuel.** "Precis des decouvertes Somiologique."

1817. ——First decade of new North American fishes. Am. Monthly Mag. and Crit. Review, Dec.

1817. **Le Sueur, Charles A.** A new genus of fishes, of the order abdominales proposed, under the name of Catostomus; and the characters of this genus, with those of its species, indicated. Journ. of the Acad. Nat. Sci. Philad. I, 1817, pp. 88–96 and 102–111.

1818. **Rafinesque.** Description of two new genera of North Am. fishes. Am. Monthly Magazine, etc. Jan. 1818.

——Second decade of new North American fishes, l. c. Jan. 1818.

——Discoveries in Natural History made during a journey through the western region of the United State by Constantine Samuel Rafinesque. Am. Monthly Magazine, etc., Sept. 1818. Dated Falls of Ohio, 20th July, 1813.

1818. **Le Sueur.** In Trans. Am. Philos. Soc. I., 388.

1818. **Rafinesque.** Further discoveries in Natural History, made during a journey through the western region of the United States, by Constantine Samuel Rafinesque. Am. Monthly Magazine, etc., Oct. 1818.

——Further account of discoveries in Natural History in the western states by Constantine Samuel Rafinesque. l. c., Oct. 1818.

——Description of three new genera of fluviatile fish, Pomoxis, Sarchirus, and Exoglossum. Journ. Philad. Acad. Sc., Nov. 1818.

1819. **Le Sueur.** De Quelques Poissons decouverts dans les Sacs de Haute Canada. Mem. Mus. v.

1819. **Rafinesque.** Prodrome de 70 nouveaux Genres d'Animaux decouverts dans l'interieur des Etats-Unis d'Amerique durant l'année 1818, Journal de Physique, de Chymie et d'Histoire Naturelle, June, 1819.

1819–1820. **Rafinesque.** Ichthyologia Ohiensis. Western Review and Miscellaneous Magazine, Dec. 1819–Nov. 1820.

1820. **Rafinesque.** Description of the Silures or Cat-fishes of the river Ohio. Quart. Journ. Sci. Lit. and Arts, Royal Institution, London. 1820.

1840–44. **Kirtland, Jared Potter.** Description of the fishes of the Ohio river and its tributaries. Bost. Journ. Nat. Hist., vols. III–V 1840–1844.

1846. **Storer, David Humphreys.** A synopsis of the fishes of North America. 1846.

1859–1870. **Gunther, Albert.** A catalogue of the fishes of the British Museum.

1875. **Jordan, David S.** The Sisco of Lake Tippecanoe. Am. Nat., March 1877, pp. 135–138.

————The Sisco of Lake Tippecanoe and its relatives. Sixth Ann. Rept. of the Geol. Survey of Indiana. 1875.

————Synopsis of the genera of fishes to be looked for in Indiana l. c.

1876. **Jordan.** Manual of the vertebrates of the Northern United States, etc. 1876. Second Ed. 1878. Third Ed. 1880. Fourth Ed. 1885. Fifth Ed. 1888.

————Concerning the fishes of the Ichthyology Ohiensis. Bull Buffalo Soc. Nat. Hist., 1876, pp. 91–97.

1876. **Jordan and Copeland, Ernest.** Check list of the fishes of the fresh waters of North America. Bull Buffalo Soc. Nat. Hist., II, 1876, pp. 133–164.

————Johnny Darters. Amer. Nat., June, 1876, pp. 335–341.

1877. **Jordan and Gilbert, Charles H.** List of fishes of Indiana. Indiana Farmer, Jan. 17, 1877.

1877. **Jordan and Copeland.** The Sand Darter. Amer. Nat., February, 1877, pp. 86–88.

1877. **Jordan.** Review of Rafinesque's Memoirs on North American fishes. Bull. U. S. Nat. Mus. 10, 1877.

Contributions to North American Ichthyology I.

————Notes on *Cottidæ*, *Etheostomatidæ*, *Percidæ*, *Centrarchidæ*, *Aphododeridæ*, *Dorosomatidæ*, and *Cyprinidæ*, with revisions of the genera and descriptions of new or little known species. Bull. U. S. Nat. Mus. 10, 1877.

Contributions to North American Ichthyology II.

————Synopsis of the Siluridæ of the fresh waters of North America. Bull. U. S. Nat. Mus. 10, 1877.

————A partial synopsis of the fishes of upper Georgia, with supplementary papers on fishes of Tennessee, Kentucky and Indiana. Ann. N. Y. Lyc. Nat. Hist. XI, 1877.

————On the fishes of Northern Indiana. Proc. Acad. Nat. Sci. Philadelphia, 1877.

1877. **Jordan and Gilbert, Charles H.** On the genera of North American fresh water fishes. Proc. Acad. Nat. Sci. Philadelphia, 1877, pp. 83–104.

1878. **Jordan.** Catalogue of the fishes of Indiana, in article Pisciculture (by Alexander Heron). Twenty-seventh annual report of the Indiana State Board of Agriculture, 1878.

1878. **Jordan and Brayton, Alembert B.** On the distribution of the fishes of the Alleghany region of South Carolina, Georgia, and Tennessee, with descriptions of new or little known species. Bull. U. S. Nat. Mus. 12, 1878.

Contributions to North American Ichthyology III.

1878. **Jordan.** A synopsis of the family Catostomidæ. Bull. U. S. Nat. Mus. 12, 1878.

1879. **Jordan.** Description of new species of North American fishes. Proc. U. S. Nat. Mus. 1879, pp. 235–244.

1881. **McKay, Charles L.** A review of the genera and species of the family Centrarchidæ, with a description of one new species. Proc. U. S. Nat. Mus. 1881, pp. 87–93.

1882. **Jordan and Gilbert.** Description of a new species of *Uranidea* (*Uranidea pollicaris*) from Lake Michigan. Proc. U. S. Nat. Mus. 1882, pp. 222–223.

1882. **Swain, Joseph and Kalb, George.** A review of the genus Noturus, with a description of one new species. Proc. U. S. Nat. Mus. 1882, pp. 638–644.

1883. **Jordan and Gilbert.** Synopsis of the fishes of North America. Bull U. S. Nat Mus. No. 16.

1883. **Jordan.** Notes on the nomenclature of certain North American fishes. Proc. U. S. Nat. Mus. 1883, pp. 110–111.

1883. **Swain, Joseph.** A description of a new species of Hadropterus (*Hadropterus scierus*) from Southern Indiana. Proc. U. S. Nat. Mus. 1883, p 252.

1884. **Gilbert.** A list of fishes collected in the East Fork of White river, Indiana, with descriptions of two new species. Proc. U. S. Nat. Mus. 1884, pp. 199–205.

————Notes on the fishes of Switz City swamp, Greene county, Indiana. Proc. U. S. Nat. Mus. 1884, pp. 206–210.

1884. **Jordan.** A catalogue of the fishes known to inhabit the waters of North America. Rept. Comm. Fish and Fisheries 1884.

1885. **Blatchley, Willis S.** On the American species of the genus Umbra. Proc. Acad Nat. Sci., Philad. 1885, 12.

1885. **Bicknell. Ernest P., and Dresslar. Fletcher B.** A review of the species of the genus Semotilus. Proc. Acad. Nat. Sci. Phila. 1885, 14.

————A review of the species of the genus Pimephales. l. c. 63.

1885. **Jordan and Eigenmann, Carl H.** Notes on skeletons of Etheostomatinæ. Proc. U. S. Nat. Mus. 1885, pp. 68–72.

1885. **Jordan.** Notes on the scientific name of the yellow perch, the striped bass, and the American fishes. Proc. U. S. Nat. Mus. 1885, pp. 72–73.

————On the Etheostoma variatum of Kirtland. Proc. U. S. Nat. Mus. 1885, pp. 163–165.

Meek, Seth E. and Newland, Robert. A review of the species of the genus Esox. Proc. Acad. Nat. Sci. Phila. 1885, 367.

Eigenmann, Carl H. and Fordice, Morton W. A catalogue of the fishes of Bean Blossom creek, Monroe county, Ind. Proc. Acad. Nat. Sci. Phila. 1885, 410.

1886. **Evermann, B. W.** A list of the fishes observed in the vicinity of Brookville, Franklin conuty, Ind. Bull. No. 2 Brookville Soc. Nat. Hist. 1886.

1886. **Jenkins, O. P.** List of the fishes collected in Vigo county in 1885 and 1886. Hoosier Naturalist.

1887. **Gilbert.** Description of new and little known Etheostomoits. Proc. U. S. Nat. Mus. 1887, pp. 47–64.

1887. **Jordan and Evermann.** The food-fishes of Indiana. Report Dept. Agr. Ind. for 1886, August 1887.

1887. **Jordan and Eigenmann.** A review of the Sciænoid fishes of America and Europe. Rept. U. S. Fish Comm. for 1886, September 1887.

1888. **Evermann and Jenkins.** Notes on Indiana fishes. Proc. U. S. Nat. Mus. 1888, pp. 43–57.

1889. **Jordan.** Report of explorations made during 1888 in the Alleghany region of Virginia, North Carolina and Tennessee, and in western Indiana, with an account of the fishes found in each of the river basins of those regions. Bull. U. S. Fish Com. VIII, pp. 97–168, pls. XIII–XV, 1889.

1890. **Jordan and Evermann.** Description of a new species of fish from Tippecanoe river, Ind. Proc. U. S. Nat. Mus. 1890, pp. 3 and 4.

1891. Jordan. Relations of temperature to vertebræ among fishes. Proc. U. S. Nat. Mus. 1891, pp. 107–120.

1891. Bollman, Charles Harvey. Review of the Centrarchidæ, or fresh water sun-fishes of North America. Rept. Comm. Fish and Fisheries 1888.

1884. Kirsch. Bull. U. S. Fish Comm. 1894.

1894. Eigenmann. The Fishes of Indiana. Proc. Ind. Acad. Sci. III.

1894. Ulrey, A. B. The Fishes of Wabash County. Proc. Ind. Acad. Sci. III,

THE FISHES OF INDIANA.*

By Carl H. Eigenmann and Charles H. Beeson.

We have compiled a list of the species of fishes so far found in Indiana. After the names, scientific and common, we give a list of all the Indiana localities and authority for the locality. The dates with the authority taken with the bibliography of Indiana fishes will probably be sufficient to enable anyone to look up any of the citations. In a few cases no date is given with the authority. This indicates that no account has been published of the collections made. I. U. Coll. indicates that specimens from that locality are in the collections of the Indiana University.

The localities are arranged in the same order observed in the list of streams which precedes the list of fishes. We give only those streams in which collections have been made. Following the name of the stream we give the name and date of the recorder for the given stream.

List of Localities Explored.

The Ohio River.

White Water River, Brookville, Franklin county—Evermann, 1886.

Laughery Creek, Milton, Ohio county—Jenkins, 1888.

Fourteen Mile Creek, Clark county—Jenkins, 1888.

Big Pigeon Creek, Evansville, Vanderburg county—Jordan, 1889.

Cypress Swamp, Posey county—Jordan, 1889.

The Wabash River.

At Delphi, Carroll county—Evermann and Jenkins, 1888.

At Terre Haute, Vigo county—Jenkins, 1886.

At Vincennes, Knox county—Jordan, 1889.

At New Harmony, Posey county—Jordan, 1889.

At Mackey's Ferry, Posey county—Jordan, 1889.

* Contributions from the Zoological Department of the Indiana University, No. 9.

Upper Wabash Basin.

Blue, Round, Shriner and Cedar Lakes, Whitley county—Kirsch, 1894.

Blue River, Columbia City, Whitley county—Jordan, 1892; Kirsch, 1894.

Eel River, Logansport, Cass county—Jordan, 1891.

Eel River, throughout its entire course—Kirsch, 1894.

Tippecanoe Lake, Kosciusko county.

Tippecanoe River—Jordan, 1877; Evermann and Jenkins, 1888.

Lake Maxinkuckee, Marshall county—Jenkins, 1888.

Deer Creeks, Carroll county—Evermann and Jenkins, 1888.

Wild Cat Creek, Carroll county—Evermann and Jenkins, 1888.

Honey Creek, Howard county—Evermann and Jenkins, 1888.

Raccoon Creek, Parke county—I. U. Coll.

Lower Wabash Basin.

West Fork White River, Indianapolis—Jordan, 1877.

Gosport—Eigenmann.

Spencer—Jordan, 1889.

Pike Creek, Madison county—Shannon.

Bean Blossom Creek, Monroe county—Eigenmann and Fordice, 1885.

Eel River, Owen county—Jordan 1889.

Switz City Swamp, Greene county—Gilbert, 1884.

East Fork White River, Bedford—Gilbert, 1884.

Blue River, Knightstown—I. U. Coll.

Flat Rock Creek, Decatur county, and Rushville—Shannon, 1887; Rush county, Gilbert, 1884.

Clifty—Shannon, 1887.

Sand.

Little Salt Creek, Franklin county—Evermann and Jenkins, 1888.

Salt Creek—Gilbert, 1884.

Clear Creek—Eigenmann.

Lost River, Orangeville, Orange county—Jordan and Eigenmann.

Patoka River, Gibson county—Jordan, 1889.

Black River, Posey county—Jordan, 1889.

Gresham's Creek, Posey county—Jordan, 1889.

Big Creek, Posey county—Jordan, 1889.

The Maumee System.

Maumee River—Jordan, Kirsch.

St. Joseph's River—Kirsch.

St. Mary's River—Kirsch.

THE ILLINOIS BASIN.

Kankakee River, at Riverside—Bates, 1886; Jordan, 1889.

Yellow River, Plymouth, Marshall county—Jordan, 1889.

LAKE MICHIGAN SYSTEM.

Lake, Michigan City—Bates, 1886; Jordan and Evermann.

Turkey Lake.

St. Joseph's River, Mishawaka—Jordan, 1889.

Trail Creek, LaPorte county—Ridgley, 1892.

Clear and Pine Lakes, LaPorte county—Jordan, 1887.

List of Indiana Fishes and their Distribution.

Class MARSIPOBRANCHII (The Myzonts).

Order HYPEROARTIA (The Lampreys).

Family *Petromyzontidæ*.

Ammocœtes branchialis (L). Brook Lamprey, Mud Lamprey.

West Fork White river at Indianapolis, Jordan 1877 as *A. niger;* Bean Blossom, Eigenmann and Fordice as *A. appterus.*

Ichthyomyzon concolor (Kirkland).

Ohio at New Albany, Jordan; Blue river at Wyandotte Cave, I. U. Coll.; Wabash at Delphi, Jenkins and Evermann 1888; at New Harmony, Jordan 1889; Indianapolis, Jordan 1877 as *A. argentatus.*

Class PISCES (The true Fishes).

Order SELACHOSTOMI.

Family *Polyodontidæ* (The Paddle-fishes.)

Polyodon spathula (Walbaum). Spoon-bill Cat, Duck-bill Cat.

Ohio at Rockport, Eigenmann; White Water at Brookville, Evermann 1886; Wabash at Delphi, Evermann 1888; at Terre Haute, Jenkins 1886; at New Harmony, Jordan 1889; Lake Manitou, Eigenmann and Norman 1894; Indianapolis, Jordan 1877 as *P. folium.*

Order CHONDROSTEI.

Family *Acipenseridæ* (The Sturgeons).

Scaphirhynchus platyrhynchus (Raf.). Shovel nosed Sturgeon.

Ohio, Rafinesque; Wabash at Delphi, Evermann 1888; at Terre Haute, Jenkins 1886.

Acipenser rubicundus Le Sueur. Lake Sturgeon, Rock Sturgeon.

Ohio at Louisville, Jordan and Evermann 1887; at Rockport, Eigenmann; at Terre Haute, Jenkins 1886; at New Harmony, Jordan 1889; Lake Michigan at Michigan City, Bates 1886.

Order Rhombognathi.

Family *Lepisosteidæ* (The Gar-fishes).

Lepisosteus osseus (L). Common Gar Pike, Long Nosed Gar, Bill-fish.

Ohio at Rockport, Eigenmann; White Water at Brookville, Evermann 1886; Big Pigeon creek at Evansville, Eigenmann; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at New Harmony, Jordan, 1889; Blue river at Columbia City, Kirsch 1894; Tippecanoe river, Evermann and Jenkins 1888; Lake Maxinkuckee, Jenkins 1888; Loon, Big and Crooked lakes, Kirsch 1894; Indianapolis, Jordan 1877; Gosport, Eigenmann.

Lepisosteus platystomus Rafinesque. Short-nosed Gar-pike.

Wabash at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Lake Manitou, Eigenmann and Norman 1894.

Lepisosteus tristœchus (Bloch and Schneider). Alligator Gar.

Wabash at New Harmony, Jordan 1889.

Order Cycloganoidei.

Family *Amiidæ* (The Bow-fins).

Amia calva L. Bow-fin, Mud-fish, Dog-fish.

Wabash at Terre Haute, Jenkins 1886; Blue river, Eel river, and in nearly all its upper tributaries, Kirsch 1894; Lake Maxinkuckee, Jenkins 1888; Switz City swamp, Gilbert 1884.

Order Nematognathi.

Family *Siluridæ* (The Cat-fishes).

Ictalurus furcatus (Le Sueur). Chuckle-headed Cat.

Ohio river, Jordan and Evermann 1887.

Ictalurus punctatus (Rafinesque). Channel Cat, White Cat, Silver Cat.

Ohio river, Rafinesque; White Water at Brookville, Evermann 1886; Laughery creek near Milton, Jenkins 1888; Big Pigeon near Evansville, Jordan 1889; Wabash at Delphi, Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; at Spencer, Jordan, 1889; East Fork White river near Bedford, Gilbert 1884; Patoka river, Gibson county, Black river and Big creek, Jordan 1889.

Ameiurus lacustris (Walbaum). Great Cat-fish, Mississippi Cat, Flannel-mouthed Cat.

Wabash at Delphi, Evermann 1888, as *A. nigricans:* Lake Michigan, Jordan and Evermann 1887, as *A. nigricans.*

Ameiurus natalis (Le Sueur). Yellow Cat.

White Water at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, Jenkins 1888; Lower Wabash, Jordan 1877 as *cupreus*; Eel River basin in all the lakes, Kirsch 1894; Tippecanoe river, Jordan 1877 as *cupreus* and 1889; Lake Manitou, Eigenmann and Norman; Lake Maxinkuckee, Jenkins 1888; Deer creeks, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877 as *cupreus*; Bean Blossom, Eigenmann and Fordice 1885; Flat Rock and Clifty creeks, Decatur county; Flat Rock Creek at Rushville, Shannon 1887; Salt creek near Bedford, Gilbert 1884; Yellow river at Plymouth, Jordan 1889; St. Joseph's river, Jordan 1877 as *cupreus*, and Clear and Pine lakes, La Porte county.

Ameiurus vulgaris (Thompson).

Ohio, Wabash, and Lake Michigan, Jordan and Evermann 1887.

Ameiurus nebulosus (Le Sueur). Common Bullhead, Horned Pout.

Wabash at Terre Haute, Jenkins 1886; Eel river and its tributary lakes and streams, Kirsch 1894; Tippecanoe river, Jordan 1877; Loon, Big and Crooked lakes, Kirsch 1894; West Fork White river at Indianapolis, Jordan 1877; Switz City swamp, Greene county, Gilbert 1884; Trail creek, LaPorte county, Ridgley.

Ameiurus melas (Rafinesque).

Wabash at Terre Haute, Jenkins 1886; Tippecanoe river and Lake Maxinkuckee, Jenkins 1888; Deer creeks, Evermann 1888; Raccoon creek at Mecca, Parke county, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877 as *xanthocephalus;* Bean Blossom creek, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan 1889; Switz City swamp, Gilbert 1884; East Fork White river and Salt creek near Bedford, Gilbert 1884; Gresham's creek at New Harmony, Jordan 1889; Trail creek, LaPorte county, Ridgley.

Leptops olivaris Rafinesque. Mud Cat, Flat-headed Cat, Russian Cat, Bashaw, Goujon.

White Water at Brookville, Evermann 1886; Laughery creek at Milton, Ohio county, Jenkins 1888; Big Pigeon creek at Evansville, Jordan 1889; Wabash river at Terre Haute, Jenkins 1886; Tippecanoe river, Jordan 1877; West Fork White river at Indianapolis, Jordan 1877; Bean Blossom creek, Eigenmann and Fordice 1885; East Fork White river near

Bedford, Gilbert 1884; Patoka river, Gibson county, Jordan 1889.

Noturus flavus Rafinesque.

White Water river at Brookville, Evermann 1886; Laughery creek at Milton, Ohio county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Vincennes and New Harmony, Jordan 1889; Eel river, Twelve Mile creek, Kirsch 1894; Deer and Little Deer creeks and Wild Cat creek, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877, and at Spencer, Jordan 1889; Bean Blossom creek, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan 1889; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock creek, Decatur county, Shannon 1887; Yellow river at Plymouth, Jordan 1889; St. Joseph's river, Jordan 1877; Clear and Pine lakes, Jordan 1877.

Schilbeodes exilis (Nelson).

Tippecanoe river, Jenkins 1888; Bean Blossom, Eigenmann and Fordice 1885.

Schilbeodes miurus (Jordan).

Laughery creek near Milton, Ohio county, Jenkins 1888; Fourteen Mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes and New Harmony, Jordan 1889; Lower Wabash, Jordan 1877; Eel river, middle course, Meredith creek, Kirsch 1894; Tippecanoe and Lake Maxinkuckee, Jordan 1889; Deer and Wild Cat creeks, Evermann and Jenkins 1888; West Fork White river, at Indianapolis, Jordan, 1877; at Gosport, Eigenmann; at Spencer, Jordan, 1889; Bean Blossom, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock creek, Decatur, county, Shannon 1887; Clear creek, Bloomington, I. U. Coll.; Patoka river, Gibson county Jordan, 1889; Maumee river, Jordan 1877.

Schilbeodes eleutherus (Jordan).

Eel river middle course, Shriner lake, Columbia City, Kirsch 1894; West Fork White river at Gosport, Eigenmann.

Schilbeodes gyrinus (Mitchill).

Wabash at Delphi, Evermann and Jenkins, 1888; Upper Blue river, Kirsch 1894; Lake Maxinkuckee, Jordan, 1889; Little Deer creek, Evermann and Jenkins, 1888; West Fork White river at Indianapolis, Jordan, 1877 as *stalis;* Bean Blossom, Eigenmann and Fordice 1885;

Big creek, Posey county, Jordan 1889; Kankakee river at Riverside, Bates 1886; Trail creek near Michigan City, Ridgley.

Schilbeodes nocturnus (Jordan and Gilbert).

Big Pigeon creek at Evansville, Jordan 1889.

Order PLECTOSPONDYLI (The Carp Fishes).

Family *Catostomidæ* (The Suckers).

Ictiobus cyprinella (Cuv. and Val.) Common Buffalo Fish, Red-mouthed Buffalo.

Ohio at Louisville, Jordan and Evermann 1887; Wabash at Delphi, Evermann, 1888; at LaFayette, Jordan and Evermann; at Terre Haute, Jenkins 1886; at Mackey's Ferry, Jordan, 1889.

Ictiobus urus (Agassiz). Razor-backed Buffalo, Mongrel Buffalo.

Ohio, Jordan and Evermann 1887; Wabash at Delphi, Evermann 1888; Wabash at Terre Haute, Jenkins 1886.

Ictiobus bubalus (Rafinesque). Sucker-mouthed Buffalo, Small-mouthed Buffalo.

Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann 1888; at Terre Haute, Jenkins 1886; Lower Wabash, Jordan 1877; and at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Switz City swamp, Greene county, Gilbert 1884.

Carpiodes carpio (Rafinesque).

Lower Wabash and West Fork of White river at Indianapolis, Jordan 1877; East Fork White river near Bedford, Gilbert, 1884.

Carpiodes difformis Cope.

Big Pigeon creek at Evansville, Jordan 1889; Lower Wabash, Jordan 1877; at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Eel river at Logansport, Jordan 1889; West Fork White river at Gosport, Eigenmann; East Fork White river, Salt creek, Gilbert 1884; Patoka river, Gibson county, and Big creek, Posey county, Jordan 1889.

Carpiodes velifer (Rafinesque). Quill-back, Skim-back, Carp Sucker, River Carp.

White Water river at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Kintner's creek, Wabash county, Ulrey; Eel river at Logansport, Kirsch 1894; Tippecanoe, Evermann and Jenkins 1888; West Fork White river at Gosport, Eigenmann.

Cycleptus elongatus (Le Sueur). Black Horse, Gourd-seed Sucker, Missouri Sucker.

Ohio, Jordan and Evermann 1887; White Water at Brookville, Evermann 1886; Wabash at Terre Haute, Jenkins 1886.

Catostomus catostomus (Forster). Northern Sucker, Lake Michigan, No authentic specimens from Indiana.

Catostomus commersoni Lacépède. Common Sucker, White Sucker, *Catostomus teres* of Indiana authors.

Wabash at Delphi, Evermann 1888; at Terre Haute, Jenkins 1886; Lower Wabash, Jordan 1877; Eel river and its tributary streams, Round lake, Kirsch 1894; Hellem's creek, Wabash county, Ulrey; Tippecanoe river, Deer creeks, Wild Cat creek and Honey creek, Evermann and Jenkins 1888; Raccoon creek at Mecca, Parke county, I. U. Coll; West Fork White river at Indianapolis, Jordan 1877; Bean Blossom creek, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, 1884 Gilbert; Flat Rock creek at Rushville, Clifty creek, Decatur county, Shannon 1887; Little Salt creek, Franklin county, Evermann and Jenkins 1888; Clear creek, Monroe county, I. U. Coll; Yellow river at Plymouth, Jordan 1889; St. Joseph's river near Mishawaka, Jordan 1889.

Catostomus nigricans Le Sueur. Hog Sucker, Stone Roller, Stone Lugger, Stone Toter, Hammer Head, Crawl-a-Bottom, Hog Molly, Hog Mullet.

White Water at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, Jenkins 1888; Fourteen Mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, Jordan 1889; Eel river and its tributary streams, Kirsch 1894; Blue river at Columbia City, Jordan 1889, and Eel river at Logansport; Tippecanoe river, Deer creeks, Wild Cat creek and Honey creek, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; at Spencer, Jordan 1889; Bean Blossom creek, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock creek, Decatur county, Clifty creek, Decatur county, Shannon 1887; Clear creek, Monroe county, I. U. Coll.; Yellow river at Plymouth, Jordan 1889; St. Joseph's at Mishawaka, Jordan 1889.

Erimyzon sucetta oblongus (Mitchill). Chub Sucker, Sweet Sucker, Creek Fish.

Eel river and tributary streams below South Whitley, Round lake, Kirsch 1894; Lake Manitou, Eigenmann and Norman; Tippecanoe river, Jordan 1877; Little Deer creek and Honey creek, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; Pipe creek, Madison county, Shannon; Switz City swamp, Greene county, Gilbert 1884; Flat Rock creek, and Clifty creek, Decatur county, Shannon, 1887; Salt creek, Gilbert 1884; Gresham's creek at New Harmony, Jordan 1889; Maumee river, Jordan 1877; Kankakee river at Riverside, Bates 1886; Yellow river at Plymouth, Jordan 1889; St. Joseph's river, Jordan 1877; Trail creek, LaPorte county, Ridgley; Clear and Pine lake, LaPorte county, Jordan 1877.

Minytrema melanops (Rafinesque). Striped Sucker.

Lower Wabash, Jordan 1877; Wabash at New Harmony and Mackey's Ferry, Jordan 1889; Eel river and tributary streams, Blue and Round lakes, Kirsch 1894; West Fork White river at Indianapolis, Jordan 1877; Bean Blossom creek, Eigenmann and Fordice 1885; East Fork White river, Clifty creek, Decatur county, Shannon 1887; Gresham's creek at New Harmony, Jordan 1889; Yellow river at Plymouth, Jordan 1889.

Moxostoma anisurum (Rafinesque). White Nose Sucker.

Lower Wabash, Jordan 1877; Kentner's creek, Wabash county, Ulrey; East Fork White river, Gilbert 1884, as *M. relatum*.

Moxostoma aureolum[*] (Le Sueur). Common Red Horse, White Sucker, Mullett.

White Water at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins 1888; Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; Wabash at Terre Haute, Jenkins 1886; Wabash at Vincennes and New Harmoy, Jordan 1889; Lower Wabash, Jordan 1877; Eel river at Logansport, Jordan 1889; Eel river and tributary streams, Kirsch 1894; Tippecanoe river, Deer creeks, Wild Cat and Honey creeks, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; Pipe creek, Madison county, Shannon 1887; Bean Blossom, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock and Clifty creeks, Decatur county, Shannon 1887; Clear creek at Bloomington, I. U. Coll; Patoka river,

[*] This species has usually been recorded as *M. duquesnii*.

Gibson county, Jordan 1889; Maumee, Jordan 1877; Yellow river at Plymouth, Jordan 1889.

Moxostoma breviceps (Cope).

Ohio river, Gilbert; Deer creek near Camden, Evermann 1888; West Fork White river at Spencer, Jordan 1889.

Placopharynx duquesnii (Le Sueur).

Wabash at Delphi and Terre Haute, Evermann 1888; Lower Wabash, Jordan 1877; Tippecanoe river, Evermann 1888.

Lagochila lacera Jordan and Brayton. Hare-lip Sucker, Rabbit-mouth Sucker, Pea-lip Sucker, Cut-lips, Split-mouth.

Tippecanoe river west of Delphi, Evermann and Jenkins 1888.

Family *Cyprinidæ* (The Minnows).

Compostoma anomalum (Rafinesque). Stone Lugger, Stone Roller.

White Water at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Blue river at Columbia City and Eel river at Logansport, Jordan, 1889; Eel river and tributary streams, Kirsch 1894; Tippecanoe river, Jordan 1877; Tippecanoe river, Deer creeks, Wild Cat and Honey creeks, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; at Spencer, Jordan 1889; Bean Blossom, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan 1889; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock creek at Rushville, and Clifty creek, Decatur county, Shannon 1887, Clear creek Monroe county, I. U. Coll.; Gresham's creek at New Harmony, Jordan 1889; Maumee river, Jordan 1877; Yellow river at Plymouth, Jordan 1889; St. Joseph's river, at Mishawaka, Jordan 1889

Chrosomus erythrogaster Rafinesque. Red-bellied Minnow.

Weasaw creek near Denver, Ind., Kirsch 1894; Honey creek, Howard county, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; Bean Blossom, Eigenmann and Fordice 1885; Clifty creek, Decatur county, Shannon 1887; Blue river at Knightstown, I. U. Coll.; Little Salt creek Franklin county, Evermann and Jenkins 1888; Salt creek near Bedford, Gilbert 1884; Clear creek Monroe county, I. U. Coll.

Hybognathus nuchalis Agassiz.

Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at New Har-

mony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877 as *argyritis;* Eel river at Logansport, Kirsch 1894; Wild Cat and Little Deer creek, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877 as *argyritis;* at Gosport, Eigenmann; Bean Blossom, Eigenmann and Fordice 1885; Little Salt creek Franklin county, Evermann and Jenkins 1888; Big creek Posey county, Jordan 1889.

Pimephales promelas Rafinesque.

White Water at Brookville, Evermann 1886.

Pimephales notatus (Rafinesque).

White Water at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Lower Wabash, Jordan 1877, and at Vincennes and New Harmony 1889; Eel river and its tributary streams and lakes except Hull and Blue lakes, Kirsch 1894, and Logansport, Jordan 1889; Tippecanoe river, Jordan 1877; Loon lake and Big lake, Kirsch 1894; Lake Manitou, Eigenmann and Norman; Tippecanoe river, Deer creeks, Wild Cat and Honey creeks, Evermann and Jenkins 1888; Lake Maxinkuckee, Jenkins 1888; Raccoon creek at Mecca, Parke county, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; Pipe creek, Decatur county, Shannon 1887; East Fork White river and Salt creek near Bedford, Gilbert 1884; Blue river at Knightstown, I. U. Coll.; Flat Rock creek at Rushville, Shannon 1887; Clear creek, Monroe county, I. U. Coll.; Lost river at Orangeville, I. U. Coll.; Patoka river, Gibson county, Gresham's and Big creeks, Posey county, Jordan 1889; Yellow river at Plymouth, Jordan 1889; Kankakee, Jordan 1877; St. Joseph's, Jordan 1877; at Mishawaka, Jordan 1889; Clear and Pine lakes, La Porte county, Jordan 1877.

Cliola vigilax (Baird and Girard). Bull-head Minnow.

Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Gosport, Eigenmann; East Fork White river near Bedford, Gilbert 1884 as *Hyborhynchus notatus;* Black creek at New Harmony, Jordan 1889; Big creek, Posey county, Jordan 1889.

Notropis cayuga Meek.

Round and Shriner lakes; Loon lake, Kirsch 1894.

Notropis anogenus Forbes.

Blue lake and Blue river, Whitley county, Kirsch 1894.

Notropis heterodon Cope.

Wabash at Vincennes, Jordan 1889; Round, Cedar and Shriner lakes, Whitley county, Kirsch 1894; Tippecanoe river, Jordan 1877; Loon lake, Kirsch 1894; Lake Maxinkuckee, Scovell; Switz City swamp, Greene county, Gilbert 1884; Yellow river at Plymouth, Jordan 1889; Kankakee at Riverside, Bates 1886; Trail creek, LaPorte county, Ridgley.

Notropis microstomus Rafinesque.

White Water at Brookville, Evermann 1886 as *deliciosus;* Wabash at Delphi, Evermann and Jenkins 1888 as *deliciosus*, at New Harmony, Jordan 1889; Eel river at Logansport, Jordan 1889; Eel river from South Whitley to its mouth, Kirsch 1894; Tippecanoe, Evermann and Jenkins 1888 as *deliciosus;* West Fork White river at Indianapolis, Jordan 1877 as *stramineus;* at Gosport, Eigenmann at Spencer, Jordan 1889; East Fork White river near Bedford, Gilbert 1884 as *deliciosus;* Yellow river at Plymouth, Jordan 1889; Kankakee, Jordan 1877 as *stramineus;* at Riverside, Bates 1886; St. Joseph's at Mishawaka. Jordan 1889.

Notropis boops Gilbert.

Wabash at Delphi, Evermann 1888; West Fork White river at Indianapolis, Jordan 1877 as *E. scabriceps* not of Cope; East Fork White river, Clifty and Flat Rock creeks, Decatur county, Shannon 1887; Flat Rock creek, Rush county, and Salt creek, Brown county, Gilbert 1884.

Notropis hudsonius (Clinton). Spawn-eater, Smelt.

Kankakee at Riverside, and Lake Michigan at Michigan City, Bates 1886; Clear and Pine lakes, LaPorte county, Jordan 1877 as *H. storerianus.*

Notropis whipplei Girard. Silver-Fin.

Laughery creek near Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins 1888; Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877 as *C. analostona;*

Kentner's creek, Wabash county, Ulrey; Eel river at Logansport, Jordan 1889; from Liberty Mills to its mouth and in all the tributaries, Kirsch 1894; Lake Maniton, Eigenmann and Norman; Tippecanoe river, Jordan 1877 as *C. analostona;* Deer creeks, Wild Cat creek, Evermann and Jenkins, 1888; West Fork White river at Indianapolis, Jordan 1877 as *C. analostona;* at Gosport, Eigenmann; at Spencer, Jordan 1889; Bean Blossom, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan, 1889; East Fork White river and Salt creek near Bedford, Gilbert 1884 as *N. analostanus;* Flat Rock creek and Clifty creek, Decatur county, Shannon 1887; Little Salt creek, Franklin county, Evermann and Jenkins, 1888; Clear creek at Bloomington, I. U. Coll.; Patoka river, Gibson county, Black river and Big creek, Posey county, Jordan 1889; Maumee, Jordan 1877 as *C. analostona;* Yellow river at Plymouth, Jordan 1889.

Notropis megalops (Rafinesque). Common Shiner, Red-Fin, Dace.

White Water at Brookville, Evermann 1886; Fourteen Mile creek, Clarke county, Jenkins 1888; Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, New Harmony, and Mackey's Ferry, Jordan 1889; Kentner's creek, Wabash county, Ulrey; Blue river at Columbia City, Jordan 1889; Eel river and all its tributary streams, Cedar lake, Round lake, Kirsch 1894; at Logansport, Jordan 1889; Tippecanoe, Jordan 1877 as *plumbeolus L. cornutus;* Tippecanoe river, Deer creeks, Wild Cat and Honey creeks, Evermann and Jenkins, 1888; West Fork White river at Indianapolis as *L. cornutus*, Jordan1877; at Spencer, Jordan 1889; Pipe creek, Madison county, Shannon 1887; Bean Blossom, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan, 1889; East Fork White river and Salt creek near Bedford, Gilbert, 1884; Flat Rock creek at Rushville, and Clifty creek, Decatur county, Shannon, 1887; Blue river at Knightstown, and Clear creek at Bloomington, I. U. Coll.; Patoka river, Gibson county, Black river and Big creek, Posey county, Jordan, 1889; Maumee, Jordan 1877; Kankakee river at Riverside, Bates, 1886; Yellow river at Plymouth Jordan's 1889; St. Joseph's river at Mishawaka, Jordan, 1889; Trail creek, LaPorte county, Ridgley; Clear and Pine lakes, LaPorte county, Jordan 1877 as *L. cornutus.*

Notropis jejunus (Forbes).

Eel river at Logansport, Kirsch 1894.

Notropis ariommus (Cope).

West Fork White river at Indianapolis, Jordan 1877; Raccoon creek, at Mecca, I. U. Coll.

Notropis ardens (Cope). Red-fin.

White Water at Brookville, Evermann 1886; Laughery creek at Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Kentner's creek, Wabash county, Ulrey; Deer creeks, Wild Cat and Honey creeks, Evermann and Jenkins 1888; Raccoon creek, at Mecca, I.U. Coll.; West Fork White river at Indianapolis, Jordan 1877 as *L. diplemius*; at Spencer, Jordan 1889; Bean Blossom, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, Gilbert 1884 as *diplemius*; Flat Rock, at Rushville, Clifty creek, Decatur county, Shannon 1887; Blue river at Knightstown, I. U. Coll.; Little Salt creek, Franklin county, Evermann and Jenkins 1888; Lost river at Orangeville; Clear creek at Bloomington, I. U. Coll.

Notropis atherinoides (Rafinesque).

Fourteen Mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes and New Harmony, Jordan 1889; Lower Wabash, Jordan 1877 as *N. rubellus;* Eel river at Logansport, Jordan 1889; Tippecanoe river, Big Deer creek, Wild Cat creek, Evermann and Jenkins 1888; Raccoon creek, Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877 as *N. rubellus*; at Gosport, Eigenmann; Pipe creek, Madison county; Flat Rock creek at Rushville, Shannon 1887; Little Salt creek, Franklin county, Evermann and Jenkins 1888; Patoka river, Gibson county, Jordan 1889.

Notropis arge (Cope).

Eel river from North Manchester to mouth and at Pawpaw, Flowers and Twelve Mile creeks, Kirsch 1894; Wild Cat creek and Deer creek, Evermann and Jenkins 1888.

Notropis dilectus (Girard).

Big Pigeon creek at Evansville, Wabash at New Harmony and Mackey's Ferry, Jordan 1889; Eel river from South Whitley to mouth, Blue river, Kirsch 1894; West Fork White river at Indianapolis, Jordan 1877 as *N. dinemus;* at Gosport, Eigenmann; Big creek and Gresham's creek, Posey county, Jordan 1889.

Notropis rubrifrons (Cope).

White Water at Brookville, Evermann 1886; Fourteen Mile creek, Clark

county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888, at Terre Haute, Jenkins 1886; Eel river at Logansport, Jordan 1889; Tippecanoe river, Jordan 1877; Tippecanoe river, Wild Cat creek, Deer creek, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; East Fork White river near Bedford, Gilbert 1884; Clifty and Flat Rock creeks, Decatur county, Shannon 1887; Clear creek Bloomington, I. U. Coll.; Yellow river at Plymouth, Jordan 1889; St. Joseph's at Mishawaka, Jordan 1889.

Ericymba buccata Cope.

Laughery creek, near Milton, Ohio county, Fourteen-mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Kentner's creek, Wabash county, Ulrey; Eel river in its lower six miles, Twelve-mile creek, Kirsch 1894; Tippecanoe river, Deer creek, Wild Cat and Honey creeks, Evermann and Jenkins 1888; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; at Spencer, Jordan 1889; Pipe creek, Madison county, Shannon 1887; East Fork White river and Salt creek, near Bedford, Gilbert, 1884; Flat Rock creek at Rushville; Flat Rock creek and Clifty creek, Decatur county, Shannon 1887; Blue river at Knightstown, I. U. Coll.; Little Salt creek, Franklin county, Evermann and Jenkins 1888; Clear creek at Bloomington, I. U. Coll.; Gresham's creek at New Harmony, Jordan 1889.

Rhinichthys atronasus (Mitchill).

Kintner's creek, Wabash county, Ulrey; Little Weasaw creek near Denver, Cunningham; Honey creek, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877 as *obtusus*; Bean Blossom creek, Eigenmann and Fordice 1885; East Fork near Bedford, Gilbert 1884; Clifty and Flat Rock creeks, Decatur county, Flat Rock creek at Rushville, Shannon 1887; Little Salt creek, Franklin county, Evermann and Jenkins 1888; Clear creek, Bloomington, I. U. Coll.; Kankakee river, Jordan 1877.

Hybopsis dissimilis (Kirtland).

Wabash at Delphi, Evermann and Jenkins 1888; at Vincennes and New Harmony, Jordan 1889; Tippecanoe river, Evermann and Jenkins 1888; West Fork White river, at Indianapolis, Jordan 1877; at Gosport, Eigenmann; at Spencer, Jordan 1889.

Hybopsis amblops (Rafinesque).

Wabash at Delphi, Evermann and Jenkins 1888; Kentner's creek, Wabash county, Ulrey; Eel river at Logansport, Jordan 1889; lower course of Eel river and tributaries; Cedar and Shriner lakes, Kirsch 1894; Tippecanoe river and Deer and Wild Cat creeks, Evermann and Jenkins 1888; West Fork White river at Indiapolis, Jordan 1877; at Gosport, Eigenmann; Pipe creek, Madison county, Shannon 1887; Bean Blossom creek, Eigenmann and Fordice 1885; East Fork and Salt creek near Bedford, Gilbert 1884; Flat Rock, Decatur county, Shannon; Trail creek, La Porte county, Ridgley.

Hybopsis storerianus (Kirtland).

Wabash at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Eel river at Logansport, Kirsch 1894; West Fork White river at Gosport, Eigenmann; at Spencer; Big Creek Posey county, Jordan 1889.

Hybopsis watauga Jordan and Evermann.

Wabash at Terre Haute, Jenkins 1886; Eel river at Logansport, Kirsch 1894; Tippecanoe river, Jordan 1889.

Hybopsis kentuckiensis (Rafinesque). Horny Head, River Chub, Jerker.

White Water river at Brookville, Evermann 1886; Wabash river at Delphi, Evermann and Jenkins 1888; Kentner's creek, Wabash county, Ulrey; Blue river at Columbia City and Eel river at Logansport, Jordan 1889; whole of Eel river, Kirsch 1894; Lake Manitou, Eigenmann and Norman; Tippecanoe river, Jordan 1877 as *N. biguttatus;* Tippecanoe river, Deer creeks, Wild Cat and Honey creeks, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877 as *N. biguttatus;* at Spencer, Jordan 1889; Pipe creek Madison county, Shannon 1887; Bean Blossom, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan 1889; East Fork White river near Bedford, Gilbert 1884 as *N. biguttatus;* Flat Rock at Rushville, Flat Rock creek and Clifty creek Decatur county, Shannon 1887; Maumee river; Kankakee river, Jordan 1877 as *N. biguttatus;* Yellow river at Plymouth, Jordan 1889; St. Joseph's river at Mishawaka, Jordan 1889 and 1877 as *N. biguttatus;* Lake Michigan at Michigan City, Bates 1886; Clear and Pine lakes, Jordan 1877 as *N. biguttatus.*

Hybopsis hyostomus Gilbert.

Wabash at Delphi, Evermann and Jenkins 1888; at Vincennes and New Harmony, Jordan 1889; Eel river at Logansport, Kirsch 1894; West

Fork White river at Gosport, Eigenmann; East Fork White river near Bedford, Gilbert 1884.

Semotilus atromaculatus (Mitchill). Horned Dace, Creek Chub.

Laughery creek near Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Kentner's creek, Wabash county, Ulrey; Eel river and its tributaries, Kirsch 1894; Tippecanoe river, Jordan 1877 as *S. corporalis;* Deer creeks and Honey creek, Evermann and Jenkins 1888; Lake Maxinkuckee, Jenkins 1888; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877 as *S. corporalis;* Bean Blossom creek, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan 1889; East Fork White river near Bedford, Gilbert 1884; Flat Rock creek Rushville and Clifty creek Decatur county, Shannon 1887; Blue river at Knightstown, I. U. Coll.; Little Salt creek Franklin county, Evermann and Jenkins 1888; Clear creek at Bloomington, I. U. Coll.; Gresham's creek at New Harmony, Jordan 1889; Maumee, Jordan 1877 as *corporalis;* Kankakee river, Jordan 1877 as *S. corporalis;* St. Joseph's, Jordan 1877 as *S. corporalis;* St. Joseph's river at Mishawaka, Jordan 1889; Trail creek, LaPorte county, Ridgley.

Phoxinus elongatus Kirtland.

Penn. to Minn. No authentic specimens from Indiana.

Opsopoodus emiliæ Hay.

Wabash at New Harmony and Mackey's Ferry and Big Creek and Cypress swamp, Posey county, Jordan 1889.

Notemigonus chrysoleucus (Mitchill.)

White Water at Brookville, Evermann 1886; Wabash at Terre Haute, Jenkins 1886; at New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877 as *N. americanus;* Hellem's creek, Wabash county, Ulrey; Blue river, Blue lake; Eel river, Blue Babe and Mud creeks, Kirsch 1894; Tippecanoe river, Jordan 1877 as *N. americanus;* Deer creek, Evermann and Jenkins 1888; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877 as *N. americanus;* Pipe creek, Decatur county, Shannon 1887; East Fork White River, near Bedford, Gilbert 1884; Flat Rock creek at Rushville, Shannon 1887; Gresham's and Big creeks, Posey county, Jordan 1889; Maumee, Jordan 1877 as *N. americanus;* Kankakee river,

Jordan 1877 as *N. americanus*; at Riverside, Bates 1886; Clear and Pine lakes, La Porte county, Jordan as *N. americanus*.

Order Isospondyli (The Salmon Herring &c.).

Family *Hiodontidæ* (The Moon-eyes).

Hiodon alosoides (Rafinesque).

Wabash at Terre Haute, Jenkins 1886; at New Harmony, Jordan 1889; West Fork White river at Gosport, Eigenmann.

Hiodon tergisus Le Sueur. Moon-eye, Silver Bass, Toothed Herring.

Tippecanoe river, Evermann 1888; Switz City swamp, Greene county, Gilbert 1884.

Family *Clupeidæ* (The Herrings).

Clupea chrysochloris Rafinesque. Skip-jack.

Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; at Mackey's Ferry, Jordan 1889.

Dorosoma cepedianum (Le Sueur). Gizzard Shad, Hickory Shad, Mud Shad, White-eyed Shad, Hairy-back.

Laughery creek near Milton, Ohio county, Jenkins 1888, and Fourteen Mile creek, Clark county; Blue river Wyandotte Cave, I. U. Coll.; Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877; Eel river at Logansport, Kirsch 1894; West Fork White river at Gosport, Eigenmann; Patoka river, Gibson county, Jordan, 1889.

Family *Salmonidæ* (The White Fishes and Trout).

Coregonus quadrilateralis Richardson. Round-fish, Pilot-fish, Shad-waiter, Menomonee White-fish.

Lake Michigan, Jordan and Evermann 1887.

Coregonus clupeiformis (Mitchill). Common White-fish.

Lake Michigan, Jordan and Evermann 1887.

Coregonus labradoricus Richardson. Sault White-fish, Musquaw river White fish, "Whiting."

Lake Michigan, Jordan and Evermann 1887.

Coregonus hoyi (Gill). Lake Moon-eye, Cisco of Lake Michigan.

Lake Michigan, Jordan and Evermann 1887.

Coregonus artedi Le Sueur. Lake Herring, Cisco Michigan Herring.

Lake Michigan, Jordan and Evermann 1887.

Coregonus artedi sisco Jordan.

Shriner and Cedar lakes, Whitley county, Kirsch 1894; Eagle lake, Kos-

ciusko county, and Lake Maxinkuckee, Jordan 1877; Tippecanoe river, Jordan 1877; Crooked and Big lake, Kirsch 1894.

Salvelinus namaycush (Walbaum). Great Lake Trout, Mackinaw Trout, Salmon Trout. Longe, Togue.

Lake Michigan, Jordan and Evermann 1887.

Family *Percopsida* (The Trout Perches).

Percopsis guttatus Agassiz. Trout Perch.

Ohio river; Lake Michigan.

Order HAPLOMI (The Pike-like Fishes).

Family *Amblyopsida* (The Cave Fishes).

Amblyopsis spelæus (De Kay). Blind Fish of the Mammoth Cave, Indiana. Jordan.

Typhlichthys subterraneus (Girard).

Corydon, I. U. Coll.

Family *Cyprinodontida* (The Killi-fishes).

Fundulus diaphanus menona (Jordan and Copeland).

Lake Maxinkuckee, Jenkins 1888; Clear and Pine lakes, La Porte county, and St. Joseph's river, Jordan 1877.

Zygonectes notatus (Rafinesque). Top Minnow.

Fourteen-mile creek, Clark county, Jenkins 1888; Big Pigeon creek at Evansville, Jordan 1889; Cypress swamp, Posey county, Jordan 1889; Wabash, at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877; Eel river and its tributary streams, Blue, Shriner, Cedar lakes; Loon, Big lakes, Kirsch 1894; Wild Cat and Deer creeks, Evermann and Jenkins 1888; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877; Clifty creek, Decatur county, Shannon, 1887; Clear creek, Monroe county, I. U. Coll.; Patoka river, Gibson county, Black river, Gresham's creek and Big creek, Posey county, Jordan 1889; Maumee river, Jordan 1877; Kankakee river at Riverside, Bates 1886; St. Joseph's river, Jordan 1877.

Zygonectes dispar Agassiz.

Cypress swamp, Posey county, Jordan 1889; Wabash at Vincennes and Mackey's Ferry, Jordan 1889; Lake Manitou, Eigenmann and Norman; Tippecanoe river, Jordan 1877; Lake Maxinkuckee, Jordan 1889; Switz City swamp, Greene county, Gilbert 1884; St. Joseph's river, Jordan 1877.

Gambusia patruelis (Baird and Girard). Top Minnow.

Mackey's Ferry, Black river and Gresham's creek, Posey county, Jordan 1889.

Family *Umbridæ* (The Mud-minnows).

Umbra limi (Kirkland). Mud-minow, Dog-fish.

Wabash at Terre Haute, Jenkins 1886; Blue river at Columbia City, Jordan 1889; Eel river, upper course, Thorn and Blue Babe creeks, Kirsch 1894; Lake Manitou, Eigenmann and Norman; Tippecanoe river, Jordan 1877; Little and Big Deer creeks and Honey creek, Evermann 1888; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877; Salt creek near Bedford, Gilbert 1884; Maumee, Jordan 1877; Kankakee at Riverside, Bates 1886; St. Joseph's river, Jordan 1877; Clear and Pine lakes, LaPorte county, Jordan 1877.

Family *Luciidæ* (The Pikes).

Lucius vermiculatus (Le Sueur). Little Pickerel.

Ohio river; Wabash at New Harmony, Le Sueur; Wabash valley, Cuv. and Val. 1846; Lower Wabash, Jordan 1877 as *E. salmoneus*; Wabash at Terre Haute, Jenkins 1886; Blue river at Columbia City, Jordan 1889; Eel river and all its tributary streams and lakes, Kirsch 1894; Tippecanoe river, Jordan 1877 as *E. salmoneus*; Lake Maxinkuckee and Loon and Big lakes, Kirsch 1894; Lake Manitou, Eigenmann and Norman; Deer creeks and Wild Cat creek, Evermann and Jenkins 1888; Raccoon creek Mecca at I. U. Coll.; West Fork Whiteriver at Indianapolis, Jordan 1877 as *E. salmoneus*; Pipe creek, Madison county, Shannon 1887; Bean Blossom, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan 1889; Switz Cityswamp, Greene county, Gilbert 1884; East Fork White river at Bedford, and Salt creek, Gilbert 1884; Maumee river, Jordan 1877 as *E. salmoneus*; Kankakee at Riverside, Bates 1886; Yellow river at Plymouth, Jordan 1889; St. Joseph's river, Jordan 1877 as *E. salmoneus*; Trail creek, La Porte county, Ridgley; Clear and Pine lakes, La Porte county, Jordan 1877 as *E. salmoneus*.

Lucius lucius (L). Pike, Northern Pickerel.

Wabash at New Harmony, Le Sueur as *Esox deprandus*: Eel river, Stoney Creek, Kirsch 1894; Paw Paw creek, Wabash county, Ulrey; St. Joseph's river, Jordan 1877.

Lucius masquinongy (Mitchill). Muskallunge, Maskinongy.

Ohio river, Meek and Newland, 1885; Lake Michigan, Jordan 1877; English lake.

Order Apodes (The Eels).

Family *Anguillidæ* (The True Eels.)

Anguilla anguilla rostrata Le Sueur. Eel.

White Water river at Brookville, Evermann 1886; Wabash at Delphi, Evermann 1888; at Terre Haute, Jenkins 1886; Eel river at Collamer as *A. chrysypa*, Kirsch 1894; Wild Cat and Deer creeks, Evermann 1888; Flat Rock and Sand creeks, Decatur county, Shannon 1887.

Order Hemibranchii (The Half-gilled Fishes).

Family *Gasterosteidæ* (The Sticklebacks).

Pygosteus pungitius (L.) Nine-spined Stickleback.

Lake Michigan.

Eucalia inconstans (Kirtland). Brook Stickleback.

Kentner's creek, Wabash county, Ulrey; Ponds tributary to Flat Rock and Clifty creeks Decatur county, Shannon 1887.

Order Percesoces.

Family *Atherinidæ* (The Silversides).

Labidesthes sicculus Cope. Brook Silverside.

Wabash river at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Lower Wabash, Jordan 1877; at New Harmony and Mackey's Ferry Posey county, Jordan 1889; Eel river and all tributaries, Kirsch 1894; at Logansport, Jordan 1889; Tippecanoe river, Jordan 1877; Lake Maxinkuckee, Jenkins 1888; Loon lake, Kirsch 1894, Lake Manitou, Eigenmann and Norman; Deer creeks and Wild Cat creek, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; Bean Blossom, Eigenmann and Fordice 1885; East Fork and Salt creek near Bedford, Gilbert 1884; Flat Rock creek Decatur county, Shannon 1887; Patoka river, Gibson county, Jordan 1889; Maumee river, Jordan 1877; Clear and Pine lakes, La Porte county, Jordan 1877.

Order Acanthopteri (The Spiny-rayed Fishes).

Family *Aphredoderidæ* (The Pirate Perches).

Aphredoderus sayanus (Gilliams). Pirate Perch.

Wabash river at New Harmony, Blue river at Columbia City, Jordan 1889; Upper course of Eel river, Thorn creek, Kirsch 1894; Raccoon creek, at Mecca, I. U. Coll.; Pipe creek, Decatur county, Shannon 1887; Bean

Blossom, Eigenmann and Fordice 1885; Salt creek near Bedford, Gilbert 1884; Big Creek, Posey county, Jordan 1889; Maumee, Jordan 1877 as *A. cookianus;* Kankakee river at Riverside, Bates 1886; Yellow river at Plymouth, Jordan 1889.

Family *Centrarchidæ* (The Sun-fishes).

Centrarchus macropterus (Lacépède).

North Carolina to Illinois. No authentic specimens from Indiana.

Pomoxis sparoides (Lacépède). Calico Bass, Grass Bass, Bar-fish, Strawberry Bass.

Fourteen-mile creek, Clark county, Jenkins 1888; Cypress swamp at Mount Vernon, Posey county, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes and New Harmony, Jordan 1889; Eel river basin in all waters, Kirsch 1894; Tippecanoe river, Jordan 1887, as *hexacanthus;* Lake Manitou, Eigenmann and Norman; Lake Maxinkuckee, Jordan 1889; Crooked lake, Kirsch 1894; West Fork White river at Indianapolis, Jordan 1877, as *hexacanthus;* at Gosport, Eigenmann; Bean Blossom, Eigenmann and Fordice 1885; Switz City swamp, Greene county, Gilbert 1884; Clifty creek, Decatur county, Shannon 1887; Patoka river, Gibson county, Jordan 1889.

Pomoxis annularis Rafinesque. Crappie, Bachelor, New Light, Campbellite, Sac-a-lai.

Falls of the Ohio, Rafinesque 1818; White Water at Brookville, Evermann 1886; Fourteen Mile creek, Clark county, Jenkins 1888; Big Pigeon at Evansville, Jordan, 1889; Wabash at Terre Haute, Jenkins 1886; at New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877; Eel river, Blue river, Meredith creek, Kirsch, 1894; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; Bean Blossom, Eigenmann and Fordice 1885; Salt creek, Bedford, Gilbert 1884

Ambloplites rupestris (Rafinesque). Rock Bass, Red Eye, Goggle Eye.

White Water river at Brookville, Evermann 1886; Fourteen Mile creek, Clarke county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Lower Wabash, Jordan 1877; Blue river at Columbia City, Jordan 1889; Eel river and tributary streams, Kirsch 1894; Eel river at Logansport, Jordan 1889; Tippecanoe river, Jordan 1877; Tippecanoe river, Evermann and Jenkins 1888; Wild Cat and Deer creeks; Lake Maxinkuckee, Jenkins 1888;

West Fork White river at Indianapolis, Jordan 1877; Pipe creek, Madison county, Shannon 1887; Bean Blossom, Eigenmann and Fordice 1885; East Fork White river at Bedford and Salt creek, Gilbert 1884; Flat Rock at Rushville; Flat Rock and Clifty creeks, Madison county, Shannon 1887; Yellow river at Plymouth, Jordan 1889; St. Joseph's, Jordan, 1877; at Mishawaka, Jordan 1889; Trail creek, LaPorte county, Ridgley.

Chaenobryttus gulosus (Cuv. and Val.) War Mouth. Red-eyed Bream.

Cypress swamp, Posey county and Wabash at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan, 1877; Eel river and tributaries; Loon and Big lakes, Kirsch 1894; West Fork White river at Indianapolis, Jordan 1877; Switz City swamp, Greene county, Gilbert 1884; Yellow river at Plymouth, Jordan 1889; Clear and Pine lakes, LaPorte county, Jordan 1877; Trail Creek and LaPorte county, Ridgley.

Lepomis cyanellus (Rafinesque). Green Sun-fish.

Ohio, Rafinesque; White Water at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, Jenkins 1888, and Fourteen Mile creek, Clark county; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, Jordan 1889; Eel river and all its large tributary streams and lakes, Kirsch 1894; Tippecanoe river, Deer creeks and Wild Cat Creek, Evermann and Jenkins 1888; Lake Maxinkuckee, Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; Pipe creek, Madison county, Shannon 1887; Bean Blossom, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan 1889; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock creek at Rushville, and Clifty creek, Madison county, Shannon 1887; Lost river at Orangeville; Clear creek, Monroe county, I. U. Coll.; Gresham's creek at New Harmony, Jordan 1889; Kankakee river, Jordan 1877; Clear and Pine lakes, LaPorte county, Jordan 1877.

Lepomis macrochirus Rafinesque.

West Fork White river at Indianapolis, Jordan 1877.

Lepomis humilis (Girard).

Big creek at New Harmony, Jordan 1889.

Lepomis pallidus (Mitchill). Blue Sun-fish, Copper-nosed Bream, Dollardee.

Wabash at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877 as *L. incis-*

or; Eel river and all its tributaries, Kirsch 1894; Tippecanoe river, Jordan 1877 as *L. incisor;* Lake Manitou, Eigenmann and Norman; Lake Maxinkuckee, Jenkins 1888; Loon, Big and Crooked lakes, Kirsch 1894; West Fork White river at Indianpolis, Jordan 1877 as *L. incisor;* at Gosport, Eigenmann; Switz City Swamp, Greene county, Gilbert 1884; Maumee, Jordan 1877 as *L. incisor;* St. Joseph's, Jordan 1877 as *L. incisor;* Clear and Pine lakes, LaPorte county, Jordan 1877 as *L. incisor.* Trail creek, LaPorte county, Ridgley.

Lepomis megalotis (Rafinesque).

Ohio river, Rafinesque; White Water at Brookville, Evermann, 1886; Laughery creek near Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins, 1888; Wabash at Delphi, Evermann and Jenkins, 1888; at Terre Haute, Jenkins, 1886; at New Harmony and Mackey's Ferry, Jordan, 1889; Kentner's creek, Wabash county, Ulrey; Eel river and its tributary streams, Hull lake, Kirsch, 1894; at Logansport, Jordan, 1889; Tippecanoe, Deer creeks and Wild Cat creek, Evermann and Jenkins, 1888; Lake Maxinkuckee, Jenkins, 1888; Loon lake, Kirsch 1894; West Fork White river, at Indianapolis, Jordan, 1877, as *L. peltastes;* at Gosport, Eigenmann; Bean Blossom, Eigenmann and Fordice, 1885; East Fork White river and Salt creek near Bedford, Gilbert, 1884; Clifty creek, Decatur county, Shannon, 1887; Clear creek, Monroe county, I. U. Coll.; Patoka river, Gibson county, Jordan, 1889; Kankakee river, Jordan, 1877, as *L. peltastes;* Yellow river, at Plymouth, Jordan, 1889; St. Joseph's at Mishawaka, Jordan 1889.

Lepomis garmani Forbes.

Mackey's Ferry, Jordan 1889.

Lepomis euryorus McKay.

Cedar and Shriner lakes and upper Eel river, Whitley county, Kirsch 1894.

Lepomis heros (B. and G.) McKay.

Round lake, Whitley county, Kirsch 1894; Lake Manitou, Eigenmann and Norman.

Lepomis notatus (Agass.) McKay.

Mackey's Ferry, Jordan 1889.

Lepomis gibbosus (L). Common Sun-fish, Bream, Pond-fish, Pumpkin-seed, Sunny.

Wabash at Terre Haute, Jenkins 1886; Eel river at South Whitley,

Cedar, Shriner, Round, Hull and Wilson lakes, Kirsch 1894; Paw Paw creek, Wabash county, Ulrey; Tippecanoe river, Jordan 1877; Loon lake, Kirsch 1894; Lake Manitou, Eigenmann and Norman; Lake Maxinkuckee, Jordan 1889; Maumee, Jordan 1877; Kankakee, Jordan 1877; at River side, Bates 1886; St. Joseph's, Jordan 1877; at Mishawaka, Jordan 1889; Clear and Pine lakes, Laporte county, Jordan 1877.

Micropterus dolomieu (Lacépède). Small-mouthed Black Bass.

White Water at Brookville, Evermann 1886; Laughery creek, near Milton, Ohio county, Jenkins 1888; Fourteen-mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Lower Wabash, Jordan 1877, as *floridanus;* Eel river at Logansport, Jordan 1889; Eel river and all tributaries, Kirsch 1894; Tippecanoe river, Jordan 1877, as *floridanus;* Tippecanoe river, Deer creeks and Wild Cat creek, Evermann and Jenkins 1888; Lake Maxinkuckee, Jenkins 1888; West Fork White river, at Indianapolis, Jordan 1877, as *floridanus;* at Gosport, Eigenmann; Bean Blossom, Eigenmann and Fordice 1885; Eel river, at Cataract, Owen county, Jordan 1889; Flat Rock and Clifty creeks, Decatur county, Shannon 1887; Blue river, at Knightstown, Clear creek, Monroe county, I. U. Coll.; Maumee river, Jordan 1877, as *floridanus;* Kankakee river, Jordan 1877, as *floridanus;* Yellow river, at Plymouth, Jordan 1889; St. Joseph's river, Jordan 1877, as *floridanus;* at Mishawaka, Jordan 1889; Clear and Pine lakes, La Porte county, Jordan 1877, as *floridanus.*

Micropterus salmoides (Lacépède). Large mouthed Black Bass, Green Bass, Oswego Bass, Bayou Bass

White Water river, at Brookville, Evermann 1886; Fourteen-mile creek, Clark county, Jenkins 1888; Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877; Blue river at Columbia City, Jordan 1889; Eel river and large tributaries, and all the lakes, Kirsch 1894; Tippecanoe river, Jordan 1877; Tippecanoe river, Deer creeks and Wild Cat creek, Evermann and Jenkins 1888; Lake Manitou, Eigenmann and Norman; Lake Maxinkuckee, Jenkins 1888; Loon, Big and Crooked lakes, Kirsch 1894; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; Switz City swamp,

Greene county, Gilbert 1884; East Fork White river and Salt creek, near Bedford, Gilbert 1884; Patoka river, Gibson county, and Black river, Posey county, Jordan 1889; Yellow river at Plymouth, Jordan 1889; St. Joseph's river, Jordan 1877; Trail creek, La Porte county, Ridgley.

Family *Percidæ* (The Perches).

Etheostoma pellucidum Baird. Sand Darter.

Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at New Harmony and Mackey's Ferry, Jordan 1889; Eel river from Collamer to Logansport, Kirsch 1894; at Logansport, Jordan 1889; Tippecanoe river, Wild Cat and Deer creeks, Evermann and Jenkins 1888; Raccoon creek at Mecca, I. U. Coll; West Fork White River at Indianapolis, Jordan 1877; at Gosport, Eigenmann; Bean Blossom, Eigenmann and Fordice 1885; East Fork near Bedford, Gilbert 1884.

Etheostoma asprellus (Jordan).

Rising Sun, Ohio county, Jenkins 1888; Wabash at Vincennes and New Harmony, Jordan 1889.

Etheostoma nigrum Rafinesque. "Johnny."

White Water river at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, and Fourteen Mile Creek, Clark county, Jenkins 1888; Wabash river at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Kentner's creek, Wabash county, Ulrey; Blue river at Columbia City, Jordan 1889; Eel river at Logansport and tributary streams, Cedar and Round lakes, Kirsch 1894; Tippecanoe river, Wild Cat and Honey creeks and Deer creeks, Evermann and Jenkins 1888; Lake Maxinkuckee, Jenkins 1888; Raccoon creek at Mecca, Parke county, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877 as *Boleostoma maculatum;* at Gosport, Eigenmann; at Spencer, Jordan 1889; Bean Blossom creek, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, Gilbert 1884 as *B. maculatum;* Flat Rock and Clifty creeks, Decatur county, Shannon 1887; Blue river at Knightstown; Lost river at Orangeville; Clear creek, Monroe county, I. U. Coll.; Patoka river Gibson county, Black river, Gresham's and Big creeks, Posey county, Jordan 1889; Kankakee river at Riverside, Bates 1886; Yellow river at Plymouth, Jordan 1889; St. Joseph's at Mishawaka, Jordan 1889; Trail

creek, LaPorte county, Ridgley.

Etheostoma chlorosoma (Hay).

Cypress swamp, Posey county, Wabash at New Harmony and Mackey's Ferry and Big creek, Posey county, Jordan 1889.

Etheostoma blennioides Rafinesque. Green-sided Darter.

White Water river at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins 1888; Wabash river at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Lower Wabash, Jordan 1877; Blue river at Columbia City, Jordan 1889; Eel river at Logansport, Jordan 1889; Eel river and its tributary streams, Kirsch 1894; Lake Manitou, Eigenmann and Norman; Tippecanoe river, Deer creeks, Wild Cat creek, Evermann and Jenkins 1888; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877; at Spencer, Jordan 1889; Bean Blossom, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock and Clifty creeks, Decatur county, Shannon 1887; Blue river at Knightstown, I. U. Coll.

Etheostoma coplandi (Jordan).

Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes and New Harmony, Jordan 1889; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann.

Etheostoma histrio Jordan and Gilbert.

Patoka river, Gibson county, Jordan 1889.

Etheostoma shumardi (Girard).

Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Hutsonville, Ill., Vincennes and New Harmony, Jordan, 1889; Lower Wabash, Jordan 1877; West Fork White river at Indianapolis, Jordan 1877.

Etheostona uranidea (Jordan and Gilbert).

Wabash at Vincennes and New Harmony, Jordan 1889.

Etheostoma caprodes Rafinesque. Log Perch, Hog-fish, Crawl-a-bottom.

White Water river at Brookville, Evermann 1886; Fourteen Mile creek Clark county, Jenkins 1888; Wabash river at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes, New Harmony and Mackey's Ferry, Jordan 1889; Lower Wabash, Jordan 1877; Lower course of Eel river, Pawpaw creek, Flowers, Twelve Mile creeks, Kirsch 1894; Eel at Logansport, Jordan 1889; Tippecanoe river, Wild

Cat and Deer creeks, Evermann and Jenkins 1888; Loon lake, Kirsch 1894; Raccoon creek at Mecca, I. U. Coll., West Fork White river at Indianapolis, Jordan 1877; at Gosport, Eigenmann; at Spencer, Jordan 1889; Bean Blossom, Eigenmann and Fordice 1885; Clifty and Flat Rock creeks, Decatur county, and Flat Rock river at Rushville, Shannon 1887; Salt creek near Bedford, Gilbert 1884; Patoka river, Gibson county, and Big creek Posey county, Jordan 1889; St. Joseph's river, Jordan 1877.

Etheostoma macrocephalum Cope.

Ohio valley. No authentic specimens from Indiana.

Etheostoma ouachitæ (Jordan and Gilbert).

Patoka river, Gibson county, Jordan 1889.

Etheostoma aspro (Cope and Jordan).

White Water river at Brookville, Evermann 1886; Wabash at Delphi, Evermann and Jenkins, 1888; at Terre Haute, Jenkins 1886; at New Harmony, Jordan 1889; Blue river at Columbia City, Jordan 1889; Eel river at Logansport, Jordan 1889; Eel river and all its tributary streams, Kirsch 1894; Tippecanoe river, Deer creeks and Wild Cat creek, Evermann and Jenkins 1888; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877; Bean Blossom, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock and Sand creeks, Decatur county, Shannon 1887; Big creek, Posey county, Jordan, 1889; Kankakee at Riverside, Bates 1886; Yellow river at Plymouth, Jordan 1889; St. Joseph's at Mishawaka, Jordan 1889.

Etheostoma phoxocephalum Nelson.

Blue river at Wyandotte Cave, I. U. Coll.; Wabash river at Delphi, Evermann and Jenkins 1888; at Terre Haute, Evermann 1888; at Vincennes and New Harmony, Jordan 1889; Lower Wabash, Jordan 1877; Eel river at Logansport, Jordan 1889; West Fork White river at Gosport, Eigenmann; at Spencer, Jordan 1889; Bean Blossom, Eigenmann and Fordice 1885; East Fork and Salt creek near Bedford, Gilbert 1884; Patoka river, Gibson county and Big creek, Posey county, Jordan 1889.

Etheostoma scierum (Swain).

Wabash at Vincennes and New Harmony, Jordan, 1889; Tippecanoe river, Jenkins 1888; West Fork White river at Gosport, Eigenmann; at Spencer, Jordan 1889; Bean Blossom, Monroe county, Swain; Salt

creek near Bedford, Gilbert 1884; Patoka river, Gibson county, Jordan 1889.

Etheostoma exile (Jordan and Copeland).

Wabash river at Delphi, Evermann and Jenkins 1888; at Vincennes and New Harmony, Jordan 1889; Lower Wabash, Jordan 1877; Eel river at Logansport, Jordan 1889; Tippecanoe river, Evermann and Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877; at Gosport, Gilbert and Swain; St. Joseph's river, Jordan 1877.

Etheostoma variatum Kirtland.

White Water at Brookville, Jordan 1885, Evermann 1886.

Etheostoma zonale (Cope).

White Water at Brookville, Evermann 1886; Blue river at Wyandotte Cave, I. U. Coll.; Yellow river at Plymouth, Jordan 1889.

Etheostoma camurum (Cope). Blue-breasted Darter.

Eel River, between South Whitley and North Manchester, Kirsch, 1894; Tippecanoe river, Jenkins 1888; West Fork White river at Indianapolis, Jordan 1877.

Etheostoma maculatum Kirtland.

Tippecanoe river, Jordan 1877; Deer creek, Jordan 1889; West Fork White river at Indianapolis, Jordan 1877; Maumee river Jordan 1877; Kankakee river, Jordan 1877; Yellow river at Plymouth, Jordan 1889; St. Joseph's river, Jordan 1877.

Etheostoma flabellare Rafinesque.

White Water at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, Jenkins 1888; Big Pigeon creek at Evansville, Jordan 1889; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; Blue river at Columbia City, Jordan 1889; Eel river between South Whitley and North Manchester, Kirsch 1894; Tippecanoe river, Wild Cat creek and Deer creeks, Evermann and Jenkins 1888; Raccoon creek at Mecca, I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877; Bean Blossom, Eigenmann and Fordice 1885; Eel river at Cataract, Owen county, Jordan 1889; Salt creek near Bedford, Gilbert 1884; Flat Rock and Clifty creeks, Decatur county, Shannon 1887; Clear creek, Monroe county, I. U. Coll.

Etheostoma squamiceps Jordan.

Gresham's creek and Big creek, Posey county, Jordan 1889.

Etheostoma tippecanoe Jordan and Evermann.

Tippecanoe river, Jordan 1889.

Etheostoma caeruleum Storer. Rainbow Darter, Soldier-fish.

White Water river at Brookville, Evermann 1886; Laughery creek near Milton, Ohio county, and Fourteen Mile creek, Clark county, Jenkins 1888; Wabash at Delphi, Evermann and Jenkins 1888; at Terre Haute, Jenkins 1886; at Vincennes and New Harmony, Jordan 1889; Kentner's creek, Wabash county, Ulrey; Blue river at Columbia City, Jordan 1889; Eel river and tributary streams, Kirsch 1894; at Logansport, Jordan, 1889; Tippecanoe river, Wild Cat creek, Deer creeks, Evermann and Jenkins 1888; Lake Maxinkuckee, Jenkins 1888; Raccoon creek at Mecca I. U. Coll.; West Fork White river at Indianapolis, Jordan 1877 as *Pacilichthys variatus;* at Gosport, Eigenmann; at Spencer, Jordan 1889; Bean Blossom, Eigenmann and Fordice 1885; East Fork White river and Salt creek near Bedford, Gilbert 1884; Flat Rock and Clifty creeks, Decatur county, Shannon 1887; Blue river at Knightstown, Clear creek, Monroe county, I. U. Coll.; Yellow river at Plymouth, Jordan 1889; St. Joseph's at Mishawaka, Jordan 1889.

Etheostoma caeruleum spectabile Agassiz.

Lakes drained by Eel river, Kirsch 1894; West Fork White river at Indianapolis, Jordan 1877; Kankakee river, Jordan 1877; St. Joseph's river, Jordan 1877.

Etheostoma jessiæ (Jordan and Brayton).

Wabash at Delphi, Evermann and Jenkins 1888; at Vincennes and New Harmony, Jordan 1889; Big Creek, Posey county, Jordan 1889.

Etheostoma fusiforme (Girard).

Cypress swamp, Posey county, Jordan 1889; Wabash at Terre Haute and New Harmony, Jordan 1889; Switz City swamp, Greene county, Gilbert 1884 as *B. palustris*; Big creek, Posey county, Jordan 1889.

Etheostoma eos (Jordan and Copeland).

Wabash at Terre Haute, Jenkins 1886; Blue, Cedar, Round and Shriner lakes, Whitley county, Kirsch 1894; Tippecanoe river, Jordan 1877; Lake Maxinkuckee, Jenkins 1888; Maumee river and St. Joseph's river, Jordan 1877; Clear and Pine lakes, La Porte county, Jordan 1877.

Etheostoma microperca Jordan and Gilbert. Least Darter.

Blue lake, Round lake, Kirsch 1894; West Fork White river at Indianapolis, Jordan 1877 as *M. punctulata*; Maumee river, Jordan 1877; Kankakee river at Riverside, Bates 1886; St. Joseph's river, Jordan 1877; Clear and Pine lakes, La Porte county, Jordan 1877.

Perca flavescens (Mitchill). Yellow Perch, Ringed Perch.

Upper courses of Eel river and Blue river, lakes drained by Blue river, Kirsch 1894; Wabash at Terre Haute, Jenkins 1886; Lake Manitou, Eigenmann and Norman; Tippecanoe river, Jordan 1877; Lake Maxinkuckee, Jenkins 1888; Loon, Big, Crooked lakes, Kirsch 1894; St. Joseph's river, Turkey lake, Jordan 1877; Lake Michigan at Michigan City, Bates 1886; Clear and Pine lakes, La Porte county, Jordan 1877.

Stizostedion vitreum (Mitchill). Wall-eye, Glass-eye, Pike-Perch, Jack Salmon.

Wabash at Terre Haute; Jenkins 1886.

Stizostedion canadense (C. H. Smith). Sauger, Sand Pike, Gray Pike, Hornfish.

White Water at Brookville, Evermann 1886; Wabash at Terre Haute, Jenkins 1886.

Family *Serranidæ* (The Sea Bass).

Roccus lineatus (Bloch). Striped Bass, Rock-fish, Rock.

No authentic Indiana specimens.

Roccus chrysops (Rafinesque). White Bass.

No authentic Indiana specimens.

Morone interrupta (Gill). Yellow Bass.

Wabash, at Terre Haute, Jenkins 1886.

Family *Sciænidæ* (The Drums).

Aplodinotus grunniens (Rafinesque). Fresh Water Drum, Gaspergou, "Sheep's-head," White Perch, Croaker, Thunder pumper.

Ohio river; White Water, at Brookville, Evermann 1886; Big Pigeon creek at Evansville, Jordan 1889; Wabash at Terre Haute, Jenkins 1886; at New Harmony and Mackey's Ferry, Jordan 1889; West Fork White river at Indianapolis, Jordan 1877; Patoka river, Gibson county, Jordan 1889.

Family *Cottidæ* (The Sculpins).

Cottus ricei (Nelson).

Lake Michigan. No authentic Indiana specimens.

Cottus bairdi (Girard). Miller's Thumb, Blob, Muffle-jaw.

White Water river at Brookville, Evermann 1886; Kentner's creek, Wabash county, Ulrey; Blue river at Columbia City, Jordan 1889; Eel river and large tributaries, Kirsch 1894; Lake Manitou, Eigenmann and Norman; Honey creek and Deer creeks, Evermann and Jenkins 1888, as *richardsoni;* West Fork White river, at Indianapo-

lis, Jordan 1877, as *wilsonii* and *carolinæ;* at Spencer, Jordan 1889; Bean Blossom creek, Eigenmann and Fordice 1885; Clifty and Flat Rock creeks, Decatur county, Flat Rock river at Rushville; Shannon 1887; Lost river at Orangeville; Yellow river at Plymouth, Jordan, 1889; Trail creek, La Porte county, Ridgley.

Cottus pollicaris (J. and G.).

Lake Michigan. No authentic Indiana specimens.

Cottus hoyi (Putnam).

Lake Michigan. No authentic Indiana specimens.

Family *Gadidæ* (The Cod-fishes).

Lota lota maculosa (Le Sueur). Burbot, Lawyer, Ling.

New Albany, Jordan 1888.

Summary of Families of Fishes found in Indiana, with their numbers of genera and species:

		No. of Genera.	No. of Species.
1	Petromyzontidæ	2	2
2	Polyodontidæ	1	1
3	Acipenseridæ	2	2
4	Lepisosteidæ	1	3
5	Amiidæ	1	1
6	Siluridæ	5	14
7	Catostomidæ	8	17
8	Cyprinidæ	13	33
9	Hiodontidæ	1	2
10	Clupeidæ	2	2
11	Salmonidæ	2	7
12	Percopsidæ	1	1
13	Amblyopsidæ	2	2
14	Cyprinodontidæ	3	4
15	Umbridæ	1	1
16	Luciidæ	1	3
17	Anguillidæ	1	1
18	Gasterosteidæ	2	2
19	Atherinidæ	1	1
20	Aphredoderidæ	1	1
21	Centrarchidæ	6	17
22	Percidæ	3	32
23	Serranidæ	2	3
24	Sciænidæ	1	1
25	Cottidæ	1	4
26	Gadidæ	1	1
		65	158

Not more than one-third of these have been found at any one locality.

The largest number recorded from any one locality is the forty-two species enumerated for Bean Blossom creek in about one mile of its course.

Over half of the genera (34), and more than two-thirds of the species belong to the following five families: Siluridæ, Catostomidæ, Cyprinidæ, Centrarchidæ, Etheostomidæ. About one fifth of the species are minnows, another fifth are darters, cat-fish and suckers together form a third fifth, the sunfishes, salmon and trout, and Cyprinodontidæ complete the fourth fifth and the last fifth is made up of nineteen other families.

BIBLIOGRAPHY OF INDIANA ORNITHOLOGY.

By A. W. Butler.

The following bibliographical notes, while far from complete, indicate many of the publications relating to Indiana birds, most of which were at hand for reference. Most of the more general works have been omitted, although several of them refer to Indiana birds.

1827–49. **Audubon, J. J.** Birds of America. 4 v. doub. elephant folio. London. 435 colored plates. Original edition colored plates.

1831–49.——Ornithological Biography, or an account of the habits of the birds of the United States of America; accompanied by descriptions of the objects represented in the work entitled the Birds of America. 5 vols., royal 8 vo. Edinburgh, 1831–49.

The original edition of the text to Audubon's great work, "The Birds of America." Very valuable. A copy at the Larking sale, May, 1892, brought £345. A copy is quoted in Quaritch's last catalogue, May, 1894, at £350.

1831. **Croghan, Col. George.** Journal of Col. Croghan, Monthly American Journal of Geology and Natural Science. Philadelphia, December, 1831.

Mentions the occurrence of some birds in Indiana.

1834. **Butler, Mann.** History of Kentucky. Louisville, 1834.

Contains a copy of the Journal of Col. Croghan down the Ohio in 1765. Refers to Indiana birds.

1840–44. **Audubon, J. J.** The Birds of America. From drawings made in the United States and their Territories. By John James Audubon. Philadelphia: J. B. Chevalier, 1840–44. 7 vols.

1846. **Croghan, George.** Journal of George Croghan. The Olden

Time, a monthly publication devoted to the preservation of documents and other authentic information in relation to the early explorations and the settlement and improvement of the country around the head of the Ohio. Edited by Neville S. Craig, Esq. Two vols., small 4to. Pittsburg, 1846–48.

1856. **Haymond, Rufus, M. D.** Birds of South-eastern Indiana. Proc. Academy of Natural Science, Philadelphia, vol. VIII, 1856, pp. 286–298.
A list of birds observed in the Whitewater valley.

1868. **Allen, J. A.** Notes on birds observed in Western Iowa, in the months of July, August and September; also on birds observed in Northern Illinois in May and June, and at Richmond, Wayne county, Indiana, between June 3d and 10th. Memoirs Boston Soc. Natural History, vol. I, pt. IV, Art. XII, December 1868, pp. 488–526.
Also issued separately. Mentions 72 Indiana species.

1869. **Haymond, Rufus.** Birds of Franklin county, Indiana. First Annual Report of the Geological Survey of Indiana, made during the year 1869, by E. T. Cox, State Geologist, 1869, pp. 209–335.
Also issued bound with Agricultural Report of the same year, entitled Indiana Agricultural and Geological Report 1869, etc.

1874. **Kirtland, J. P.** Letter from, dated 1857, mentioning various Indiana birds. Proc. Cleveland Acad. Nat. Science, 1874, pp. 131–132.

1874. **Ridgway, R.** The Wabash valley and its avian fauna. Proc. Boston Soc. Nat. Hist., vol. XVI, pp. 303–332.

————The lower Wabash valley considered in its relation to the faunal districts of the Eastern regions of North America, with a synopsis of its avian fauna, by Robert Ridgway. Boston, 1874, pp. 31.
Repaged edition of the above.

1874. **Coues, Elliott.** Birds of the Northwest, a handbook of the Ornithology of the region drained by the Missouri river and its tributaries. Dept. of the Interior, U. S. Geol. Survey of the territories, Miscellaneous Publications, No. 3, 1874.

1876. **Jordan, David Starr.** Manual of the vertebrates of the Northern United States, including the district east of the Mississippi river and north of North Carolina and Tennessee, exclusive of marine species, by David Starr Jordan, Ph. D., M. D., Professor of Natural History in N. W. C. University, and in Indiana State Medical College. Chicago, Jansen, McClurg & Co., 1876.
Refers to a number of Indiana birds. A second edition, dated 1878; a third, 1880; a fourth in 1888.

1876. **Smith, G. Aug.** Birds of Ft. Wayne, Indiana. Forest and Steam, vol. XI, 1876, pp. 148.

Fifty species mentioned, some by error.

1876. **Coues, Elliott.** Peculiar nesting site of Bank Swallow, (*i. e., Stelgidopteryx serripennis*). Bull. Nuttall Orn. Club, vol. I. 1876, p. 96.

1876. **Haymond, R.** Notes on the Bank Swaliow, (*i. e., Stelgidopteryx serripennis*). Field and Forest, vol. I, 1876, No. 11, p. 88.

1876. **Coues, Elliott.** Notable change of habit of the Bank Swallow, (*i. e., Stelgidopteryx serripennis*). American Naturalist, vol. X, 1876, pp. 493–492.

1876. **Nelson, E. W.** Additions to the avi-fauna of Illinois, with notes on other species of Illinois birds. Bull. Nuttall Orn. Club, vol. I, 1876, pp. 39–44.

Notes some observations on the Wabash river.

————The Louisiana Heron in Indiana. Bull. Nuttall Orn. Club, vol. II, 1877, p. 51.

————Birds of Northeastern Illinois. Bull. of the Essex Institute, vol. VIII, 1877, pp. 90–155.

Some observations noted about the southern end of Lake Michigan along the Indiana and Illinois line.

————Notes upon birds observed in Southern Illinois between July 17 and September 4, 1875. Bull. of the Essex Institute, vol. IX, 1877, pp. 32–65.

Part of the observations made on the Wabash river and part on the White river.

1877. Oologist (**A. W. Butler**). The nesting of the Wood Pewee. The Oologist, vol. III, 1877, p. 37.

1877. **Langdon, Frank W.** A catalogue of the birds in the vicinity of Cincinnati, Frank W. Langdon, Salem, Mass. Naturalists' Agency, 1877, pp. 18.

Mentions several observations on Indiana birds.

1878. **Ridgway, Robert.** A review of the American species of the genus Scops Sarigny. Proc. U. S. National Museum, vol. I, 1878, pp. 85–117.

Notes the results of observations on the dichromatic phrases of *Scops asio*. In part made in Indiana.

1878. **Brewster, William.** The Prothonotary Warbler. Bull. Nuttall Orn. Club, vol. III, 1878, pp. 153–162.

Based on observations made in Knox and Gibson counties, Indiana.

1878. **Ridgway, Robert.** Notes on birds observed at Mt. Carmel,

Southern Illinois, in the spring of 1878. Bull. Nuttall Orn. Club, vol. III, 1878, pp. 162–166.

Based in part upon observations in the Cypress swamp in Indiana.

1878. **Allen, J. A.** Early nesting of the Shore Lark near Indianapolis. Bull. Nuttall Orn. Club, vol. III, 1878, p. 189.

1878. **Cones, Elliott.** Birds of the Colorado valley. Dept. of the Interior U. S. Geol. Survey of the territories. Miscellaneous Publications, No. 11. Part First, Passeres to Laniidæ. 1878.

1879. **Langdon, Frank W.** A revised list of Cincinnati birds. Journal Cincinnati Soc. Nat. Hist., vol. II, 1879, pp. 1–27.

Mentions several Indiana birds.

1880. **Ridgway. Robert.** On six species of birds new to the fauna of Illinois, with notes on other rare Illinois birds. Bull. Nuttall Orn. Club, vol. V, 1880, pp. 30–32.

Notes the occurrence of *Ibis alba* at Mt. Carmel, Illinois.

1880. **Brayton, Alembert W.** A catalogue of the birds of Indiana, with keys and descriptions of the groups of the greatest interest to the Horticulturist, by Alembert W. Brayton, B. S., M. D. Transactions Indiana State Horticultural Society for 1879, pp. 87–165.

1880. **Allen, J. A.** Review of Brayton's catalogue of the birds of Indiana. Bull. Nuttall Orn. Club, vol. V, 1881, pp. 174–175.

1880. **Langdon, Frank W.** Ornithological field notes, with five additions to the Cincinnati avi-fauna. Journ. Cincinnati Soc. of Nat. Hist., vol. III, 1880, pp. 121–127.

Contains several notes on birds of Franklin county, Indiana.

1881. **Quick, E. R.** *Catharista atrata* Less. Journ. Cincinnati Soc. Nat. Hist., vol. IV, 1881, p. 340–341.

Two specimens noted near Brookville, Indiana.

———— Chen hyperboreus Boie. Journ. Cincinnati Soc. Nat. Hist., vol. IV, 1881, p. 341,

Specimens taken near Brookville, Indiana.

1881. **Langdon, F. W.** Zoological Miscellany—Ornithology. Journ. Cincinnati Soc. Nat. Hist., vol. IV, 1881, pp. 337–341.

Contains several Notes from Brookville, Indiana.

1881. **Ridgway, Robert.** A catalogue of the birds of Illinois. Bull. No. 4, Illinois State Laboratory of Nat. Hist., May 1881, pp. 163–208.

Mentions the occurrence of the Louisiana Heron (*Ardea tricolor ruficollis* Gosse) in Indiana, etc.

————Notes on some of the birds observed near Wheatland, Knox county, Indiana, in the spring of 1881. Bull. Nuttall Orn. Club, vol. VII, 1882, pp. 15–33.

1882. Langdon, F. W. Dichromatism in the Screech Owl (*Scops asio* Bp). Journ. Cincinnati Soc. Nat. Hist., vol. V, 1882, pp. 52-53.
Refers to several Indiana specimens.

1882. Langdon, F. W. A synopsis of the Cincinnati fauna. Zoological Miscellany, Journ. Cin. Soc. Nat. Hist., Vol. V, No. 3, pp. 185–194.
Includes birds.

1882. Quick, E. R. Winter Birds of 1880 and 1881 on the White Water. Journ. Cincinnati Soc. Nat. Hist., vol. V., 1882, pp. 54–56.

———Ornithological Notes from Brookville, Indiana. Journ. Cincinnati Soc. Nat. Hist., vol. V., 1882, p. 192.

1882. Butler, A. W. The Birds of Franklin county, Indiana. Atlas of Franklin county, Indiana, etc., J. H. Beers & Co., Chicago, 1882, pp. 11–12.

———Ornithological Notes from Brookville, Indiana. Journ. Cincinnati Soc. Nat. Hist., vol. V, 1882, pp. 192–193.

1882. Quick, E. R. Brookville (Indiana) Notes. Journ. Cincinnati Soc. Nat. Hist., vol. V, pp. 93-95.
Appears under the caption "Ornithology" under "Zoological Miscellany."

1882. Wheaton, J. M., M. D. Report on the birds of Ohio. Report of the Geological Survey of Ohio, vol. IV; Zoology and Botany, Part I; Zoology, Section II, Columbus, Ohio, 1882, pp. 187–628.
Notes several observations on Indiana birds.

1883. Langdon, F. W., M. D. Bibliography of the Cincinnati fauna. Journ. Cincinnati Soc. Nat. Hist., vol. VI, 1883, pp. 5–53.
Mentions several publications on Indiana birds.

1883. Evermann, B. W. Notes from Bloomington, Indiana. Vol. VIII, pp. 27–28.

1884. Butler, A. W. Local Weather Lore. The Meteorological Journal, Dec. 1884, pp. 313-316.
Relating to birds.

———Local Weather Lore. Proc. A. A. A. S., vol. XXXIII, 1884, pp. 609–603.
Abstract from above.

———The Cærulean Warbler. Ornithologist and Oologist, vol. IX, 1884, pp. 27–28.

1884. Evermann, B. W. Arrivals of birds at Camden, Indiana, 1894. Ornithologist and Oologist, vol. IX, 1884, p. 74.

1884. Noe, Fletcher M. Chimney Swallows. Ornithologist and Oologist, vol. IX, 1884, p. 104.

1884. **Evermann, B. W.** Bird Migration. Am. Field, vol. XXI, pp. 544–545.

1884. **Noe, Fletcher M.** Are Owls beneficial to the Farmer; also notes on the species in Indiana. Indiana Farmer, July 5, 1884.

1885. **Sharpe, R. Bowdler.** Catalogue of the Passeriformes or Perching birds in the collection of the British Museum, etc., vol. X., London, 1885.

Contains a number of Indiana references, including *Geothlypis macgillivrayi* (?) from Wolf lake, Indiana. This series of publications, which began to be issued in 1874, and is still being published, contains a number of references to Indiana birds.

1885. **Noe, Fletcher M.** Red Crossbill in Indiana. Ornithologist and Oologist, vol. X., 1885, p. 32.

1885. **But er, A. W.** The Cuckoo. Indiana Farmer, April 1885, p. 14.

————Observations on faunal changes. Bull. Brookville, Soc. Nat. Hist. No. 1, p. 5–13

Includes note on birds which were republished in Ornithologist and Oologist, vol. X., 1885, pp. 98–99.

————Observations on faunal changes. Ornithologist and Oologist, Vol X., 1885. pp. 98–99.

Reprint of last

1885. **Noe, Fletcher M.** The value of birds as insect destroyers. Indiana Farmer, Jan. 17, 1885.

1885. **Evermann, Barton W.** A day with the birds of a Hoosier swamp. Ornithologist and Oologist, vol. XI, 1886, p. 99.

1886. **Butler, Amos W.** A list of birds observed in Franklin county, Indiana. Bull. Brookville, Soc. Nat. Hist. No. 2, 1886, pp. 12–39.

1886. **Blatchley, W. S.** Winter birds of the vicinity of Bloomington Indiana. Hoosier Naturalist, 1, pp. 169–171.

1886. **Evermann, B. W.** White eggs of the Bluebird. Ornithologist and O logist, vol II, 1886, p. 124.

1886. **Noe, Fletcher M.** Notes on the destruction of Indiana birds for millinery purposes. Indianapolis News, Feb. 22, 1886.

————Notes on Indiana birds, Indianapolis News, Feb. 27, 1886.

1886. **A. O. U.** Check list.

————The code of nomenclature and check list of North American birds, adopted by the American Ornithologists' reunion New York, 1886.

1886. **Gregg, J. C.** Letter. Hoosier Naturalist, Vol. I, p. 155.

1886 **Butler, A. W.** The periodical cicada in Southeastern Indiana.

U. S. Dep't of Agriculture, Division of Entomology, Bulletin No. 12, pp. 24–31.

Refers to birds known to eat cicadas.

1887. **Evermann, B. W.** Birds of Monroe county, Indiana. The Hoosier Naturalist, vol. II, 1887, pp. 137–145.

1887. **Evermann, B. W.** Some rare Indiana birds. American Naturalist, Vol. XXI, 1887, pp. 290–291.

————Bird migration. Popular Science Monthly, April 1887.

————An addition to the list of birds of Monroe county, Indiana. Hoosier Naturalist, vol. II, 1887, p. 164.

1887. **Ridgway, Robert.** A manual of North American birds. Philadelphia. 1887.

1888. **Butler, A. W.** Tropical Sojourners. The Agassiz Companion, vol. III.

————Notes on the range of the Prothonotary Warbler in Indiana. Ornithologist and Oologist, vol. XII, 1888, pp. 33–34.

1888. **Evermann, Barton W.** Birds of Carroll county, Indiana. The Auk, vol. V, 1888, pp. 344–351; continued in vol. VI, 1889, pp. 22–30.

1888. **Butler, Amos W.** Notes concerning albinism among birds. Journ. Cincinnati Soc. Nat. Hist. Jan. 1, 1888, pp. 214–216.

1888. **Noe, Fletcher M.** Do English Sparrows protect trees from insect ravages? Indianapolis, News, June 15, 1888.

1889. **Langdon, F. W., M. D.** On the occurrence of large numbers of sixteen species of birds. Journ. Cincinnati Soc. Nat. Hist., vol. XII, 1889, pp. 57–63.

Notes the unusual abundance of the Rose-breasted Grosbeak at Brookville, Indiana, in the spring of 1885.

1889. **Evermann, B. W.** The Wood Ibis of Indiana. The Auk, vol. VI, 1889, pp. 186–187.

1889. **Ridgway, Robert.** The Ornithology of Illinois. Natural History Survey of Illinois. State Laboratory of Natural History, S. A. Forbes, Director. Part 1, Descriptive Catalogue, by Robert Ridgway, vol. I, Springfield, Ill., 1889, pp. 520—VIII, pls. XXXII.

The present volume ends with Columbæ. Contains many references to Indiana birds.

1889. **Barrows, Walter B.** The English Sparrow (*Passer domesticus*) in North America, especially in its relations to agriculture. Prepared under the directions of Dr. C. Hart Merriam, Ornithologist, by Walter B. Barrows, Assistant Ornithologist. Bulletin No. 1, U. S. Department

of Agriculture, Division of Economic Ornithology and Mammalogy. Washington, 1899, pp. 405 and map.

A number of Indiana observations noted.

1889. **Dwight, Jonathan, Jr.** The horned Larks of North America. The Auk, vol. VII, 1890, pp. 138–158 and map.

Notes specimens from Indianapolis, Indiana.

1889. **Thompson, Maurice.** Preliminary sketch of the Aquatic and shore birds of the Kankakee region. Rept. Ind. Geol. Survey 1888, pp. 102–164.

1889. **Davie, Oliver.** Nests and eggs of North American Birds. 4th Ed. 1892, pp. 455+12+11. Three previous editions.

1890. **Noe, Fletcher M.** Wood Ibis in Indiana. Ornithologist and Oologist, vol. XV, p. 167.

1891. **Butler, Amos W.** A catalogue of the birds of Indiana. Trans. Indiana Hort. Soc. 1890, p. 1–135.

Apendix C. Also seperately printed.

1891. **Butler, Amos W.** Our Birds and what they do for the farmer. Rept. State Board of Agl. Ind. 1890, pp. 113–125.

Also issued separately in pamphlet form.

1891. **Hasbrouck, Edwin M.** The Carolina Parquet (*Conurus carolinensis*). The Auk, vol. VIII, 1891, pp. 369–379.

1891. **Allen, J. A.** Butler's Birds of Indiana. Review. The Auk, vol. VIII, p. 383.

1891. **Hasbrouck, Edwin M.** The present status of the Ivory-billed Woodpecker (*Campephilus principalis*). The Auk, 1891, vol. VIII, pp. 174–186.

1892. **Butler, Amos W.** Notes on Indiana birds. Proc. Ind. Acad. Sci. 1891.

————Notes on the range and habits of the Carolina Parakeet. The Auk, vol. IX, No. 1, Jan. 1892, pp. 49–56.

1892. **McBride, R. Wes.** Some notes on the birds of Indiana. Proc. Ind. Acad. Sci. 1891, pp. 166–169.

1892. **Butler, Amos W.** Some notes concerning the Evening Grosbeak. The Auk, vol. IX, pp. 238–247.

1892. **Noe, Fletcher M.** Note on White Pelican. New Castle, Ind. O. and O., vol. VI, p. 123.

1892. **Ulrey, A. B.** Notes on the American Bittern (*Botaurus lentiginosus*). O. and O., vol. XVII, pp. 76–77.

1892. Gould, James E. Note on nesting of Bald Eagle at English Lake Ind. O. and O., vol. XVII, p. 64.

1892. Kindle, E. M. Arrivals of some migratory birds of Johnson county Indiana. Ornithologist and Oologist, Vol. XVII, p. 44.

1892. Bendire, Charles, Capt. U. S A. Life Histories of North American Birds, Smithsonian Institution, United States National Museum; Special Bulletin No. 1, 1892.

1893. Butler, Amos W. Further notes on the Evening Grosbeak. The Auk, vol. X, 1893, pp. 155–157.

1893. Cook, A. J. Birds of Michigan. Bull. 94 Mich. Agl. College, pp. 1–148 1st Edition.

1893. Butler, Amos W. Range of the Crossbill (*Loxia*) in the Ohio valley with notes on their unusual occurrence in summer. Proc. Ind. Acad. Sci. 1892, pp. 63–72.

1893. Cook, A. J. Birds of Michigan. Bull. 94 Mich. Agl. College, pp. 1–168, 2d Edition.

1893. Fisher, A. K., M. D. The Hawks and Owls of the United States in their relation to agriculture. Bull. No. 3, Div. Orn. and Mam. U. S. Dept. Agriculture. 1893, 210 pp.

1893. Cox, Ulysses O. A list of the birds of Randolph county, Ind. with some notes on the mammals of the same county. O. and O., vol. XVIII, 1893, p. 2–3.

1893. McBride, Herbert W. Letter. Notes on Rose-breasted Grosbeak in Michigan and Indiana. O. and O., vol. XVIII, p. 47.

1893. Butler, Amos W. On the migration of birds. Indiana Farmer, Oct. 21, 1893.

————The range of Crossbills in the Ohio valley with notes on their unusual occurrence in summer. The American Naturalist, vol XXVIII, 1894, pp. 136–146.

NOTES ON INDIANA BIRDS.

By A. W. Butler.

The following observations are supplementary to the paper on the Birds of Indiana published in the Transactions of the Indiana Horticultural Society 1890:

Ammodramus leconteii (Aud.). Le Conte's Sparrow.

Mr. J. E. Beesley took a specimen of this species from a flock of three or four sparrows, possibly of the same kind at Lebanon, Ind., March 30, 1892. This is the third record for the state.

Dendroica discolor (Vieill.). Prairie Warbler.

Mr. Beesley took two or them at Lebanon, Ind., April 29, 1892. This is the fourth locality from which they have been reported in the state and the first record from the northern half. Another record however has recently come to hand. Mr. W. O. Wallace took one specimen May 2, 1892 at Wabash.

Dendroica tigrina (Gmel.). Cape May Warbler.

The spring of 1892 this species was comparatively common throughout the state. Only twice have they heretofore been reported in any numbers, and never so numerously as last year.

Ardea egretta (Gmel.). American Egret.

Rare throughout the northern part of the state. A male in full plumage was killed May 17, 1892 near Frankfort, Ind. Detailed information regarding its breeding in the state is much desired.

Pelecanus erythrorhynchos Gmel. White Pelican.

A bird of this species was killed May 25, 1892 near Bloomfield, Greene county, Ind.

Botaurus exilis (Gmel.). Least Bittern.

One specimen was taken May 10 and another May 19, 1892 near Lebanon, Ind. I am informed by Mr. J. E. Beesley that they breed in that vicinity but not abundantly. Mr. W. O. Wallace took two specimens at Wabash early in May 1892.

Clangula hyemalis (Linn.). Old Squaw.

Mr. Beesley informs me that a bird of this species was killed near Thorntown, in May 1892.

Phalaropus lobatus (Linn.). Northern Phalarope.

A pair taken in Boone county, June 7, 1889 (Beesley). This is the second record for the state. The specimens and those of the next species are probably now in the state collection at Indianapolis.

Phalaropus tricolor (Vieill.). Wilson's Phalarope.

A pair of these birds taken May 9, 1889 in Boone county. This is the first record from that part of the state.

Anser albifrons gambeli. (Hartl.). American White-fronted Goose.

One was killed April 17, 1892 near Peru. (Beesley). This is its third reported occurrence in the state.

Anhinga anhinga (Linn.). Anhinga; Snake bird.

Mr. Beesley informs me that he killed a pair of these birds on what is known as the "Broad cut" of the canal just north of Indianapolis in 1858.

This is the first record from the state, but another specimen is reported to have been taken since. (Cat-birds of Ind. p. 18).

Phalacrocorax dilophus floridanus (Aud.). Florida Cormorant.

The same gentleman took a bird of this species near Indianapolis, May 8, 1858.

Tryngites subruficollis (Vieill.). Buff-breasted Sandpiper.

Messrs. C. D. and L. A. Test took this bird Sept. 10, 1892 from a large shallow pond about four miles northwest of Lafayette. This is the first reported occurrence of this bird within the state.

Micropalama himantopus (Bonap.). Stilt Sandpiper.

The same gentlemen took a specimen of this bird from the same locality Oct. 10, 1892. This is the first time it has been reported within the state. Through the kindness of the collectors this specimen, the one last mentioned and *Junco hyemalis shufeldti* have been placed in my collection.

Colymbus holbællii (Reinh.). Holbœll's Grebe.

Dr. J. L. Hancock, of Chicago, reports having identified it at Wolf lake, Ind., in the spring of 1883, also at Park Side, Ill., April 29, 1883. This is the only reported record of the species in Indiana.

Larus philadelphia (Ord.). Bonaparte's Gull.

Dr. Hancock informs me this species is a summer resident in the northwestern part of the state where it frequents the large lakes in early spring and later breeds in the small inland lakes.

Sterna antillarum (Less.). Least Tern.

Found nesting at Wolf lake. Common some years ago but now rather rare. (Dr. J. L. Hancock).

Aythya marila nearctica (Stejn.). American Scaup Duck.

Identified April 9, 1887 at Hammond, by Graham Davis (Dr. Hancock).

Ampelis garrulus Linn. Bohemian Waxwing.

Dr. Hancock says: "A flock of eight of these birds were seen feeding on mountain ash berries March 1, 1880 in Chicago. I shot two specimens."

Cistothorus stellaris (Licht.). Short-billed Marsh Wren.

Noted at Hammond, Apr. 9, 1887 by Graham Davis (Dr. Hancock).

Tringa bairdii (Coues). Baird's Sandpiper.

A specimen taken Aug. 26, 1893 by W. O. Wallace at Wabash. The The first Indiana record.

Nyctea nyctea (Linn.). Snowy Owl.

A specimen taken at Cedar Grove, Franklin county, December 1893. This is a rare bird in the southeastern quarter of the state.

Calcarius lapponicus (Linn.). Lapland Longspur.

Has been taken at Wabash, Ind. One specimen. (Wallace).

Dendroica kirtlandi Baird. Kirtland's Warbler.

One specimen, Wabash, Ind., May 1, 1893 taken by W. O. Wallace. This is the first specimen of this rare warbler reported from the state. Mr. Wallace has very kindly presented me with the specimen.

The species was described from a specimen taken by Dr. Kirtland near Cleveland, O. The following are the reported records of its occurrence:

1. At sea off Abaco, Bahamas, by Dr. Samuel Cabot, second week in October, 1841.

2. Near Cleveland, O., by Dr. Dr. J. P. Kirtland, male, May 15, 1851. Type specimen.

3. Near Cleveland, O., by R. K. Winslow, female, June, 1860.

4. Near Cincinnati, O., by Charles Dury, male, first week in May, 1872.

5. Ann Arbor, Mich, by A. B. Covert, female, May 15, 1875.

6, 7. Rockport, Cuyahoga county, O., by Wm. and John Hall, May, 1878.

8. Andros Island, Bahamas, by Charles B. Cory, female, Jan. 9, 1879.

9. Ann Arbor, Mich., by A. B. Covert, female, May 16, 1879.

10, 11. Cleveland, O., reported by Dr. Langdon, male and female, May 4, 12, 1880.

12. Battle Creek, Mich., male, May 11, 1883, now in U. S. National Museum.

13. St. Louis, Mo., May 8, 1885. Otto Widmann.

14. Spectacle Reef, Mich., May 25, 1885. Wm. Marshall. Struck the light at Spectacle Reef light house.

15. Near Dublin Gap Springs, Pa., June 25., 1885. Prof. H. J. Roddy. He says: "Saw one with family."

16. St. Helena Island, S. C., Apr. 27, 1886. Walter Hoxie. Reports seeing three others.

17. Near Fort Meyer, Va., Sept. 25, 1887. Wm. Palmer. Another seen a week later.

18. Ann Arbor, Mich., Apr. or May 1888, female, by Mr. Knapp.

19. Chester, S. C., female, Oct. 11, 1888. L. M. Loomis.

20. Near Minneapolis, Minn., May 13, 1892, male. H. M. Guilford.

21. Wisconsin. Dr. P. R. Hoy. Reported seen.

22. Wabash, Ind., May 1, 1893. W. O. Wallace.

The winter home of this rare and narrowly restricted species is apparently the Bahama Islands. It has been taken most commonly during the

spring migrations near Cleveland, O. and Ann Arbor, Mich. It has never been taken in the interior of the United States during the fall migrations. The summer home of this warbler would seem to be northern Michigan and Wisconsin or north thereof and possibly in the mountains of Pennsylvania. The line of its spring movements seems to be a narrow route from the Bahamas past the western end of Lake Erie toward Lake Superior. Perhaps the return migration may be over the same route but it is possible this may be, in whole or in part, farther to the eastward passing down the coast after it reaches the Atlantic.

Its distribution is very remarkable. Yet there seems to be an effort on the part of other species to follow a line remarkably similar to that noted. From the northwest into South Carolina, even to the coast, there seems to be a migration route analagous to this. Along it would seem to move, in a southeastly migration, such forms as Brewer's Blackbird, Yellow-headed Blackbird, Leconte's Sparrow, Prairie Horned Lark, typical plains forms.

BIBLIOGRAPHY OF INDIANA MAMMALS.

By B. W. Evermann and A. W. Butler.

1687. **La Hontan.** New voyages to North America. English edition, vol. I, p. 217.

1718. **Vandreuil.** New York coll. of mss. Paris documents, VII, pp. 885–891.

1720. **Charlevoix.** Letters. Goadby's English edition, p. 303.

1778. **Hutchins, Thomas.** Topographical description of Virginia, Pennsylvania and North Carolina, comprehending the rivers Ohio, Kanawha, Scioto, Cherokee, Wabash, Illinois, Mississippi, etc. London, 1778.

Referred to in Allen's History of the American Bison, p. 505; foot note mentions buffalo as "innumerable" northwestward of the Ohio river, from the mouth of the Kanawha far down the Ohio.

1831. **Croghan, Col. George.** Journal of Col. Croghan, Monthly American Journal of Geology and Natural Science. Philadelphia, December, 1831.

References to the buffalo in 1765.

1834. **Butler, Mann.** History of Kentucky.

Contains copy of the Journal of Col. Croghan down the Ohio in 1765, in which references are made to the buffalo, deer, bear, etc.

1842. **Duvernoy.** Notices pour servir a la monographie du genre Musaraigne. Sorex Cuv., Magazin de Zoologie, 2me ser., IV, 1842. Mammiferes 1-48, pl. 38–84.

Containing descriptions of *Brachysorex harlani* and *Amphisorex lesueurii*.

————Abstract of above. Comptes Rendus, XV, 1842, 7–13.

————Abstract of above. Institut X, 1842, 247–248.

1846–7. **Croghan, George.** Journal of George Croghan. The Olden Time. A monthly publication devoted to the preservation of documents and other authentic information in relation to the early explorations, and the settlement and improvement of the country around the head of the Ohio. Edited by Neville B. Craig, Esq. Two vols., small 4to. Pittsburg, 1846–48.

Referred to by Allen's History of the American Bison, p. 505, foot note. References to buffalo, 1765, also 1770–1785.

1851. **Audubon, J. J. and Bachman, John.** Quadrupeds of North America, etc. Vol. II. Buffalo in Indiana, p. 36.

1856. **Kennicott, Robert.** The quadrupeds of Illinois, injurious and beneficial to the farmer. Patent Office Report, 1856, pp. 52–110.

Refers to a number of mammals from Indiana. *Arvicola scalopsoides*, says, is probably the same as mentioned by Dr. Plummer as *Arvicola riparius*, in Silliman's Journal, as existing in Wayne county, Indiana.

1857. **Baird, Spencer F.** Mammals. Explorations and Surveys for a railroad route from the Mississippi river to the Pacific ocean. War Dept. Vol. IX.

1869. **Haymond, Rufus.** Mammals found at the present time in Franklin county. Indiana Agricultural and Geological Report 1869, 203–208.

Gives a list of 31 or 32 species.

————Geology of Franklin county, Indiana. Dr. Rufus Haymond's report of a geological survey of Franklin county, Ind., made during the summer and fall of 1869. First Ann. Rept. Geo. Sur. of Ind., pp. 199–200.

Reference to remains of mastodon and mammoth.

1876. **Jordan, D. S.** Manual of the vertebrates of the Northern United States, including the district east of the Mississippi river and north of North Carolina and Tennessee, exclusive of Marine species, by David Starr Jordan, M. S., M. D. Chicago. Jansen, McClurg & Co., 1876.

Other editions dated 1878, 1880, 1888.

1877. **Allen, J. A.** History of the American Bison (*Bison Americanus*), by J. A. Allen. Ninth Annual Rept of the U. S. G. and G. Survey of the Territories, embracing Colorado and parts of adjacent territories,

1877. Pt. III, Zoology, pp. 441–587.

Practically a republication of The American Bison, Living and Extinct, by the same author, from vol. I, pt. II Memoirs of the Geological Survey of Kentucky, etc., 1876. Published also in the Memoirs of the Museum of Comparative Zoology, etc. Cambridge, Mass., vol. IV, 1876, etc.

1877. **Coues, Elliott.** Fur-bearing animals. U. S. Geological Survey of the territories, F. V. Hayden, U. S. Geologist, Miscellaneous Publications, No. 8.

————Fur-bearing animals. A monograph of North American *Mustelidæ*. Elliott Coues, Washington, Government printing office, 1877.

1877. **Coues, Elliott, and Allen, Joel Asaph,** U. S. Geographical Survey of the territories.

————Monographs of North American *Rodentia*. Elliott Coues and Joel Asaph Allen. Washington, Government printing office, 1877.

1881. **Langdon, Frank W.** The mammalia of the vicinity of Cincinnati. Journal of the Cin. Soc. N. H., January 1881, pp. 297–313.

A list of species with notes. References to Indiana mammals.

———— Editor. Canis lupus, Lutra canadensis, Cariacus virginianus, Atalapha cinereus, Sciurus carolinensis leucotis, Sciurus niger ludovicianus, Tamias striatus, Lepus sylvaticus. Journ. Cin. Soc. N. H.

Mentions specimens from Indiana.

1881. **Quick, E. R.** Hesperomys lecucopus Leconte. Jour. Cin. Soc. N. H., vol. IV., p. 337.

Albino specimen from Brookville, Indiana.

1882. **Langdon, F. W.** A synopsis of the Cincinnati fauna. Zoological Miscellany, Journ. Cin. Soc. N. H., vol. V, No. 3, pp. 185–194.

Includes mammals.

1882. **Brayton, A. W.** Report on the mammals of Ohio. By Alembert W. Brayton, M. D. Report of the Geological Survey of Ohio, vol. IV., Zoology and Botany, pp. 1–185.

Refers to Indiana specimens.

1882. **Quick, E. R.** Arvicola riparius Ord. Journ. Cin. Soc. N. H., vol. V, p. 52.

Reference to specimens from Brookville, Indiana.

————Mammals found in Franklin county, Indiana. Atlas of Franklin county, Indiana. J. H. Beers & Co., Chicago, 1882, pp. 9–10.

1883. **Langdon, Dr. F. W.** Bibliography of the Cincinnati fauna Journ. Cin. Soc. N. H., vol. VI, 1883, pp. 5–53.

Includes mammalia.

1884. **Cope, E. D. and Wortman, J. L.** Post-pliocene vertebrates of Indiana. Fourteenth report of the State Geologist. Part II, pp. 1–62.

1884. **Butler, A. W.** Local Weather Lore. American Meteorlogical Journal, Dec. 1884, pp. 313–316.

Proverbs relating to mammals noted.

————Local Weather Lore. Proc. A. A. A. S., vol. XXXIII, pp. 609–613.

Abstract of above.

1885. **Quick, Edgar R. and Butler, A. W.** The habits of some Arvicolinæ. American Naturalist, vol. XIX, 113–118.

Notes on *S. cooperi, A. pinetorum, pennsylvanicus* and *austerus.*

————The habits of some Arvicolinæ. Proc. A. A. A. S., vol. XXX, in 1884, pp. 539–542.

Abstract of above.

1885. **Butler, Amos W.** Observations on the Muskrat. Proc. A. A. A. S., vol. XXXIV, pp. 324–328.

Abstract of next paper.

————Observations on the Muskrat. The American Naturalist, vol. XIX, Nov. 1885, pp. 1044–1055.

————Observations on faunal changes. Bull. Brookville Soc. Nat. Hist. No. 1, pp. 5–13.

Refers in part to mammals.

1886. ———The common Meadow-mouse. Indiana Farmer, Jan. 9, 1886, p. 7.

————Some more mice. Indiana Farmer, March 6, 1886, p. 3.

————Meadow-mice in Southeastern Indiana. The Hoosier Naturalist, vol. I, pp. 144–145.

————The periodical cicada in Southeastern Indiana. U. S. Dept. of Agriculture, Division of Entomology, Bull. No. 12, pp. 24–31.

Notes mammals that were found feeding on cicadas.

1887. ———Zoological miscellany. Jour. Soc. Nat. Hist., Cincinnati, January, 1887.

Notes on the common Meadow-mouse *Arvicola riparius,* and the common Mole, *Scalops aquaticus.*

1888. ———Zoological miscellany. Jour. Soc. Nat. Hist., Cincinnati, January, 1888.

Notes the occurrence of the Star-nosed Mole, *Condylura cristata* in Indiana.

1888. **Evermann, B. W.** The occurrence of the Star-nosed Mole (*Condylura cristata*) in Indiana. American Naturalist, vol. XXII, p. 359.

1891. **Butler, A. W.** Our smaller mammals and their relation to Horticulture. Transactions Indiana Horticultural Society, 1891, vol. XXXI, pp. 117–123.
Repaged and issued separately.

1892. ———Our Indiana shrews. Proc. Indiana Acad. of Science, 1891, pp. 161–163.

1892. **Merriam, Dr. C. Hart.** The occurrence of Cooper's Lemming Mouse (*Synaptomys cooperi*) in the Atlantic states. Proc. Biol. Soc. of Washington, vol. VII, 1882, pp. 175–177.

1893. **Fisher, A. K., M. D.** The Hawks and Owls of the United States in their relations to Agriculture. U. S. Dept. of Agriculture, Division of Ornithology and Mammalogy, Bulletin No. 3.
Refers to mammals used as food.

1892. **Dury, Charles.** Zoological notes. What I found in the nest of a field mouse. Journ. Cin. Soc. Nat. Hist., 1892, p. 183.

1893. **Cox, Ulysses O.** A list of the birds of Randolph county, Ind., with some notes on the mammals of the same county. Ornithologist and Oologist, vol. XVIII, pp. 2–3.

PRELIMINARY LIST OF INDIANA MAMMALS.

1. *Didelphis virginiana* Shaw. Common Opossum.

Randolph county (Cox).

Wabash county. Specimen in Galbraith's collection.

Benton county. One sent me from there the winter of 1889–90.

Carroll county, Vigo county, Monroe county. I have seen it in all of these counties (Evermann).

Parke county. W. S. Blatchley's brother caught seven in one night the fall of 1890 near Rockville. Very plenty (M. H. Anderson). Many are brought in every winter to the market at Terre Haute.

Pike county. (Abundant), Indiana Farmer.

Howard county. Formerly abundant until the winter of 1855–6, when they were almost exterminated by severe winter. Since that time have been very scarce. One seen winter of 1885–6 (A. W. Moon).

Huntington county. Wm. E. Bardsley reports an opossum killed near Pleasant Plain the winter of 1892–3.

Hendricks county. Unusually abundant near Hadley winter of 1892–3. Reported in Indiana Farmer, Feb. 4, 1893, (A. Hadley).

Franklin county. Have not been noticeably abundant for a number of

years, until 1892, when quite a number were reported, even coming into Brookville and killing poultry.

Miami county. Abundant until the winter of 1854 (I think it was). Only a few have been seen since (Oliver Borden).

Porter county. Opossums are becoming numerous in this section of the state (R. B. Trouslot).

St. Joseph county. A number found winter of 1892–3 (H. H. Swain).

Dr. Jordan, in his Manual, says the first toe is without a claw. I have a specimen that has a well-developed claw on each of the first three toes (Evermann).

2. *Lepus sylvaticus* Bachman. Cotton-tail.

Abundant all over the state. Two young ones found at Brookville, January 8, 1890.

3. *Lepus campestris* Bachman.

Mr. Chas. L. Reynolds, of Frankfort, informs me that he mounted one that was taken near Chauncy, in the summer of 1888. The specimen is now in the possession of Mr. Max Spring, a stationer, of La Fayette.

In the winter of 1876–77, I was told that an unusual rabbit was caught near Prince William, in Carroll county (Evermann).

4. *Erethizon dorsatus* (L.). Canada Porcupine.

Mr. C. L. Reynolds says he saw a porcupine on the Wild Cat creek, near La Fayette, about eleven years ago. Dr. Haymond gives it in his mammals of Franklin county. Mr. E. R. Quick reports it having occurred several years since. My mother gave me a vivid account of a fight between a dog and a porcupine which she witnessed in Franklin county forty or more years ago (Butler).

La Grange county (S. D. Steininger, 1860–1870).

Huntington county. Formerly observed; none reported in past seven or eight years (W. E. Bardsley).

Grant county. In the fall of 1892 a fine specimen of the porcupine was taken near Marion (E. L. Guthrie).

Randolph county. Quite common twenty years ago, now not found (Cox).

5. *Zapus hudsonicus* (Zimm.). Jumping Mouse.

Mr. A. J. McCarthy, of Burlington, Carroll county, says in the spring of 1890 he caught three mice that had very long tails and very long hind legs, but short fore legs. They were seen by J. M. Beck also.

They are, apparently, jumping mice. Mr. A. B. Ulrey reports a specimen from Wabash county in Mr. Galbraith's collection.

La Grange county. According to S. D. Steininger.

Reported by Ernest W. Vickers from Mahoning county, Ohio.

Vigo county. Terre Haute, 1889 (W. S. Blatchley).

Stark county. Rather common, frequenting wild sod (Amos P. Atwood).

Knox county. Not uncommon, especially in the low prairie lands along the Wabash river (J. M. Risley).

Howard county. Rare. Only two seen in a lifetime (Isaac F. Street).

6. *Geomys bursarius* (Shaw). Pocket Gopher.

Mr. W. W. Archibald, of Newton county, tells that "a brown pouched gopher is found in that county, but it is not common" (Evermann).

7. *Fiber zibethicus* (L.). Muskrat.

Carroll, Monroe, Franklin and Vigo counties. It seems common in Vigo county. In the Five-mile pond, near Terre Haute, I counted 140 houses the other day, and in the Goose pond, ten miles south of Terre Haute, I have seen many houses. A trapper, near the Goose pond, told me that for several years he had caught about 160 each year at this pond (Evermann).

La Grange county (S. D. Steininger).

Wabash county (Ulrey).

Randolph county (Cox). Common.

Fayette, Fulton and Marshall counties.

The paper by one of the authors on the habits of the muskrat, published in the American Naturalist, November, 1885, gives the result of the observations of the writer in the White Water valley.

8. *Synaptomys cooperi* Baird. Lemming Mouse.

Franklin county. Identified by Dr. Haymond at Brookville thirty-five or more years ago. Its range appears to be quite restricted. It has been found on Brown's hill, southeast of Brookville, and along the bluffs for a mile and a half northwest of Brookville. From the stomach of a hawk killed in the eastern part of the county was obtained the skull of one of these mice. This mouse is considered to be quite a rare mammal. In 1878 Mr. E. R. Quick discovered its presence in numbers.

Brown county, Nashville, (Jordan).

Washtenaw county, Ann Arbor, Mich. Taken by Prof. J. B. Steere. He

informs me he does not know of its occurrence elsewhere in the state. At Ann Arbor it is confined to a very restricted locality.

9. *Arvicola pinetorum* (Le C.). Pine Mouse.

Franklin county. To Mr. Quick belongs the credit of obtaining the first reported pine mice from Indiana. In certain localities they are some years plentiful enough.

Vigo county. Terre Haute, Nov. 3, 1890; spring 1891.

Randolph county. Farmland, Jan. 1891. (U. O. Cox).

Wabash county. One specimen, North Manchester (A. B. Ulrey).

10. *Arvicola austerus* (Le C.).

Franklin county. A few specimens have been taken, but it does not appear to be abundant.

Vigo county. Terre Haute, May 1, 1891.

11. *Arvicola pennsylvanicus* Ord. Meadow Mouse.

Franklin, Carroll, Wayne, Vigo and Randolph counties.

Apparently common wherever reported. The most common meadow mouse.

Clinton county. A partial albino taken by C. J. Reynolds at Frankfort in 1890.

12. *Mus rattus* L. Black Rat.

Introduced into America about 1544, but is now being replaced by the succeeding. Included by Dr. Haymond in 1869, Franklin county. None have been reported since.

13. *Mus decumanus* Pallas. Brown Rat; Norway Rat.

Our common rat. Introduced into America about 1775. Appeared in Brookville in the summer of 1827 (Haymond).

14. *Mus musculus* (L.). House Mouse.

Our common species. Introduced—cannot learn the date of its introduction.

15. *Evotomys rutilus gapperi* (?) Coues. Long-eared Mouse.

There is a specimen in the collection of C. L. Reynolds at Frankfort which seems to belong to this species. It was taken near Montmorenci, Tippecanoe county, in 1889.

16. *Calomys americanus* Kerr. Common White-footed Mouse.

Carroll, Monroe and Vigo counties.

I have often caught an old female with young hanging to her teats and carried her by the tail for many rods before the young would drop off. (Evermann).

La Grange county. (Steininger).

Franklin county. Very common. They often infest the dwellings and outbuildings of the country residents. Sometimes nest in woodpecker holes or other cavity in an old snag.

Randolph county (Cox).

17. *Castor fiber* (L.). Beaver.

This was certainly rather common in Indiana in early days. "Beaver lake" was, no doubt, so named because of the presence of beavers there. Mr. C. L. Reynolds says he saw a beaver swimming in the Wabash river about twelve miles above La Fayette, in the summer of 1889. He says he is sure of it. In Sept., 1888, I saw a skull in Mr. Sampson's collection at New Harmony, that was taken near there not many years ago (Evermann).

Mr. S. D. Steininger says there are traces of the beaver still to be seen in La Grange county.

Beavers were formerly found in some numbers in Franklin county. In Bath and Springfield townships were extensive colonies, and the remains of their dams are still to be seen. They were also found along the rivers. In the spring of 1883 Mr. Edward Hughes obtained the skull of a beaver from the alluvial deposit at the mouth of Yellow Bank creek four miles from Brookville. The specimen is in the collection of the Brookville Society of Natural History.

Randolph county. Extinct. Traces of beaver dams still found (Cox).

18. *Arctomys monax* (L.). Ground Hog.

Franklin, Carroll, Monroe and Vigo.

Randolph county (Cox).

Wabash county (Ulrey).

La Grange county (Steininger).

Generally very abundant and very destructive.

19. *Spermophilus tridecemlineatus* (Mitchill). Striped Gopher.

In the summers of 1883 and 1884 I saw perhaps three or four individuals in Tippecanoe township, Carroll county, just west of Pittsburg. In Vigo county it seems to be rather common. I have the skin of one taken near Terre Haute, a few years ago, and given me by Miss Ida Lawrence. Mr. W. S. Blatchley has one taken just north of Terre Haute, in the spring of 1888. Last spring I saw one alive southeast of Terre Haute, and in June last I saw a dead one hanging on the fence, five miles south of the city.

Miss Helen Rankin, who lives three miles north of Terre Haute, tells

me that it is seen on their farm every summer. [Evermann.]

Mr. C. L. Reynolds has one that was taken near La Fayette. He says he has seen them in the grounds of Purdue University.

Mr. W. W. Archibald says it is pretty common in Newton county.

La Grange county (Steininger).

Benton county. Has been reported from both Benton and White counties by Mrs. D. C. Ridgley.

White county. Mr. Charles Dury informs me there are some specimens in the Cuvier club collection, Cincinnati, Ohio, that were taken at Chalmers.

Mr. Jas. O. Dunn reports having kept two striped gophers in a cage for nearly a year.

Dr. C. Hart Merriam informs me that Robert Potter sent him a specimen of this species taken at Austin, Oakland county, Mich., and further that he received a specimen from J. W. Anderson, Lakeville, Oakland county, Mich.

Found in some numbers by Dr. R. M. Byrnes, in 1862, near Middletown, Butler county, Ohio. See Langdon Mammalia of the vicinity of Cincinnati.

20. *Spermophilus franklini* Sabine. Gray Spermophile.

Remington, Jasper county. Abundant.

Monticello, White county (Jas. O. Dunn).

This is the first reported occurrence in Indiana. Further notes on its range in the state are desired.

Dr. C. Hart Merriam informs me that the U. S. Department of Agriculture received a specimen of *S. franklini* in flesh from R. Carroll, Earl Park, Benton county, Indiana, also that J. B. Chesebrough reported its occurrence at Kentland, Newton county. Dr. Merriam writes he has two records, one from Robert Potter, Austin, Oakland county, and the other from J. W. Anderson, of Lakeville, Oakland, county, Mich.

21. *Tamias striatus* (L.). Ground Squirrel.

Carroll county. Abundant.

Monroe county. Abundant.

Vigo county. Abundant.

Wabash county (A. B Ulrey).

Randolph county (U. O. Cox). Common.

Franklin county (Haymond; Butler).

La Grange county (Steininger).

22. *Sciurus hudsonicus* Erxleben. Red Squirrel. Chickaree.

Miami county (J. C. Cunningham).

Fulton county. Shot one near Kewanna, 12-24-'89.

Wabash county (Ulrey; Blatchley).

Randolph county (Cox). Occasionally seen.

Blackford county (Cox). Abundant.

Franklin county (Haymond).

La Grange county (Steininger).

Huntington county. The most common squirrel. Some neighbor boys raised fourteen young in 1892 (W. E. Bardsley).

23. *Sciurus carolinensis carolinensis* Allen. Southern Gray Squirrel.

Franklin county. Some years quite common in this part of the state. Both forms are found here. The gray squirrel is still plenty enough to be extensively hunted.

24. *Sciurus carolinensis leucotis* Gapper. Northern Gray Squirrel.

Carroll county. Formerly abundant.

Monroe county. Not common now.

Vigo county. Not common now.

Wabash county (Ulrey).

Randolph county (Cox). Common in places.

Franklin county (Haymond).

This squirrel is now much less common than it was fifteen to twenty-five years ago. I have for five years watched the Terre Haute market, and in all that time I have not seen over a dozen gray squirrels, while hundreds of fox squirrels were seen. The few gray squirrels that I did see in the market here came from the lower Wabash somewhere (Evermann).

La Grange county (Steininger).

This form with the other is found in Franklin county, though the numbers vary from year to year.

I myself have not seen a black squirrel for many years, though they were not rare in Carroll county when I was a boy.

It is now agreed that the Black Squirrels are a form of the Northern Gray Squirrel. They were formerly quite common in southeastern Indiana, but are now never seen. The lessening of the numbers of this form, *leucotis*, and the increase of the numbers of the southern form, *carolinensis*, is noted by most of the inhabitants. The older men speak of the disappearance of the black and of the gray squirrels "we used to have," and of the appearance of the reddish gray squirrels, which they term a cross between

the gray and the fox squirrels. Dr. Haymond, 1869, says: "Years ago there were about one-sixth of the squirrels in southeastern Indiana black; in northeastern Indiana nearly half of them were black. There are no black squirrels to be seen in southeastern Indiana, neither has there been for several years. * * The further north I have gone in this state the more black squirrels I have seen." In 1872 the last black squirrel was seen in Franklin county.

25. *Sciurus niger ludovicianus* Allen. Fox Squirrel.

Carroll, Monroe and Vigo counties. Still common in each of these counties.

Wabash county (Ulrey). One in Galbraith's collection with the under parts black.

Randolph county (Cox). One killed near Farmland last summer that was about half black. An uncle of Mr. Cox, several years ago found a nest of young fox squirrels, of which two were red, two white and two black.

Last year a white (albino) squirrel was sent me from Bloomington. It was taken in Brown county.

Two white squirrels were seen occasionally on Coal creek, in Vigo county, last year.

QUERY.—Do we not find melanism and albinism in both gray and fox squirrels?

Fox squirrels remain about stationary as to numbers in Franklin county. Generally the gray squirrels are much more frequent. Albino examples are met with almost every year.

26. *Sciuropterus volans* (L.). Common Flying Squirrel.

Carroll, Monroe and Vigo counties. I have never found this squirrel very common in any of these counties.

April 16, 1890, I found a nest containing two young, south of Terre Haute. They were in a woodpecker's hole in a maple snag, about twenty feet from the ground. I broke the snag at the hole and took the two young and placed them on the ground near the root of the tree. The mother had come out of the hole upon my first striking the tree and flown to another tree near by, where she remained, watching my movements. After some little time, she flew back to the snag. Of course, she seemed disturbed by the changed appearance of things. She looked all about, and finally came down to the ground, took one of the young in her mouth, and ran up to the top of the snag. Pretty soon she flew across to

another tree, perhaps thirty feet away, with the young one in her mouth, and ran up the tree to, perhaps a height of fifty feet, where she found a knot-hole into which she carried the young. In a moment she reappeared and flew back to the snag after the other young. I had, in the meantime, stationed myself by the young, ready to catch the old one when she came to seize it. After several advances and retreats, she finally came and seized it in her mouth and was putting up the snag when I caught her.

On December 16, 1890, I received three live ones from Burlington, Carroll county, that had been caught by J. M. Beck. In felling a tree he found a family of six, three of which he caught and sent to me.

Randolph county. Mr. Cox reports it not so common as it was formerly. He says that on Thanksgiving day, a few years ago, he found fifteen in a small rotten stump, a little higher than a man's head.

Wabash county (Ulrey). This squirrel makes a very interesting pet.

Franklin county. Very abundant in Franklin county. They breed during the sugar-making season in early spring. It is remarkable what a number of these animals can be found by going from snag to snag and pounding upon it at that time of the year. I have found their nests in woodpecker's holes in tall sycamores and in various buildings, including dwellings.

La Grange county (Steininger).

27. *Blarina brevicauda* Say. Mole-shrew.

Carroll, Monroe and Vigo counties.

Tippecanoe county. (Reynolds' collection.)

I have seen a good many of these shrews in Monroe county, and a few in Carroll and Vigo. On two occasions I put a shrew and a white-footed mouse in the same tin can, with the same result each time—the shrew ate the mouse (Evermann).

La Grange county (Steininger).

Franklin county. Common.

See my paper "On Indiana Shrews," Proc. Ind. Academy of Science 1891, pp. 161–3, for an account of the insects that were found by Chas. Dury in a nest of this species. (Butler).

Vigo county. One specimen, spring 1891.

Randolph county, 1891 (Cox).

28. *Blarina exilipes* (Baird).

I have seen but four specimens of this little shrew, all of which were

taken by Mr. H. M. Hawley, near Terre Haute. The first one was brought me by him Jan. 18, 1890, the next Oct. 1, 1890 and the next Oct. 10, 1890. Mr. Hawley says it is not very common about his place, but that his cat manages to catch four or five every year. He calls it the bee mole, because it gets into his bee hives and there builds its nest and feeds upon the brood (Evermann).

Franklin county. Sometimes taken.

Randolph county. Farmland, winter 1890 (U. O. Cox).

29. *Blarina platyrhinus* (DeK.). Common Shrew.

Wabash county. A specimen of this shrew was taken by Mr. A. B. Ulrey at North Manchester. This is the only reported occurrence in the state.

30. *Blarina parva* (Say). Least Shrew.

Franklin county (Butler).

Two small shrews, submitted by Mr. E. R. Quick to Dr. Langdon, were referred to Dr. Coues. That gentleman, Jan. 15, 1879, wrote Dr. Langdon: "I have not the slightest doubt that you have the veritable animal of Say (*Sorex parva*) in the specimen you send." It is not uncommon about Brookville.

Marion county (Jordan). Brayton, Ohio Mammals.

Ann Arbor, Washtenaw county, Mich. Reported by Prof. J. B. Steere who, however, informs me that he is not certain of its identity.

31. *Blarina cinerea* (Bach.). Cinereus Shrew.

Jefferson county. A dead shrew, found by me near Hanover, in 1877 was referred to the late Prof. S. F. Baird, and he returned it, saying that it was this species.

32. *Scalops aquaticus* (L.). Common Mole.

Carroll, Monroe and Vigo counties (E).

Tippecanoe county (Reynolds).

Randolph county (Cox).

Franklin county (Haymond; Butler). Many moles taken here are more or less marked with white on throat and lower parts.

Rather common in all the above named counties.

La Grange county (Steininger).

33. *Condylura cristata* (L.). Star-nosed Mole.

The first specimen of this mole taken in Indiana was secured by Mr. J. C. Cunningham, near Denver, Miami county, July 5, 1887. The taking of this specimen was reported by Mr. Evermann at the meeting of the

Academy in December, 1887, this note being afterward published in the American Naturalist, vol. XXII, p. 359. Mr. Butler also examined the specimen and reported it in Journal of the Cincinnati Soc. Nat. Hist. for January, 1888, p. 214. The specimen was deposited in the Museum of the Indiana State Normal School, but was lost in the fire of April 8, 1888.

Miami county. Mr. Wm. Heddleson near Deedsville, captured a Star-nose Mole, March 19, 1894. The specimen is now in possession of Mr. C. F. Fite of Denver. (J. C. Cunningham).

Ernest W. Vickers, Ellsworth, Mahoning county, Ohio, informs me of the occurrence of this species in that county, also in Cuyahoga county near Cleveland.

Prof. J. B. Steere informs me the Star-nosed Mole is abundant at Ann Arbor, Mich. in low swampy ground which has been drained. He has also taken it in Ionia county, Mich.

34. *Vespertilio gryphus* Fr. Cuv. Little Brown Bat.

Carroll county, Monroe county, Vigo county. Common in all of these counties. (E.)

Wabash county. Ulery's collection.

Tippecanoe county. Reynold's collection.

Clinton county. Collection of Mr. Al. Keyes.

La Grange county (Steininger).

Franklin county (Haymond). The most common bat in southeastern Indiana.

35. *Vespertilio gryphus lucifugus* (LeC.).

Vigo county. A specimen taken at Terre Haute in 1889. (Evermann).

36. *Lasionycteris noctivagrans* (Le C.). Silvery Bat.

LaPorte county. I have a specimen taken near Michigan City, May 10, 1890, and presented to me by Mrs. D. C. Ridgley.

Franklin county. Has been taken by E. R. Quick.

Marion county. Two specimens in the collection of W. P. Hay, Irvington. One taken in 1886, the other in 1889.

37. *Adelonycteris fuscus* (Beauv.). Brown Bat.

Vigo county. A specimen taken by me in 1889 at Terre Haute. (Evermann).

Franklin county. Identified by Mr. Quick.

38. *Atalapha noveboracensis* Erxleben. Red Bat.

Carroll county, Monroe county, Vigo county. Rather common in all these counties.

Wabash county. Ulrey's collection. Took one at Terre Haute, Sept. 8, 1890.

Franklin county (Haymond). Next to the Little Brown Bat this is perhaps the most common species in southeastern Indiana.

39. *Atalapha cinerea* (Beauvais). Hoary Bat.

White county. A specimen taken in White county (1890) by Miss Eva Chamberlain.

Franklin county (Haymond). Has been taken by E. R. Quick.

40. *Vesperugo carolinensis* (Geoff.). Carolina Bat.

Franklin county. Identified by Mr. Quick.

41. *Cariacus virginianus* (Boddaert). Virginia Deer.

Commmon in the early days.

Franklin county (Haymond—1847, Butler). I have no recent records, unless La Grange county, 1870, (Steininger) be alright.

Ripley county. Only few years ago. (Butler).

42. *Cervus canadensis* Erxleben. Wapiti; Elk.

Franklin county. Was found comparatively rarely in the White water region at the time of its settlement and soon after disappeared. I have evidence of its occurrence in Ripley county subsequent to 1810. Its former abundance was indicated early in the century by the great numbers of antlers to be found in the beds of the streams most of which soon disappeared, but often they are still found buried beneath the surface of the soil.

43. *Bison bison* (L.). Bison; Buffalo.

The Buffalo is on the seal of the state of Indiana, and was no doubt found in the state in an early day. Allen, in Ninth Report of the U.S. Geological and Geographical Survey, 1875, pp. 502, etc., gives all that he could find as to its former distribution in North America. From this it appears that it was at one time abundant over large portions of Indiana. Charlevoix, writing in 1720, says "all the country that is watered by the Ouabache and by the Ohio which runs into it, is very fruitful. It consists of vast meadows, well-watered, where the wild Buffaloes feed by thousands." Vaudreuil, writing about the same time, and La Hontan who saw Lake Erie and the surrounding country in 1687, also speak of the Buffalo as being abundant in this region then. See also Audubon's article on the Buffalo given in The Life of Audubon by Mrs. Horace St. John.

Franklin county. Only the earliest settlers and they but once, so far as can be learned, reported the occurrence of the Buffalo in this county

about four miles southeast of Brookville. The last one reported from Ohio was in 1795. They doubtless left Indiana about 1800. That they once were very abundant in the Ohio valley is shown by the abundance of their remains at "Big Bone Lick" in Kentucky. The earlier explorers, too, tell us of their numbers. Col. Croghan, in May, 1765, speaking of Kentucky just below the mouth of the Big Miami river, on the way to "Big Bone Lick," says: "On our way we passed through a fine timbered clear woods: we came into a large road which the Buffaloes have beaten, spacious enough for two waggons to go abreast, and leading straight into the Lick."

44. *Procyon lotor* (L.). Raccoon

Carroll county, Monroe county, Vigo county. Formerly more common than now.

Wabash county (Ulrey). Galbraith's collection.

Randolph county (Cox). Very abundant.

Franklin county. Still found in some numbers.

La Grange county (Steininger).

45. *Ursus americanus* Pallas. Brown, Black or Cinnamon Bear.

Franklin county. No doubt common in Indiana at one time, but there are few exact records. The last Bear was seen in Franklin county about 1839. A few years ago the skull of a bear was found in a hollow tree. It was brought to Dr. Haymond, who turned it over to Mr. Butler. It is now in Mr. Quick's collection.

La Grange county, 1878 (Steininger).

46. *Lutra hudsonica* (Lacépède). American Otter.

Franklin county (Haymond). Mr. C. L. Reynolds tells me that a Mr. Wells, at La Fayette, has an otter that was killed near there not many years ago. It occurred at Venice, Butler county, several years ago. (Dury.)

47. *Mephitis mephitica* (Shaw). Skunk.

Carroll County, Monroe county, Vigo county. Not uncommon in each of these counties, though less so than formerly.

Randolph county. Not common. (Cox).

Wabash county (Ulrey).

La Grange county (Steininger).

Franklin county. Still abundant. E. R. Quick reports the capture of a fine black male in the winter of 1892–3. This seems to be unusual as the general impression is that the males are usually light col-

ored. Is this impression correct?

48. *Taxidea americana* (Boddært). American Badger.

One was killed 2 miles east of Quaker Hill, or 5 miles southwest of Newport, Vermillion county, in 1880, by a cousin of S. B. McCool of Quaker Hill. Reported by Mr. F. T. Peters. Mr. S. D. Steininger, says "the badger has been found in Elkhart, La Grange, Steuben, De Kalb, Noble and Kosciusko counties. Four have been caught in La Grange county within the last ten years, the last one in 1887. Three were caught in the northeast part of Elkhart county in 1888. In 1880 a black one was caught in Noble county, the hide of which was sold to Chas. Edson.

Grant county. A badger was reported taken but could not verify it (E. L. Guthrie).

Franklin county. July 28, 1889 a badger was killed near Metamora. Upon examining it the gentleman who killed it said two others had been taken the preceding year (1888).

49. *Putorius vison* (Schreber). Mink.

Carroll county, Monroe county, Vigo county. I have seen it occasionally in each of these counties. (Evermann.)

Wabash county (Ulrey). Galbraith's collection.

Randolph county. Common (Cox). Mr. Cox reports that a mink killed 24 half-grown chickens for him in one night two years ago. Each chicken was bitten only through the head.

Tippecanoe county. Reynold's collection.

La Grange county (Steininger).

Franklin county. Not uncommon in certain locatities, especially about drift piles along streams. Last year, 1893, the writer saw three minks at one time in daylight about a drift pile within the corporate limits of the town of Brookville. *Putorius nigrescens* (A. and B.). Little Black Mink is not now thought to be a distinct species. Both forms are found in Franklin county.

50. *Putorius erminea* (L.). Weasel.

Carroll county, 1878; Monroe county, 1883; Vigo county, 1890. I have seen the weasel in each of these counties, but never found it common (Evermann).

Wabash county (Ulrey). Galbraith's collection.

Randolph county (Cox). Occasional.

La Grange (Steininger).

Franklin county. Not uncommon. Some reported every year.

51. *Vulpes vulpes* (L.). Red Fox.

Carroll county, Monroe county, Vigo county. Rather common in each of these counties. In Vigo county several "fox drives" are had every winter and from none to three or four foxes caught each time.

Wabash county (Ulrey). Galbraith's collection.

Randolph county. Common. Cox.

La Grange county (Steininger.)

Franklin county. According to Dr. Haymond the Red Fox came into the county about forty years ago. Previous to that time the gray form only was found. They are numerous. Fox drives were much in vogue a few years ago but none have been had for several years.

52. *Urocyon cinereo-argentatus* (Schreber). Gray Fox.

Franklin county. These foxes are numerous; probably as much so as they ever were. (Haymond, 1869). They are still found but are rare. Their shy habits perhaps make them appear less numerous than they are.

53. *Canis lupus* (Say). Wolf.

Periodical reports of "wolves" are heard, but there is no definite record that I have seen. One was said to be in Clay county in 1890.

Franklin county. Formerly found in numbers. Wolves have been reported killed within twenty or twenty-five years but the greater number had disappeared before that time.

Lake county. Several wolves said to be "Prairie Wolves" found along the Kankakee river in the last two years. (M. A. Brannon, 1890).

54. *Lynx canadensis* (Desmarest). Canada Lynx.

Mr. C. L. Reynolds tells me he mounted a Lynx that was killed in 1885, 7 or 8 miles west of Chauncey, Tippecanoe county.

La Grange county, 1875 (Steininger.)

Montgomery county. One was killed Nov. 22, 1890 near Garfield. (David Binford.)

Franklin county. Was formerly found but never common.

55. *Lynx rufus* (Guldenstädt). American Wild Cat.

Franklin county. In 1869 Dr. Haymond noted "occasionally seen but rare." That was about the end of their existence in this county. Wild cat reports are seen in the papers almost every winter. Definite records are needed.

56. *Felis concolor* L. American Panther.

Franklin county. Formerly found. Known to the early settlers as Pan-

ther, Painter, Cougar, Catamount. Never was common. But few have been seen since 1835. Two young were taken east of Brookville in 1838. None have been reported for thirty years or more. Other definite records needed.

SPECIES CONCERNING WHICH FURTHER KNOWLEDGE IS DESIRABLE REGARDING THEIR POSITION IN THE INDIANA FAUNA.

Nycticejus humeralis O. Thomas. Twilight Bat. Pennsylvania to Nebraska and South.

Scapanus americanus (Bartram). Hairy-tailed Male. Massachusetts to Ohio. Adams county, Ohio.

Scalops argentatus A. and B. Prairie Mole. Silvery Mole. Michigan to Louisiana and West.

Neosorex palustris (Rich.). Water Shrew. Massachusetts to Rocky Mountains and North.

Sorex forsteri (Rich.). Forster's Shrew. Northern U. S. to Pennsylvania.

Sorex cooperi Bach. Cooper's Shrew. Massachusetts to Nebraska and North.

Brachysorex harlani (Duver.)

Brachysorex brevicaudatus (Duver.)

Amphisorex leseurii (Duver.)

These three last species were described by Duvernoy in 1842. The two former from New Harmony, Ind. The latter from Wabash valley, Ind. Their present relationship are not known.

Ochetodon humilis (A. and B.). Harvest Mouse. South Carolina to Iowa, Utah and South.

Calomys palustris Harlan. Rice-field Mouse. New Jersey to Kansas and South. Madisonville, Hamilton county, Ohio, 1876 (Langdon).

Calomys michiganensis (A. and B.). Michigan Field Mouse. Michigan to Illinois and Kansas.

Calomys aureolus (A. and B.). Red Mouse. Pennsylvania to Illinois and South.

Neotoma floridana Say and Ord. Wood Rat. New York to Colorado, Arizona and South.

Lepus palustris Bach. March Hare. North Carolina to South Illinois and South in Swamps.

Lepus aquaticus Bach. Water Hare. South Illinois to Louisiana and Southwest in canebrakes and about lowland streams.

Mephitis putorius (L.). Little Striped Skunk. Wisconsin to Georgia and Southwest.

A CONTRIBUTION TO A KNOWLEDGE OF INDIANA MOLLUSCA.

By R. Ellsworth Call.

The wonderful diversity of physical features in Indiana contributes to the development of an interesting molluscan fauna. Swamp, pond, creek and river each presents forms or groups of forms characteristic of such stations; hillside, river bottom, prairie, contributes each its own peculiar species. So that in a state of such widely different natural conditions it is not surprising that a great array of forms, most of which are by no means conspicuous, should have been discovered.

There has never been made a geographic study, within this state, of its mollusks. Nor have systematic collections ever been made of so much as even a single stream. One could name on the fingers of the hands the men and the places which have thus far yielded our sole knowledge of Indiana mollusks. It is the object of this paper to state, in a few words, the present condition of our information in this line and to indicate if possible, the direction along which future effort should be made.

It does not need words of mine to demonstrate that the first essential condition to a complete study of the geographic distribution of Indiana mollusca lies in complete and painstaking local collections. This is not the task of a week nor of a single season. The habits of our mollusks are so peculiar that certain seasons present sometimes many forms which fail to appear again for several successive years. Often, even in the case of the most common species, numbers of individuals are spasmodically great; then years go on and few of certain forms are to be found. No less interesting will be the life history of these retiring animals. Not the life history of a single Indiana species is known. And, so far as my information goes, there is not a student in the state who is doing more than collect the pretty and variously ornamented shells that they may grace a cabinet! What their biological significance may be in that great sum which makes up the animal life of Indiana no one seems to be investigating.

A further necessity for immediate action that the original inhabitants of the state may be listed lies in the danger of extinction of very many forms. The sewerage of towns and villages, the refuse of factories and other manufacturing plants, the gradual encroachment on the primitive forests, the drying up of streams, the drainage of swamps, the general increase in tilled lands, these all conspire against the chances of perpetuity of a rich molluscan fauna. What is done must be systematically done

and thoroughly and at once.

This "Contribution" seeks to do little more than to call attention to a neglected branch of animal life which will yield the student a mass of valuable data and prove a veritable mine of pleasure. In it there has been given simply, without attempt to discuss any scientific question, a list of the forms credited to the state. Very many of those mentioned have been seen within the state or in collections containing authentic specimens. Others are listed on the authority of undoubtedly correct writers. How much has been already accomplished and what yet remains to do the lists themselves will indicate.

The general plan of simply naming a single locality, at most two or three, has been followed in order that a definite locality within the state would fix the form as belonging to the Indiana fauna. Not a single form has been admitted that has been recorded from neighboring states notwithstanding that such a course would have been justifiable on the ground that the artificial lines imposed by state boundaries are unknown to mollusks, and species found in localities close to Indiana may reasonably be expected within its limits. This course would have largely increased our list, but it was preferred to make a record only of those shells known in the state. The student may rest assured that every species named herein has been found in Indiana and will be found again.

An attempt at a bibliography has been made. But works or papers dealing with our shells solely are very few in number. General works there are, quite numerous too, from which help may be had. These two classes of information are given below in separate lists. The paucity of literature pertaining to this state will be evident at a glance.

The Ohio river has been a prolific source of Unionidæ. From that stream come most of the forms of wide geographic distribution; indeed, most of them were originally made known from that river. The Wabash and the White rivers have contributed many forms but most of them are common to the Ohio. It has been the rule to insert in this list of Indiana shells all the species which were originally described from the Ohio whether there is special record of their occurrence within the limits of the state or not.

In every portion of the commonwealth it is hoped that persons will become interested in these animals sufficiently to collect locally and send to some central point what may be found, in order that a complete list, with distribution, varietal characters, and other facts of a biologic nature may

be eventually prepared. It is hoped every reader of this preliminary paper will become personally interested in the matter.

BIBLIOGRAPHY. A.—GENERAL WORKS.

This list includes general faunal lists and general descriptive works in North American Conchology. In all of them are to be found matters of more or less interest to the student of Indiana mollusca.

Poulson, C. A. A Monograph of the Fluviatile Bivalve Shells of the river Ohio, containing twelve genera and sixty-eight species. 1832.

A translation of Rafinesque's older work, which see.

Say, Thomas, F. M. L. S. American Conchology, or Descriptions of the Shells of North America. New Harmony, Indiana. 1830–1834.

Illustrated by colored figures from original drawings executed from nature.

Conrad, T. A. Monograph of the Family Unionidæ. 1835–1839.

Lea, Isaac. LL. D. Observations on the Genus Unio. 13 volumes, 4to. 1830-1874.

These volumes were originally published as portions of the Transactions of the American Philosophical Society and of the Journal of the Philadelphia Academy of Sciences. They were afterwards collated and issued separately under the above title.

———A Synopsis of the Family Unionidæ. Four editions. 1830–1870.

This work has almost a complete bibliography of the Unionidæ, particularly the American forms. There are also tables of geographical distribution, but these are little more than a mere list of the original localities for the American species.

Catalogue of the Unios, Alasmodontas and Anodontas of the Ohio river and its northern tributaries, adopted by the Western Academy of Natural Sciences of Cincinnati. January, 1849, pp. 19.

There are listed in this remarkable little brochure fifty-six species of *Unio*, six of *Margaritana*, and five of *Anodonta*. The catalogue is remarkable as being the first open expression hostile to the claims of both Say and Rafinesque. It marks the beginning of a long and bitter controversy, from the effects of which American malacology has not yet fully recovered.

Binney, Amos. Terrestrial Air-breathing Mollusks of the United States. Boston, 1851. Three volumes—text, two volumes; plates, one volume.

Lea, Isaac. Check list of the shells of North America. *Unionidæ*. Washington, 1860.

This is a mere list of species without definite locality references.

Prime, Temple. Check list of the shells of North America. *Cyclades*. Washington, 1860.

Same limitations as the work last cited.

Binney, W. G. Check list of the shells of North America. *Terrestrial Gasteropoda.* Washington, 1860. Second edition.

List number II of this work is general for that portion of the United States which includes Indiana.

——Check list of the shells of North America. *Fluviatile Gasteropoda.* Washington, 1860.

Rafinesque, Constantine Smaltz. The complete writings of, on recent and fossil Conchology. Edited by Wm. G. Binney and George W. Tryon, Jr. New York, 1864.

This work gives all the published work of Rafinesque in this department of science and is an indispensable adjunct where justice and fairness govern in determining the claims of authors. It has been misconstrued and misinterpreted: its value has not always been recognized.

Stimpson, William. Smithsonian Miscellaneous Collections. 201. Researches on the *Hydrobiinæ* and allied forms. Washington, 1865.

Prime, Temple. Smithsonian Miscellaneous Collections. 145. Monograph of American *Corbiculadæ*, recent and fossil. Washington, 1865.

Binney, Wm. G. Smithsonian Miscellaneous Collections. 143. Land and fresh water shells of North America. Part II. *Pulmonata Limnophila* and *Thallasophila.* Washington, 1865.

Tryon, George W., Jr. A Monograph of the Terrestrial Mollusca inhabiting the United States. New York, 1866.

Lea, Isaac. Rectification of T. A. Conrad's Synopsis of the Family of Naiades of North America. New edition. Philadelphia, 1872.

Tryon, George W., Jr. Smithsonian Miscellaneous Collections. 253. Land and Fresh-water shells of North America. Part IV. *Strepomatidæ.* Washington, 1873.

Harper, George W., and Wetherby, A. G. Catalogue of the land and fresh water Mollusca found in the immediate vicinity of Cincinnati, Ohio. Cincinnati, 1876.

This brochure, which originally appeared in the Journal of the Cincinnati Society of Natural History, is very valuable as an indicator of what the collector may expect in the Ohio along the shores of Indiana. It lists seventy-four *Unios*, eight *Margaritanas* and nine *Anodontas.*

Lewis, James, M. D. On *Unio subrostratus* Say. In Proceedings of the Academy of Natural Science of Philadelphia. 1878. Reprint, p. 4.

Contains some valuable information concerning a shell originally described from this state.

Binney, Wm. G. Terrestrial Air-breathing Mollusks of the United States and the adjacent territories of North America. Bull. Museum

Comparative Zoology. vol. IV. 2 volumes, 1878.

Call, R. Ellsworth. Geographic Distribution of the *Unionidæ* of the Mississippi Valley. Bull. Des Moines Academy of Science, vol. 1, number 1, pp. 5–56. 1885.

Binney, Wm. G. Bulletin United States National Museum, No. 28. A manual of American land shells. Washington, 1885.

Wright, Berlin Hart. Check list of North American *Unionidæ* and other fresh water bivalves. Portland, Oregon, 1888.

B.—LOCAL LISTS AND SPECIAL REPORTS.

Plummer, Dr. John T. Scraps in Natural History (Mollusca). American Journal of Science and Arts, O. S., vol. XLVIII, No. 1, pp. 93–96. 1844.

This paper gives a list of shells found about Richmond, Wayne county, Indiana. There are in it the names of twenty-one species of land shells, eight univalve fresh water forms, one *Anodon*, two *Margaritanas*, and one *Sphærium*.

Pleas, E. Shells of Henry county. In "The Nautilus," vol. VII, No. 6, pp. 68–70. 1893.

This paper lists fifty-nine species and varieties of land mollusks and sixty-four species and varieties of fresh water forms. They were all found within five miles of Dunreith. There will, doubtless, be some question of correct indentifications.

Department of Geology and Natural History. Indiana. 16th Annual Report, pp. 428–468. 1889.

This volume gives a mere list of the contents of certain cases in the State's Museum, and is absolutely valueless for any conceivable purpose. Many of the forms listed are, doubtless, from this state, but in the absence of locality references the list has no value to the student. The proof-reading is a marvel of carelessness.

Moore, D. R., and Butler, A. W. Land and fresh water Mollusca observed in Franklin county, Indiana. See Bull. of the Brookville Society of Natural History, No. 1, pp. 41–44. 1885.

This really valuable paper gives a list of some thirty-eight species and varieties of land shells, ten species of fresh water univalves, and fifteen species of fresh water bivalves. Of the latter, seven belong to *Unio*, three to *Margaritana* and four to *Anodonta*. One belongs to *Sphærium*.

Say, Thomas. Descriptions of several new species of shells and of a new species of *Lumbricus*. Transylvania Journal of Medicine, vol. IV. 1831.

On pp. 525–529 occur several descriptions of shells, among which one *Unio* (*Unio capillus*) from the Wabash river and one land shell (*Helicina occulta*) from near New Harmony are found.

Cox, E. T., State Geologist. Geological Survey of Indiana. Annual Report for 1875.

This volume contains a paper by G. M. Levette, entitled, "Observations on the Depth and Temperature of some of the Lakes of Northern Indiana." There is given in the paper a list of fifteen *Unios*, one *Margaritana*, four *Anodons* and nineteen species and varieties of fresh water univalves. The list, except the portion pertaining to the *Unionidæ*, was prepared by Mr. John W. Brykit, of Indianapolis. It is intended to cover only northern Indiana.

Stein, Fred. Geological Survey of Indiana. Annual report for the year 1880. Pp. 451–467. Contains the molluscous fauna of Indiana.

There are listed the *Unionos*, *Margaritanas*, *Anodontas*, and other fresh water bivalves, of several genera and species. Besides these there are given the genera and species of fresh water univalves, and all the known species and varieties of land shells. This list bears the distinction of being the very first to endeavor to present a complete view of the shell-life Indiana.

Species described from Indiana.

In collating the lists of mollusks known from this state it has been matter of great interest to note those which had an original habitat ascribed to some part of Indiana. This was to be expected, perhaps, since the earliest of the best known and most scientific writers in conchology, Thomas Say, was for a long time a resident of that interesting colony—the basal principle of which was a kind of Utopian doctrine of communism—which founded New Harmony. While resident here, under the inspiration of association with such men as Troost, Maclure, and the older Owen, opportunity was afforded Say to collect and examine very many of the mollusks of the region. He improved the occasion, as we well know, and gave to the world of science its best early American contributions to conchology. Since his day other species have been found, supposed to be new and described as such by various authors until the list has grown to very respectable proportions. While some of the names following are properly recognized as syononyms yet they are given with the reference to the forms which have priority, for it is but fair to the workers of other days that we recognize the disadvantages of long distance from scientific centers and the other untoward conditions of life in a practical wilderness.

LAND SHELLS.

HELICINA OCCULTA Say. Near New Harmony.

SUCCINEA VERMETA Say. New Harmony.

POLYGYRA FASTIGIATA Say. New Harmony.

ANCYLUS TARDUS Say. Wabash river.

VIVIPARA SUBPURPUREA Say. Wabash river.

CAMPELOMA PONDEROSUM Say. Ohio river.

PLEUROCERA CANALICULATUM Say. Falls of the Ohio.

PLEUROCERA MONILIFERUM Lea. New Harmony.

PLEUROCERA ANTHONYI Lea. Fox river, "Indiana."

PLEUROCERA TROOSTII Lea. Near New Harmony.

LITHASIA OBOVATA Say. Wabash and Falls of the Ohio.

ANGITREMA VERRUCOSA Say. Wabash river.

ANGITREMA ARMIGERA Say. Wabash river.

MELANIA NUPERA Say. Wabash river.

=ANGITREMA VERRUCOSA. Wabash river.

ANCULOSA PRÆROSA Say. Falls of the Ohio.

ANCULOSA TRILINEATA Say. Falls of the Ohio.

GONIOBASIS DEPYGIS Say. Falls of the Ohio.

GONIOBASIS INTERSITA Haldeman. Swan creek.

This species was based on specimens furnished by Mrs. Say after the death of her husband.

GONIOBASIS CONSANGUINEA Anthony. "Indiana."

GONIOBASIS BICOLORATA Anthony. Camp creek, near Madison.

GONIOBASIS CUBICOIDES Anthony. Wabash river.

GONIOBASIS INFANTULA Lea. Falls of the Ohio.

GONIOBASIS LOUISVILLENSIS Lea. Falls of the Ohio.

GONIOBASIS INTERLINEATA Anthony. Christy creek.

GONIOBASIS SPARTANBURGENSIS Lea. Wabash river.

GONIOBASIS INFORMIS Lea. Falls of the Ohio.

GONIOBASIS KIRTLANDIANA Lea. "Indiana."

=GONIOBASIS SEMICARINATA Say. Richmond.

=GONIOBASIS BICOLORATA Anthony. Camp creek.

MESESCHIZA GROSVENORII Lea. Wabash river.

This genus is now recognized to have been based upon pathologic specimens of a *Goniobasis*, probably *Goniobasis cubicoides* Anthony. The specimens were not only pathologic but immature. The writer has several times, in streams in the South, noted many specimens of traumatic shells which might easily be referred to this genus.

UNIO ABRUPTUS Say. Wabash river.

UNIO ORBICULATUS Hildreth.

UNIO ARQUATUS Conrad. Wabash river.

=UNIO RECTUS Lamarck. Pathologic.

UNIO CAPILLUS Conrad. Wabash river.

=UNIO FABALIS Lea. Ohio river

UNIO CICATRICOSUS Say. Wabash river.

=UNIO VARICOSUS (?) Lea.

UNIO CYLINDRICUS Say. Wabash river.

UNIO ELEGANS Lea. Wabash and Ohio rivers.

UNIO HEROS Say. Wabash river.

=UNIO MULTIPLICATUS Lea.

UNIO MYTILOIDES Rafinesque. Wabash river.

UNIO PERSONATUS Say. Wabash river.

UNIO PHILLIPSII Conrad. Wabash river.

UNIO SAMPSONII Lea. Wabash river.

=UNIO PERPLEXUS Lea.

UNIO SECURIS Lea. Ohio and Wabash rivers.

UNIO SULCATUS Lea. Wabash and Ohio rivers.

UNIO UNDULATUS Barnes. Wabash river.

MARGARITANA CONFRAGOSA Say. Wabash river.

MARGARITANA DEHISCENS Say. Wabash river.

=UNIO DEHISCENS Say.

MARGARITANA MONODONTA Say. Wabash and Ohio rivers.

=UNIO MONODONTA Say. From Falls of the Ohio.

ANODONTA EDENTULA Say. "Indiana." Locality not given.

ANODONTA FERRUGINEA Lea. Simon's creek.

ANODONTA IMBECILLIS Say. Wabash river.

ANODONTA SUBORBICULATA Say. Ponds near Wabash river.

A summary of this list of shells originally described from Indiana shows three species of land shells; twenty-nine species of fresh water univalves; and twenty-one species of *Unionidæ*. While several of these have been relegated to the standing of pure synonyms they yet serve a useful purpose in determining the exact nature of the molluscan fauna. It may be that more extended opportunities in the matter of literature will add to this list other forms, thus enriching the original contributions of Indiana to conchologic lore.

GENERAL LIST OF MOLLUSCA.

In the following lists there has been no serious attempt to classify the shells of the state in any systematic manner. At the present time geographical distribution is the most important feature. In pursuance of this object, the arrangement is chiefly alphabetical. Only in a few instances have data which give exact localities been attainable. In seeking to enlarge the list hereafter only specimens accompanied with exact locality references should be admitted.

A number of shells listed from Indiana in various amateur papers, and known to belong to a fauna entirely different, have been excluded as not being authentic. No injustice is done any student by relegating these forms to a doubtful list and awaiting the result of careful examination within the state. Should such examination reveal the forms so excluded it will be a source of congratulation that so many extralimital shells should be found in Indiana.

Register of Land Forms.

Conulus fulvus Drapernaud.

Helicina occulta Say. New Harmony.

Helicodiscus lineatus Anthony.

Limax flavus Linnæus. New Albany.

This form is very abundant in and about Louisville, Ky., having been introduced through commerce.

Limax campestris Say. Franklin county.

Limax (*Tebennophorus*) *carolinensis* Bosc.

Limax (*Tebennophorus*) *dorsalis* Binney.

Mesodon albolabris Say. All over the state.

Mesodon clausa Say. Southern Indiana.

Mesodon exoletus Binney. Indianapolis.

Mesodon mitchelliana Lea. Franklin county.

Mesodon multilineata Say. All over south Indiana.

Mesodon profunda Say. Indianapolis; Madison; Charleston.

Patula alternata Say. Generally distributed.

Patula perspectiva Say. Indianapolis.

Patula solitaria Say. Indianapolis; Charleston.

Patula striatella Anthony. Indianapolis; New Albany.

Polygyra fastigiata Say. New Harmony.

Polygyra leporina Gould. No specimens seen.

Pupa armifera Say. Bloomington; Indianapolis.

Pupa contracta Say. Bloomington.
Pupa corticaria Say. Indianapolis.
Pupa fallax Say. Indianapolis; Bloomington.
Pupa muscorum Linnæus. Bloomington.
Pupa pentadon Say. Bloomington.
Pupa rupicola Say. Franklin county.
Selenites concava Say. Generally distributed.
Stenotrema hirsutum Say. Generally distributed.
Stenotrema monodon Rackett. Generally distributed.
Stenotrema monodon fraternum Say. Indianapolis.
Stenotrema monodon leaii Ward. Indianapolis.
Stenotrema stenotrema Ferussac. Indianapolis; Madison.
Succinea avara Say. Generally distributed.
Succinea obliqua Say. Credited to state.
Succinea ovalis Gould. Indianapolis.
Succinea totteniana Lea. Vincennes.
Succinea vermeta Say. New Harmony.
Strobila labyrinthica Say. South Indiana.
Triodopsis appressa Say. Indianapolis; Madison.
Triodopsis fallax Say. Indianapolis.
Triodopsis inflecta Say. Indianapolis; south Indiana.
Triodopsis obstricta Say. Indianapolis.
Triodopsis palliata Say. Generally distributed over central and northern Indiana.
Vallonia pulchella Muller. Indianapolis; Bloomington.
Vertigo gouldii Binney.
Very doubtful determination. Probably some other form was really in the hands of the authority.
Vertigo ovata Say. Generally distributed.
Zonites arboreus Say. Indianapolis; generally over the state.
Zonites friabilis W. G. Binney. New Harmony.
Zonites fuliginosus Griffith. Indianapolis; Charleston.
Zonites milium Morse. Southern Indiana.
Zonites nitidus Muller. Generally distributed.
Zonites indentatus Say. Franklin county.
Zonites inornatus Say. Referred to Indiana.
Zonites intertextus Binney. Authority of Binney.
Zonites ligerus Say. Indianapolis; southern Indiana.

Zonites limatulus Ward. Indianapolis; generally distributed.

Register of Fresh Water Univalves.

Carychium exiguum Say. In all damp places under leaves.
This is one of the most minute of American shells.

Ancylus tardus Say. Wabash, White and Ohio rivers.

Bulinus hypnorum Linnæus. Indianapolis; northern Indiana.

Helisoma bicarinatus Say. Indianapolis.

Planorbis trivolvis Say. Indianapolis; generally distributed over the state.

Limnophysa columella Say. Credited to Indiana.

Limnophysa caperata Say. Indianapolis; Wabash river.

Limnophysa desidiosa Say. Indianapolis; generally distributed over the state.

Limnophysa humilis Say. All over the state.

Limnophysa palustris Muller. Generally distributed.

Limnophysa reflexa Say. Indianapolis.

Menetus exacutus Say. Generally distributed in ponds.

Physa gyrina Say. All over the state.

Physa heterostropha Say. All over the state.

Valvata tricarinata Say. Credited to the state.

Somatogyrus isogonus Say. White river; Wabash river.

Pomatiopsis lapidaria Say. Wabash river. Probably generally distributed.

Campeloma apertum Lewis. (Ms.) West Fork White river.
=*Campeloma integrum* DeKay.

Campeloma decisum Say. St. Joseph river.

Campeloma integrum DeKay. St. Joseph river.

Campeloma ponderosum Say. Wabash and Ohio rivers.

Campeloma rufum Haldeman. St. Joseph and White rivers.

Campeloma regularis Lea. Ohio river.
=Junior *C. ponderosum* Say.

Campeloma subsolidum Anthony. Wabash river.

Lioplax subcarinata Say. Laporte.

Viripara contectoides Binney. Wabash river.

Viripara subpurpurea Say. Wabash river.

Anculosa prærosa Say. Falls of the Ohio.

Anculosa trilineata Say. Falls of the Ohio.

Angitrema armigera Say. Wabash river.

Angitrema nupera Say. Wabash river.

=*Angitrema verrucosa* Say.

Angitrema verrucosa Say. Wabash and Ohio rivers.

Goniobasis bicolorata Anthony. Camp creek, Madison.

Goniobasis consanguinea Anthony. "Indiana."

It is probable that a no more satisfactory author than this one ever wrote on American shells. Exact localities are rarely ever mentioned by him, and most of those given are open to serious question. He was notorious for looseness in this very important matter. Rarely can his references be used for geographic distribution.

Goniobasis cubicoides Anthony. Wabash river.

Goniobasis depygis Say. Falls of the Ohio.

This is one of the most abundant shells at the falls, and at low water may be secured by the gallon with very little effort.

Goniobasis infantula Lea. Falls of the Ohio.

=*Goniobasis depygis* Say.

Goniobasis informis Lea. Falls of the Ohio.

Goniobasis interlineata Anthony. Christy creek.

=*Goniobasis semicarinata* Say.

Goniobasis intersita Haldeman. Swan creek.

Goniobasis louisvillensis Lea. Falls of the Ohio.

=*Lithasia obovata* Say.

Goniobasis kirtlandiana Lea. "Indiana."

=*Goniobasis bicolorata* Anthony.

=*Goniobasis semicarinata* Say.

Goniobasis semicarinata Say. Richmond; Franklin Co.

Goniobasis spartenbergensis Lea. Wabash river.

=*Goniobasis depygis* Say.

Lithasia obovata Say. Wabash river; Falls of the Ohio. Very abundant at the last locality.

Meseschiza grosvernorii Lea. Wabash river. Pathologic form.

Pleurocera anthonyi Lea. "Fox river, Indiana."

There is considerable uncertainty about this locality reference. Fox river is in Illinois.

Pleurocera canaliculatum Lea. Falls of the Ohio.

A very abundant and exceedingly variable shell.

Pleurocera elevatum Say. Ohio river.

Pleurocera moniliferum Lea. Wabash and Ohio rivers.

Pleurocera simplex Lea. Ohio river.

Pleurocera troostii Lea. New Harmony, Wabash river.

This species was based upon specimens submitted to Dr. Lea from very widely separated localities. The greater number came from North Alabama and Georgia. There is very much doubt that this species was found in the northern locality to which it is credited.

Pleurocera undulatum Say. Ohio river.

FRESH WATER BIVALVES.

Pisidium abditum Haldeman. Ohio river. Probably generally distributed over the state.

Pisidium virginicum Bourgiuignat. Ohio river.

Sphaerium solidulum Prime. Franklin county.

Sphaerium sphaericum Anthony. Ponds along Wabash river.

Sphaerium stamineum Conrad. Ohio river.

Sphaerium sulcatum Lamarck. Ohio river.

Sphaerium transversum Say. Ohio and Wabash rivers.

Anodonta decora Lea. Ohio river.

Anodonta edentula Say. Wabash, White and Ohio rivers; lakes in northern Indiana.

Anodonta ferruginea Lea. Simon's creek.

Anodonta ferussaciana Lea. Ohio river; Lakes in northern Indiana.

Anodonta footiana Lea. South Bend.

Anodonta grandis Say. Flat Rock creek; Wabash river. Probably distributed all over the state.

Anodonta imbecillis Say. Wabash and Ohio rivers; Canal at Indianapolis.

Anodonta pavonia Lea. Flat Rock creek.

Anodonta plana Lea. Ohio river; Flat Rock creek.

Anodonta salmonia Lea. Blue river.

Anodonta shæfferiana Lea. Flat Rock creek.

Anodonta suvcylindracea Lea. White river.

Anodonta suborbiculata Say. Ponds near Wabash river.

Anodonta wardiana Lea. White river.

Margaritana calceola Lea. Ohio river; Flat Rock creek.

=*Margaritana deltoidea* Lea.

Margaritana complanata Barnes. Ohio and White rivers.

Margaritana confragosa Say. Ohio and Wabash rivers.

Margaritana dehiscens Say. Wabash and Ohio rivers.
Described as *Unio dehiscens* Say.
Margaritana deltoidea Lea. Wabash, White and Ohio rivers.
Margaritana hildrethiana Lea. Ohio river.
Margaritana marginata Say. White river.
Margaritana monodonta Say. Falls of the Ohio river; Wabash river.
Described as *Unio monodontus* Say.
Margaritana rugosa Barnes. Wabash and Ohio rivers; Lakes in northern Indiana.
Unio abruptus Say. Wabash river.
= *Unio orbiculatus* Hildreth.
Unio æsopus Green. Ohio river.
Unio alatus Say. Ohio, White and Wabash rivers.
Unio anodontoides Lea. Ohio and Wabash rivers.
Described as *Unio teres* Rafinesque, from the Wabash.
Unio arctior Lea. White, Wabash and Ohio rivers.
= *Unio gibbosus* Barnes, white nacred variety.
Unio arquatus Conrad. Wabash river.
= *Unio rectus* Lamarck, pathologic.
Unio asperrimus Lea. Wabash and Ohio rivers.
Unio camelus Lea. Ohio river.
= *Unio phaseolus* Barnes.
Unio phaseolus Barnes.
Unio camptodon Say. Ohio river.
Unio capax Green. Ohio river.
Unio cicatricosus Say. Wabash river.
= *Unio varicosus* Lea.
Unio cincinnatiensis Lea. Ohio river.
= *Unio perplexus* Lea.
Unio circulus Lea. Wabash, White and Ohio rivers.
Unio clavus Lamarck. Wabash, White and Ohio rivers.
Unio coccineus Lea. Wabash and Ohio rivers.
Unio cooperianus Lea. Ohio river.
Unio cornutus Barnes. Wabash and Ohio rivers.
Unio crassidens Lamarck. Wabash and Ohio rivers.
Unio cylindricus Say. Wabash and Ohio rivers.
Unio distans Anthony. St. Joseph river.
= *Unio luteolus* Lamarck.

Unio donaciformis Lea. Wabash river; Ohio river.

Unio dorfeuillianus Lea. Ohio river.

Unio ebenus Lea. Ohio and Wabash rivers.

Unio elegans Lea. Wabash and Ohio rivers.

Unio ellipsis Lea. Ohio and Wabash rivers.

Unio fabalis Lea. Ohio river.

Unio foliatus Hildreth. Ohio river.

Unio fragosus Conrad. Wabash and Ohio rivers.

Unio gibbosus Barnes. Lakes in northern Indiana; Ohio, White and Wabash rivers.

Unio glans Lea. Ohio and White rivers; lakes in northern Indiana.

Unio gracilis Barnes. Ohio river.

Unio graniferus Lea. Ohio river.

Unio heros Say. Wabash river.

= *Unio multiplicatus*. Lea.

Unio iris Lea. St. Joseph's, White and Ohio rivers; lakes in northern Indiana.

Unio irroratus Lea. White and Ohio rivers.

Unio lachrymosus Lea. Ohio river. *Unio asperrimus* Lea is a synonym of this form.

Unio laevissimus Lea. White and Ohio rivers.

Unio lens Lea. Canal, Indianapolis; Ohio river.

= *Unio circulus* Lea.

Unio ligamentinus Lamarck. Wabash and Ohio rivers.

Unio luteolus Lamarck. Lakes in northern Indiana; Ohio river. Probably generally distributed.

Unio metanevrus Rafinesque. Wabash, White and Ohio rivers.

Unio multiradiatus Lea. Canal, Indianapolis; White river.

Unio multiplicatus Lea. Ohio and Wabash rivers.

Unio mytiloides Rafinesque. Ohio and Wabash rivers.

Unio nasutus Say. Lakes in northern Indiana. Only in those which drain into the Great lakes.

Unio obliquus Lamarck. Ohio and Wabash rivers.

Unio occidens Lea. Ohio river.

= *Unio ventricosus* Barnes.

Unio orbiculatus Hildreth. Ohio and Wabash rivers. See *Unio abruptus* Say.

Unio ovatus Say. Ohio river.

Unio parvus Barnes. Ohio river; Wabash river. Probably over a great portion of the state.

Unio perplexus Lea. Wabash and Ohio rivers.

Unio personatus Say. Wabash river.

Unio phascolus Barnes. Wabash, White and Ohio rivers.

Unio phillipsii Conrad. Ohio and Wabash rivers.

= *Unio perplexus* Lea.

Unio plenus Lea. Wabash and Ohio rivers.

Unio plicatus Lesueur. Ohio river.

Unio pileus Lea. Ohio river.

= *Unio personatus* Say

Unio pressus Lea. Lakes in northern Indiana; Canal at Indianapolis; Ohio river.

Unio pustulatus Lea. Ohio river.

Unio pustulosus Lea. Wabash and Ohio rivers.

Unio pyramidatus Lea. Ohio and Wabash rivers.

Unio rangianus Lea. Ohio and White rivers; Wild Cat creek, Carroll county.

= *Unio perplexus* Lea.

Unio rectus Lamarck. Ohio and Wabash rivers.

Unio retusus Lamarck. Ohio and Wabash rivers.

Unio rubiginosus Lea. Lakes in northern Indiana; Ohio and White rivers.

Unio sampsonii Lea. Wabash river.

= *Unio perplexus* Lea.

Unio securis Lea. Ohio and Wabash rivers.

Unio solidus Lea. Wabash and Ohio rivers.

Unio spatulatus Lea. Lakes in northern Indiana.

Unio subovatus Lea. Ohio and White rivers.

Unio subrostratus Say. South Bend; Wabash river.

Unio subrotundus Lea. Ohio river.

Unio sulcatus Lea. Wabash and Ohio rivers.

Unio tenuissimus Lea. Ohio river.

Unio triangularis Barnes. White and Ohio rivers.

Unio trigonus Lea. Ohio river, Wabash river.

Unio tuberculatus Barnes. White, Wabash and Ohio rivers.

Unio undulatus Barnes. Wabash and Ohio rivers.

Unio varicosus Lea. Ohio river.

Unio ventricosus Barnes. Ohio river; lakes in northern Indiana.

Unio verrucosus Barnes. Wabash and Ohio rivers.

Unio zigzag Lea. Ohio river, Wabash river.

= *Unio donaciformis* Lea.

Summarizing the data herein presented, exclusive of synonyms and doubtful forms referred to the state by writers, we find the following totals: Of land shells, 17 genera and 58 species; of fresh water univalves, 18 genera and 47 species; of fresh water bivalves, 5 genera and 102 species. That the number of species will be largely increased on careful examination there can be no question.

Louisville, Ky., Nov. 30, 1893.

GEOLOGY.

GEOLOGICAL LITERATURE OF INDIANA—STRATIGRAPHIC AND ECONOMIC.

By Vernon F. Marsters and E. M. Kindle.—Geological Department, Indiana University.

The following alphabetical list of the contributions to Indiana Geological literature includes such as deal especially with the physical and economic phases of the subject, and only brief references to the larger and more important contributions to the paleontology of the state. This list is so arranged that the student can ascertain: First, what *counties* of the state have been subject to investigation, second, *by whom* the work was done, third, *where the results are published*, fourth nature and results of the investigations. A brief statement of the contents of the more important papers, Reports, etc., is placed under the *author's name*. The references of an *economic* phase are placed under the heading *Economic Geology* which comes in its proper place in the alphabetic series. Under this heading are placed the following subdivision: *Clays, coals, gas, hydraulic cements, oil, ore* (*minerals*), *stone* (*building*). The reference to the paleontology of the state are not included *in detail* in this list for the reason that they demand a somewhat different treatment in order to make the treatise the most useful to the student.

Adams county, Geology of. R. Owen's Rep. 1859–60.

Allen county, Geology of. R. Owen's Rep. 1859–60.

————Geology of. M. Thompson's Rep. 1888.

Altitudes, table of, in Indiana and elsewhere. Owen's Rep. 1859–60.

Bartholomew county, Geology of. Owen's Rep. 1859–60.

————Geology of. J. Collett's Rep. 1881.

Benedict, A. C. Geology of Wabash County. (See Elrod, M. N.)

————Petroleum in Indiana—S. S. Gorly (17th Annual Rep.) 1891.

Discusses briefly the history of Petroleum, its discovery in the United States; mentions the oil fields of United States, geological distribution; describes extent of bed, and oil field in Crawford and Wells counties.

Benton county, Geology of. Owens Rep. 1859–60.

————Geology of. M. Thompson's Rep. 1885–86.

Bessemer Iron, Manufacture of. E. T. Cox, 1876–77–78.

Beckwith, H. W., Indian names of water courses in the state. J. Collett's Rep. 1882; pp. 39–44.

Bigney, A. J., Preliminary notes on the geology of Dearborn county. Proc. Ind. Acad. Sci. pp. 66–67.

Notes the finding of mammoth and sloth remains.

Beachler, C. S. Keokuk group at Crawfordsville, Ind. Am. Geol., vol. II, pp. 407–412.

Describes the stratigraphic features of the Keokuk rocks and gives a list of the fossils of this locality.

————Notice of some new and remarkable forms of crinoidea from the Niagara limestone at St. Paul, Ind. Am. Geol., vol. IV, pp. 102–103.

————Corrected list of fossils found at Crawfordsville, Ind. (Keokuk.) Ind. Geology and Nat. Hist. Sur., 1888.

————List of fossils found at Crawfordsville, Ind. Am. Geol., Dec., 1888.

————List of fossils from Crawfordsville rock. M. Thompson's Rep. 1888.

————The rocks at St. Paul, Ind. Am. Geo., vol. VII, March 1891, p. 178.

————Abandoned Pleistocene river channel in Eastern Indiana. Proc. Am. Geol. Society, vol. IV, p. 62.

Blackford county. Gas. (See Phinney, Natural Gas in Indiana.)

Blatchley, W. S. A catalogue of the Butterflies known to occur in Ind. S. S. Gorby (17th annual Rep.) 1891, pp. 365–408.

Black Shale Fossils. Whitfield, 1874.

Blackford county, Geology of. Owen, 1859–60.

Boone county, Geology of. M. Thompson, Rep. 1885–86.

Boerner, C. G. Meteorology of Switzerland county. E. T. Cox Rep. 1872.

Borden, W. W. Scott county, Geology of. (Map.) Geo. Survey of Ind. 1874.

The geological formations are the drift, knobstone, black shale (Hamilton,) and coniferous limestone; list of fossils.

———Jefferson county. Geol. Survey Ind. 1874.

Geological formations were the Champlain, drift, black shale, coniferous limestone, Niagara, Clinton and Cincinnati; list of fossils.

———Rep. of Geol. Surv. of Clark and Floyd counties. E. T. Cox Rep. 1873, pp. 134–189.

Gives a brief account of the geological formations in the counties (Cin. group, Niagara, New Albany black shale, probably the equivalent of the Genesee, N. Y., and Knabe stone.

Boone county, Geology of. Owen's Rep. 1859–60.

Branner, J. C. Geol. Map Ind.

Brown county, Geology of. Owen's Rep. 1859–60; also Collett's Rep. 1874.

Brown, R. T. Geology of Hamilton and Madison counties. Collett's Rep. 1884.

———Fish culture in Indian. Collett's Rep. 1884.

———Geology of Hancock county. M. Thompson's Rep. 1885–86.

Discusses topography, drainage, nature of glacial drifts, archæology.

———Geology of Morgan county. J. Collett's Rep. 1883, pp. 76–83.

Discusses drainage, topography, extent and thickness of Paleozoic formations, glacial phenomena; gives list of fossils and connected section of the county.

———Geology of Putnam county. J. Collett's Rep. 1881, pp. 89–125.

Describes the topography and stratigraphic geology; notes extent and character of the coal-seams. Refers briefly to building stone.

———Marion county, Geology and topographical survey of. J. Collett's Rep. 1882, pp. 79–69.

Discusses topography and stratigraphic features.

———Morgan county, Geology of. J. Collett's Rep. 1883, pp. 71–85.

Bradner, E. A partial catalogue of the flora of Steuben county. S. S. Gorby, 17th Annual Rep. 1891.

Building Stones. Thompson, 1888.

Byrkit, J. W. Catalogue and check-list of the trees and woody shrubs of America north of Mexico. E. T. Cox Rep. 1876–78, pp. 279–290.

Campbell, J. L. The Kankakee river and pure water for Northwestern Indiana and Chicago. Proc. Ind. Acad. Sci. 1891, pp. 70–73.

Describes the Kankakee channel and basin.

Carbonic (upper and lower). (See Stevenson, J. S.)

Carboniferous fossils. Owen's Rep.

Carroll county, Geology of. E. T. Cox's Rep. 1872. S. S. Gorly 17th Annual Rep. 1891.

————Geology of. R. Owen.

Cass county, Geology of. E. T. Cox's Rep. 1872; do Richard Owen.

Chalk beds of Indiana. M. Thompson's Rep. 1885–86.

Chamberlin, T. C. The Glacial boundary in Indiana and adjacent states. (Introduction) Bull. No. 58 U. S. G. S. 1890.

————Preliminary paper on the Terminal Moraine of the second Glacial Epoch. (Notice) A. J. S. III, vol. 28, p. 228, 1884. (From 3d Ann. Rep. of the Director of the U. S. G. S. 1881–82.)

————Hillocks of Angular Gravel and Disturbed Stratification, A. J. S. III, vol. 27, p. 370, 1884.

Discusses structural features of these deposits, nature and analysis of contents. (Sections of gravel bank from Tippecanoe county, Ind. A long list of contributions to this subject is appended.)

————The Bearing of some Recent Determinations and the Correlation of the Eastern and Western Terminal Moraines; A. J. S. III vol. 24, p. 93, 1882.

Cincinnati Arch. E. T. Cox's Geol. Rep. 1876–77–78; Am. Geol. vol. IV, pp. 6–20.

Cincinnati Group. A. J. S. III, vol. 17, p. 484. Question of nomenclature.

It was agreed by a committee from the Cincinnati Academy of Science that the term Cincinniti Group should not be retained.

Clark county, Geology of. E. T. Cox, Rep. 1873; also R. Owen.

Clay county, Geology of. Owen's Rep.

Clinton county, Geology of. Owen's Rep.

————Geology of. M. Thompson's Rep. 1885–86.

Collett, John. Geology of Brown county. Owen's Rep. 1859–60.

Indicates Bean Blossom ridge as the southern drift limit; considers the deep valleys due to glacial streams and the silt to indicate a former central post glacial lake; the gold of drift origin; formations, drift, geode beds and knob stone. Report accompanied by map.

————Geological report on Harrison and Crawford counties. E. T. Cox Rep. 1876–78, pp. 291–522.

Discusses the Stratigraphic geology (quaternary carbon, Dev. and Sil.) Gives lists of fossils from coalmeasures, and the subdivisions of subcarboniferous; also a list of fossil fish teeth (by J. S. Newberry); analyses of Harrison county meteorites; mention is also made of building stone, hydraulic cement, clays, mineral waters, oil (Crawford, county) caves, archæology.

——Geology of Warren county. E. T. Cox Rep. 1873, pp. 191–259.

Describes briefly the topographical features, quaternary deposits, extent and physical features of paleozoic formation (carboniferous and subcarboniferous). Mention is also made of coal, clays, gold and copper, building stone.

——Geology of Lawrence, Knox and Gibson counties. E. T. Cox Rep. 1873, pp. 260–430.

Describes the stratigraphy, gives numerous local sections and general connected sections of each county, exhibiting especially the relations of coal-seams. Mention is also made of fossils noted in the local sections, iron ore, building stone, clays, etc.; analysis of coals, archæological remains.

——Geol. Rep. of Vanderburg, Owen and Montgomery counties. E. T. Cox Rep. 1875, pp. 240–422.

Describes glacial deposits, physical features and extent of Geol. formations (Carbon Dev. sections) with occasional reference to fossils (Carbonif.); also details concerning development of coal, building stone, iron ore. A list of fossils from the Keokuk rock Crawfordsville is appended.

——Geology of southeast part of Clay county. E. T. Cox Rep. 1875, pp. 423–462.

Describes the glacial deposits, extent of paleozoic rocks (Carbonif.) as made out from borings.

——Geological reconnoissance of the coal-measure rocks of Putnam county. E. T. Cox Rep. 1875, pp. 463–468.

——Geological reconnoissance of Jasper, White, Carroll, Cass, Wabash, Miami, Howard, Lawrence, Knox and Gibson counties. E. T. Cox Rep. 1872, pp. 291–337.

——Second Annual Report of the Department of Statistics and Geology, 1888.

Agricultural and health statistics, pp. 5–368.

Geology of Indiana (with outlined Geol. map), pp. 375–384.

Brief outline of geographical extent of Geological formations by counties; describes oolitic limestone and Portland cement. Indiana coal versus Pittsburg coal.

The mammoth and mastodon remains in Indiana and Illinois. Archæology, pp. 384–396.

Geology of Putnam county, pp. 397–426.

Gives a connected section of the formations of the county (Quaternary, Carbonif., Subcarbonif.) and sections showing local details bearing on stratigraphy; fossils; tables of altitudes in Monroe and Putnam counties.

Geology of Monroe county, by G. K. Greene, pp. 426–499.

Synopsis of the Molluscous Fauna of Indiana, by Frederick Stein, pp. 453–467.

Fossils from Silurian, Devonians and subcarboniferous rocks of Indiana, by C. A. White (descriptions and plates), pp. 468–522.

————Department of Geology and Natural History (eleventh annual report), 1881. 52 pl.; maps.

Statistics concerning the production of coal, and its cost, etc.; increase in production in the coal-producing states; also notes on clays (Kaolin) Lawrence county; tabulated statements indicating the capital, labor and appliances devoted to the quarrying of stone in Indiana, and the value of the product; brief outline of the extent of the oolitic limestone of Owen, Monroe, Washington, Harrison and Crawford counties and output of the various quarries; analysis, pp. 13–33.

Experiments upon the transverse strength and elasticity of building stones, by Thos. H. Johnson, pp. 34–47.

Tables of altitudes between Indianapolis and Cincinnati, on Cincinnati, Indianapolis, St. Louis & Chicago Railroad and other roads in S. Indiana, pp. 47–54.

Geology of Shelby county, pp. 55–88.

Describes topography; glacial drift (Collet's Glacial river); Stratigraphic Geology with numerous local sections; a list of fossils found in the county from Dev. (corniferous) and Sil. (Niagara); notes on building stone, clays, etc.

Putnam county. Geology and Geography. R. T. Brown, pp. 89–125.

Delaware county, Geology of. A. J. Phinney, pp. 126–149.

Gives a general outline of the topography; Quaternary and Paleozoic Geology (Silurian), with list of fossils found in the county; notes on clays, agriculture, etc.

Bartholomew county, Geology of. Moses N. Elrod, pp. 150–213.

Descriptions of the species of fossils found in the Niagara group at Waldron, Ind. Prof. James Hall, pp. 214–345.

Fossils of the Indiana rocks. No. 2. C. A. White, pp. 347–375.

With description and plates (37–43).

VanCleave's Fossil Corals, pp. 376–410.

Description and plates (44–55).

————Geology and Natural History Ind. (Twelfth Annual Report 1882, pp. 1–38.

In an introductory chapter the author gives observations on building stone, coal, glass, sand, clay, gas; United States surveys; growth of timber; Archæology.

Archæology: Indian names of water courses in the state of Indiana. H. W. Beckwith, pp. 39–44.

Outline Geology of Ind. pp. 45–47.

Newton county Geological Survey, pp. 48–64.

Describes surface configuration, quaternary and paleozoic formations, accompanied by numerous sections.

Jasper county, Geological Survey of, pp. 65–78.

Describes recent and paleozoic geology, a list of fossils from two localities; notes on clay, iron, building stone, petroleum; table of altitudes in Jasper and Newton counties.

Marion county, Report of a Geological and Topographical Survey; R. T. Brown, pp. 79–99.

Decatur county, Geology of. M. N. Elrod, pp. 100–152.

Jay county, Geology of. D. S. McCaslin, pp. 153–176.

Randolph county, Geology of. A. J. Phinney, pp. 177–195.

Catalogue of the flora of central-eastern Indiana by A. J. Phinney, pp. 196–236.

Paleontology—Van Cleve's fossil corals, identified and compiled by Dr. James Hall, pp. 239–270. Descriptions and plates.

Descriptions of fossil corals from the Niagara and upper Helderburg groups of Ind. Prof. James Hall, pp. 271–375.

Diatoms of the waters of Ind. Rev. S. L. Curtis, pp. 377–384.

————Geology and Natural History of Indiana 1883. (Thirteenth Annual Report). Part I Geology and Nat. Hist. Part II Paleontology. (Map.)

Report and work of the Geol. Department. Outlined Geology of Ind.; stone coals of Ind.; pp. 1–10.

Fuel values of coals. G. M. Livette, pp. 10–11.

Comparison of Ind. Block Coals with Ill. coals. E. T. Cox, pp. 35–37.

Posey county, Geology, pp. 45–70.

Describes the topography, alluvial and drift deposits and Pal. formations; gives general and local sections; notes fossils in a few sections. Economic Geology.

Morgan county, Geology of. R. T. Brown, pp. 71–85.

Rush county, Geology of. M. N. Elrod, pp. 86–115.

Johnson county, Geology of. D. S. McCaslin, pp. 116–137.

Grant county, Geology of A. J. Phinney, pp. 138–153.

Glossary of terms commonly used in Geological reports. W. T. S. Cornett, pp. 154–169.

Principles of Paleozoic Botany (Pt. II). Leo. Lesquereux, pp. 7–106.

Fossils of Indiana Rocks (No. 3). C. A. White.

————Geology and Natural History of Ind. (Fourteenth Annual Re-

port). Pt. I, Geology. Pt. II, Postpliocene Vertebrates of Ind. 1884.

Outlined Geology of Ind., pp. 18–19.

Hamilton and Madison counties, Geol. and Topographical Survey of. R. T. Brown, pp. 20–40.

Fayette county, Geology of. M. N. Elrod, pp. 41–60.

Union county, Geology of. M. N. Elrod, pp. 61–72.

Drift deposits of Indiana. J. S. Newberry, pp. 85–98.

Ohio river floods, pp. 99–102.

Glossary of Terms used in Geol. Rep. pp. 103–109.

Post pliocene Vertebrates of Ind. E. D. Cope and J. L. Wortman, pt. II pp. 3–41 (6 plates).

Claypole, E. W. Evidences from the Drift of Ohio, Indiana and Illinois in support of the preglacial origin of the basins of Lake Erie and Ontario, A. A. A. S., vol. 30, 1881, p. 147.

Cope, E. D. and Wortman, J. L. Postpliocene Vertebrates of Indiana. J. Collett's Rep. 1884, pp. 3–41. (6 plates.)

Give a brief summary of some Geological facts bearing upon faunal relations in this period. (Quaternary). Describes nature of deposits in which mammalian remains are most frequently found; and some structural features of the chief groups of mammalia of quaternary times; also descriptions of a number of genera and species. Appendix, Genus Equus.

Cope, E. D. Faunas of Wyandotte and Mammoth Caves, E. T. Cox Rep. 1872.

———E. T. Cox, Geol. Rep. 1872.

———Fanuas of Wyandotte Cave, E. T. Cox, Geol. Rep. 1876–78.

Cox, E. T. Second Rep. Geol. Surv. Ind. (Maps of counties) 1870.

Gives general outline of quaternary deposits; emphasizes the importance of the coal in Indiana; gives analyses and sections from Sullivan, Daviess, Martin counties; general observations on coals of Knox, Dubois, Pike, Gibson, Warrick, Spencer, Perry, Vanderburg, and Posey counties. The Geol. formations and economic products and fossils are briefly described,

Putnam and Vigo counties. Observations on mineral springs, coals; also paper by Dr. T. Sterry Hunt, oil wells of Terre Haute, pp. 118–163.

Western Coal-Measures of Ind. pp. 164–187.

Sullivan county, Geology of. J. Collett Rep. pp. 191–240.

Jefferson county, Catalogue of the Flora of. A. H. Young, pp. 245–288.

———How to prepare and cook fish and other animal food. S. Collett's Rep. 1884.

———Temperature of two deep bores in Indiana. Proc. A. A. A. S. vol. 24, p.—, 1875.

———Western coal measures of Indiana. A. A. A. S. vol. 20, (B. Nat. Hist. Soc.) 236–252.

———Analysis of Peat from northern counties of Ind. T. Collett's Rep. 1883.

———Third and fourth Annual Reports of Geol. Surv. Ind. 1871–72.

Introductory chapter treats of the development of the coal seams, gives numerous analyses of samples from various parts of the area; discusses coking qualities of the coals (Sullivan, Daviess, Dubois, Pike, Spencer counties).

Perry County, Geol. of. pp. 62–143.

Discusses especially the extent and development of the coal seams, and stratigraphy of subcarboniferous and coal measures, and economic use of the quaternary deposits; describes building stone, lime, oil wells; describes and illustrates the opening and working of coal seams.

Geological notes of a trip from New Albany, in Floyd county, to Harrison and Crawford counties, pp. 145–182.

Describes the general geological features; Putnam and Wyandotte caves, and their faunas (the latter, E. D. Cope).

Dubois and Pike counties, Geology of. pp. 192–287.

Describes the Statigraphy with numerous sections from various parts of the county, showing positions of coal seams; gives list of fossils from sections examined; mentions clays, iron, building stone.

Jasper, White, Carrol, Cass, Miami, Wabash and Howard counties. Geol. reconnoissance of Prof. John Collett, pp. 291–337.

Parke county, Report of Geol. Surv. of. B. C. Hobbs, pp. 341–384.

Dearborn, Ohio and Switzerland counties, Geology of. pp. 387–434.

Describes surface features, topography, stratigraphy, lower and upper silurian, drift, terrace, building stone, hydraulic cement, clays, iron ore.

Meteorology of Vevay, Switzerland county. C. G. Boerner.

———Fifth Annual Report. Ind. Geol. Surv. made during year 1873, (maps and wood cuts).

Report of Vienna exposition (maps). pp. 5–12.

The Iron and Steel Industries of Rhenish Prussia and Westphalia, Germany, at the Vienna Exposition (maps), 1873. Hugh Hartmann. pp. 13–70.

Spiegeleisen manufacturing. Hugh Hartmann, pp. 71–101.

Report on iron ores of Clark and Floyd counties. p. 102.

Describes, in addition, the use of raw coal in the blast furnace; cooking qualities of Indiana block coal; hydraulic cement, mounds.

Clark and Floyd. Report of a Geol. Surv. of. W. W. Borden. pp. 134–189.

Warren county, Geology of. John Collett. pp. 191–259,

Description of Reptilian footprints. p. 247.

Lawrence county, Geology of. John Collett. pp. 260–314.

Knox county, Geology of. John Collett. pp. 375–382.

Gibson county, Geology of. John Collett. pp. 383–430.

Dekalb, Steuben, Lagrange, Elkhart, Noble, St. Joseph, and Laporte. Observations on. G. M. Levette. pp. 430–474.

————Annual report of the Geological Survey of Indiana for 1874, p. 287; two plates and maps. (County reports by Cox, Collett and Borden; fossil lists by Hatfield and Cornett; papers on fishes, Jordan; on botany, Coulter.)

In the chapter on geology it gives a sketch of continental development; a list of Loch's fossils; reports the discovery of Porcelain clay, and tables of analyses of clays and of iron ore.

————Geological survey of Indiana, 1875, (with maps of several of the counties appended).

Describes briefly the varieties of Indiana coals; discusses their industrial values and the method of analysis of coals, which should be followed, and reviews the Geological work accomplished during the year. Analysis of coals from Clay, Owen, Fountain, Vanderburg, Greene, Warrick, Posey, Sullivan, Daviess, Vermillion, Vigo, Parke, Montgomery, Fayette (Pa.), Mecklenburg (Ky), Lignite, Robertson county (Tex).

Geology of Vigo county, pp. 79–115.

Traces the various coal-seams and gives numerous sections from quaternary and the coal-bearing areas. Building stone, clays, petroleum, iron ore.

Huntington county, pp. 116–133.

The only rocks represented here belong to Paleozoic (Niagara), followed directly by glacial drift. Reference is made to the fossils of the Niagara to Glacial drift (quaternary.)

Species of Fossil Marine Plants from the carboniferous measures, pp. 135–145, by L. Lesquereux.

Jennings and Ripley counties, pp. 146–202.

Describes the stratigraphic features of the geol. formations represented, viz: Quaternary, Devonian (Hamilton), Up. Silurian.

Orange county, pp. 203–239, by M. N. Elrod and E. S. McIntire.

Vanderburg, Owen and Montgomery counties, Geology of. John Collett, pp. 240–422.

Clay county, Geology of. John Collett, pp. 423–462.

Geological Reconnoissance of the Coal Measure Rocks of Putnam county. John Collett, pp. 463–468.

Observations on the depths and temperatures of some lakes of Northern Indiana. G. M. Levett, pp. 469–503.

Catalogue of the Flora of the Wabash valley below the mouth of White river, and observations thereon, by J. Schneck, pp. 504–576.

————Eighth, Ninth and Tenth Annual Reports of the Geol. Survey of Ind., made during the years 1876–78 with maps.

Discusses the nature and extent of the Cincinnati arch whether anticlinal or synclinal; the processes of development, growth of subsequent formations in Indiana, Ohio and Kentucky.

Catalogue of fossils found in the Hudson river, Utica Slate, and Trenton Groups as exposed in S. E. Ind., S. W. Ohio and northern part of Ky. S. A. Miller.

Statements of the views of eastern and western Geologists on the "Cincinnati Group" and its eastern equivalents; extent and analysis of hydraulic cement and building stone. Also brief outline of glacial theories and deposits in Indiana.

Wayne county, Geology of.

Discusses briefly the topography and hydrography and development of the geological formations.

Catalogue and check-list of the Trees and Woody Shrubs of America, north of Mexico. John W. Byrkit, pp. 275–290.

Geological Report on Harrison and Crawford counties. John Collett, pp. 291–522.

Observations on Wyandotte Cave and its Fauna. (E. D. Cope.)

Cornett, W. J. S. List of Silurian and Dev. fossils of Jefferson county, Ind. Geol. Surv. '74.

————Glossary of Terms commonly used in Geological Reports. J. Collett's Rep. 1883.

Coulter, J. M. and **Thompson, H.** Origin of Indiana Flora. M. Thompson's Rep. 1885–86, pp. 253–282.

Coulter, J. M. Some Glacial Actions in Indiana Science, vol. II, p. 6, 1883.

Crawford county, Geology of. Owen, R.

————E. T. Cox, do 1876–77–78. J. Collett's Rep. 1881.

Crinoidea, Classification of. Miller, 1888.

Curtis, J. L. Diatoms of the waters of Indiana. J. Collett's Rep. 1882, pp. 377–384.

Cystidians, Hubbard.

Dana, J. D. and **Guyot, A.** Artesian Well at Terre Haute, A. J. S. (Second series) vol. XLVII, p. 270.

Authors record the thickness and character of strata through which the well passed.

Daviess county, Geology of. R. Owen's Rep. 1859–60, do Cox, E. T., 1872, do 1870, do 1875. J. Collett's Rep. 1883. (Coal, see Lesquereux).

Dearborn county, Geology of. R. Owen's Rep. 1859–60. E. T. Cox's Rep. 1872. Flora of. M. Thompson's Rep. 1888. Gas. (See Phinney, Natural Gas in Indiana.)

Decatur county, Geology of. R. Owen's Rep. 1859–60, do J. Collett's Rep. 1882. Gas and oil. (See A. J. Phinney, Natural Gas in Ind.)

DeKalb county, Geology of. R. Owen's Rep. 1859–60, do E. T. Cox's Rep. 1873, M. Thompson's Rep. 1888. Gas and oil. (See A. J. Phinney, Natural Gas in Indiana.)

Delaware county, Geology of. J. Collett's Rep. 1881; M. Thompson's Rep. 1885-86. Gas. (See Phinney, Natural Gas in Indiana.)

Dennis, D. W. Analytical key to the fossils of Richmond, Ind., 1889. pp. 1–48.

Devonian. Fossils of Jefferson county. Whitfield. Cornett, 1874.

Deverneuil, M. Memoir on the parallelism of American and European formations.

Mentions the black slate of Indiana, Kentucky and Tennessee. He considers it the equivalent of the "Genesee" of the New York series. (See also Bull. Geol. Soc. France vol. IV, 2d series.)

Dryer, C. R. Geology of Dekalb county. M. Thompson's Rep. 1888, pp. 98–101.

Describes surface features, extent and nature of glacial drift, moraines, lakes, etc., sections as exhibited by borings.

————Geology of Allen county. M. Thompson's Rep. 1888, pp. 105–129.

Describes the topographical features and character of the drift which covers the entire county; well section at Fort Wayne.

————Geol. Report of Steuben county. S. S. Gorby (17th annual Rep.) 1891.

Describes the physical features of the moranic deposits, associated lakes and drainage.

————History of the UpperMaumee Valley, Chicago, 1888. Map of the drift of Northeast Indiana, 1893.

Dubois county. Geology of. R. Owen's Rep. 1859–60. E. T. Cox, 1872, do 1870.

————Coal. See Collett's Rep. 1883, do Lesquereux.

Clays. Cox, E. T., Rep. 1870. Davies, Martin, Sullivan counties; do 1872, Dubois, Pike, Park counties; do. 1873 Warren county; do. Cox's Rep. 1874.

Cox, E. T., Rep. 1875. Vigo, Orange counties.

Cox, E. T., Rep. 1876–78. Analyses of clays.

Collett, J., Rep. 1880. Monroe county.

Collett, J., Rep. 1881. Bartholomew, Delaware, Shelby counties.

Collett, J., Rep. 1882. Clays of Indiana.

Collett, J., Rep. 1883. Rush, Grant counties.

Thompson, M., Rep. 1885–86. Clay of Indiana; do, Marshal county.

Thompson, M., Rep. 1888. Clays of Indiana (DeKalb county).

Kaolin, Statistics of production, 10th census U. S., p. 842, 848–849.

Coals. Cox, E. T., Rep. 1870. Western measures and Ind. coal.

Cox, E. T., Rep. 1870. Daviess, Martin, Sullivan. Notes on Knox, Dubois, Pike, Gibson, Warrick, Spencer, Perry, Posey, Vanderburg counties.

Cox, E. T., Rep. 1872. Clay, Dubois, Pike, Jasper, White, Carroll, Cass, Miami, Wabash, Howard, Park counties.

Cox, E. T., Rep. 1872. Development and analysis of coals.

Cox, E. T., Rep. 1872. St. Joseph county (peat).

Cox, E. T., Rep. 1873. Warren, Knox, Gibson counties.

Cox, E. T., Rep. 1875. Analyses of, from Clay, Owen, Fountain, Vanderburg, Greene, Warrick, Posey, Sullivan, Daviess, Vermillion, Vigo, Parke, Montgomery, Fayette, (Pa.), Macklenburg, (Ky.) Robertson, (Tex.) counties.

Collett, J., Rep. 1880. Ind. coal vs. Pittsburg coal.

Collett, J., Rep. 1881. Cost and increase of production.

Collett, J., Rep. 1881. Putnam county.

Collett, J., Rep. 1882. Observations on Ind. coal.

Collett, J., Rep. 1883. Fuel values of coals, do. (Clay, Gibson counties).

Collett, J., Rep. 1883. Comparison of Ind. block with Ill. coals.

Collett, J., Rep. 1883. Analysis of peat.

Collett, J., Rep. 1883. Stone-coals of Ind.

Thompson, M., Rep. 1885–86. Washington county.

Min. resurces of U. S. 1885, p. 11–29.

Owen, R. Gibson and Green counties. See Lesquereux.

Indiana Coal. Min. resources of U. S. 1886, pp. 228, 230, 261.

Annual production of, p. 265.
Mines, classification of, p. 262.
Annual production of, 1887, p. 243.
Gas coals, comparison with Pittsburg coals, p. 242.
Mines and wages, p. 242.
Statistics on production, consumption of, Min. Res. U. S. 1888.
Statistics on production of, 10th census U. S. 1880.
The following are reported upon: Clay, Daviess, Dubois, Fountain, Gibson, Greene, Harrison, Knox, Martin, Owen, Park, Perry, Pike, Spencer, Sullivan, Vanderburg, Vermillion, Vigo, Warren, Warrick.
Indiana coal fields. Clay, Dubois, Perry, Pike, Posey, Spencer, Vanderburg and Warrick counties. (See Lesquereux.)
Thompson's Rep. 1888.
Cannelton. (See Lesley.)

Coke. Character of Ind. coking coals, 10th census U. S. mining industries, 1880, p. 48.
History of the coking industry, 10th census U. S. 1880, p. 27–28.

Gas. Collett, J., Rep. 1882. Observations on Gas in Indiana.
Collett, J., Rep. 1883. Observations on Gas in Indiana. Article on comparison of Indiana block with Illinois coals.
Thompson, M., Rep. 1885–86. Natural Gas. What is it?
Thompson, M., Rep. 1888. Natural Gas and Petroleum.
Gorby, S. S., Rep. 1890. (See Jordan, E. J. S.) Gas in Grant, Howard, Tipton, Hamilton, Madison, Hancock, Delaware, Blackford, Henry and Rush counties.
Gas field of Indiana. (See Leveritt.)
Natural Gas field of Indiana. Eleventh Ann. Rep. of Director of U. S. G. S. (See Phinney) pp. 617–742.
Rock Gas and Related Bitumens. Eleventh Ann. Rep. of Director of U. S. G. S. (See Magee, W. T.)
Natural Gas in Indiana. Min. Resources of U. S. 1886, p. 508; do 1887, pp. 485, 488, 489; do 1888, p. 486.
Orton, Edward. Origin of the Rock Pressure of the Natural Gases of the Trenton lime stone of Ohio and Indiana. A. J. S. III, vol. 29, p. 225.

Gold in Indiana. (See Sutton.)
Gold in Indiana. (See Cox's Geol. Rep. 1878, p. 116, Morgan and Brown counties.)

Gold in Indiana. (See Cox's Geol. Rep. 1874, p. —) Bean, Bloss. and Salt creeks.

Gold in Indiana. (See Cox's Rep. 1875, p. 370.) Montgomery and Warren counties.

Hydraulic Cement. Analysis of. E. T. Cox's Rep. 1876–78. J. Collett's Rep. 1883; S. S. Gorby's Rep. 1891.

J. Collett's Rep. 1883, pp. 38–44. Economic Geology of the state.

S. S. Gorby's Rep. 1891, p. 54.

Indiana Cements. Mineral Resources of U. S. 1885, p. 406.

Ores and Minerals. E. T. Cox's Rep. 1870. Ores of Daviess, Martin, Sullivan counties.

E. T. Cox's Rep. 1872. Ores of Dubois, Pike, Parke counties.

E. T. Cox's Rep. 1873. Ores of Lawrence, Knox, Gibson (iron).

E. T. Cox's Rep. 1875. Vigo county (iron).

J. Collett's Rep. 1880. Monroe county (iron).

J. Collett's Rep. 1882. Jasper county (iron).

J. Collett's Rep. 1883. Morgan and Rush counties.

Min. Resources of U. S. 1885, p. 88.

M. Thompson's Rep. 1885–86. Washington, Boone counties (iron).

M. Thompson's Rep. 1888. Outline sketch of the minerals of Indiana.

Iron Ores of Indiana, 10th Census U. S. Mining Industries, 1880.

Novaculite. Mineral Resources of U. S. 1886, p. 592.

Minerals of Indiana. Min. Resources of U. S. 1887, p. 727.

Mineral Waters of Indiana. Min. Resources of U. S. 1887, p. 683.

Oil. E. T. Cox's Rep. 1870. Putnam, Sullivan, Vigo counties.

E. T. Cox's Rep. 1872. Perry county (oil wells).

E. T. Cox's Rep. 1875. Vigo county.

E. T. Cox's Rep. 1876–78. Harrison and Crawford counties.

J. Collett's Rep. 1883. Jasper county.

Leverett. Am. Geol. vol IX, pp. 6–20.

Petroleum. Min. Res. of U. S. 1888, p. 464.

Petroleum in Indiana. Tenth Census of U. S. 1880, p. 26 and p. 37.

Hunt, Dr. T. S. Oil wells of Terre Haute, Ind. A. J. S. III, vol. I, p. 369.

Salt. Mineral Resources of U. S. 1886, p. 628.

Salt. Mineral Resources of U. S. 1887, p. 611.

Stone (building). E. T. Cox's Rep. 1870. Daviess and Martin counties.

E. T. Cox's Rep. 1872. Perry and Dubois counties.

E. T. Cox's Rep. 1873. Warren, Lawrence and Gibson counties.

E. T. Cox's Rep. 1875. Vigo and Orange counties.

E. T. Cox's Rep. 1876–78. Harrison and Crawford counties.

J. Collett's Rep. 1880. Oolitic Limestones.

J. Collett's Rep. 1881. Oolitic stone quarrying appliances, output, etc., in Owen, Monroe, Washington, Harrison and Crawford counties.

J. Collett's Rep. 1881. Putnam and Bartholomew counties.

J. Collett's Rep. 1881. Transverse strength of building stone.

J. Collett's Rep. 1882. Jasper and Decatur counties. Observations on building stone.

J. Collett's Rep. 1883. Economic Geology of the state, pp. 38–44. Grant county quarries.

J. Collett's Rep. 1884. Quarries in Union county.

M. Thompson's Rep. 1885–86. Indiana Building Stone.

M. Thompson's Rep. 1885–86. Quarries in Washington and Benton counties.

M. Thompson Rep. 1888. Outline sketch of the valuable minerals of Indiana, pp. 77–85.

S. S. Gorby's Rep. 1891. Quarrying industry in Indiana.

Limestones of Indiana. Mineral Resources of U. S. 1886, p. 541.

Structural Materials. Mineral Resources of U. S. 1887, p. 509.

Structural Materials. Mineral Resources of U. S. 1888, p. 524.

Descriptions of Quarries and Quarrying Regions in Indiana. Tenth Census of U. S. 1880, pp. 215–219.

Enumerates the counties yielding building stone, the companies and describes briefly the character of the stone and where used.

Indiana Marble and Limestones 10th Census Rep. U. S. 1880, pp. 50, 51, 84, 87.

Indiana Sandstones in 10th Census Rep. U. S. 1880, pp. 50, 51, 86, 87.

Elkhart. E. T. Cox. Geol. Rep. 1873.

————Geology of Fayette and Union counties. E. T. Cox. Rep. 1884.

Elrod, M. N., and Benedict, A. C. Geology of Wabash county. S. S. Gorby, 1891 (17th annual report).

Describes the topography, stratigraphy (with general section); quaternary deposits; its fossil contents. Discusses gas-developments and gives numerous well-sections.

Elrod, M. N. Geology of Bartholomew county. J. Collett's Rep. 1881, pp. 150–213.

Describes the topography, glacial deposits (Collett's glacial river valley), paleozoic

formations with connected section and local details (Carbonif. Dev. Sil.); gives lists of Hartsville fossils and notes on mineral springs, building stones, clays, etc.

————Geology of Decatur county. J. Collett's Rep. 1882, pp. 100–152.

Describes the topography, quaternary deposits and paleozoic formations; gives tablated lists of fossils from Sil. and Dev. rocks; sections from quarries; notes on the character of building stone. Archæology.

————Geology of Rush county. J. Collett's Rep. 1883, pp. 86–115.

Describes drainage, topography, physical features and fossils of corniferous and Niagara rocks; glacial features; mentions the occurrence of clays, iron ores, mineral springs, Archæological relics.

————Geology of Union county. J. Collett's Rep. 1884, pp. 61–72.

Gives general description of quaternary deposits and paleozoic rocks, with lists of Hudson river fossils; local details gathered from sections in the quarry region.

————Geology of Fayette county. J. Collett's Rep. pp. 41–60.

Discusses topography, drainage, character of drift deposits, extent of paleozoic rock and its fossils.

Elrod, M. N., and McIntire, E. S. Geology of Orange county. E. T. Cox Rep. 1875, pp. 146–239.

Discribes briefly the topography and structural features of the geological formations (Carboniferous and Subcarboniferous), millstone grit (Chester and St. Louis), with vortical sections, and relation of fossil horizons indicated. Reference is also made to mineral springs of the county (French Lick, West Baden), with analysis of iron ores, whet stones, building stone and clays, pp. 240–422.

Fayette (Pa.). E. T. Cox Rep. 1875.

Fayette county Geology. J. Collett's Rep. 1884.

————Owen, Richard.

Floyd, S. Mounds and earthworks in Vanderburg county, Indiana. Annual Rep. Board of Regents of the Smithsonian Inst. 1881. 47th Congress, 1st session. Senate Mis. Doc. No. 109.

Floyd county, Geology of. Owen, R.

Fountain county, Geology of. Owen, R.

————E. T. Cox, Geol. Report, 1875; coal, J. Collett's Rep. 1883.

Franklin county. Alluvial terraces. Quick, E.

————Fossils. Moore, R. D.

————Corals, Moore, R. D.

————Gas (see Phinney, Natural Gas in Indiana).

————Geology of. Owen, Richard.

Fulton county. Geology of. Owen, R.

Gibson County. Coal. Geol. Rep. E. T. Cox; 1870, do. 1873. J. Collett's Rep. 1883.

Goldsmith, E. Basanite from Crawford county, Ind. Proc. Acad. Nat. Sci. vol. 12, 1889–90.

Gorby, S. S. Department of Geology and Natural Resources (Ind.) Seventeenth Annual Report, 1891.

A report upon the various stones used for building and found in Indiana. Maurice Thompson, pp. 18–112.

Steuben county, Geology of. C. R. Dryer, pp. 114–134.

A partial catalogue of the flora of Steuben county. E. Bradner, pp. 135–159.

Carroll county, Geology and Natural History of. Maurice Thompson, pp. 171–191.

Wabash county, Geology of. M. N. Elrod and A. C. Benedict, pp. 192–259. Flora of Wabash county, pp. 260–272.

Report of the Inspector of Mines. S. McQuire, pp. 273–298.

Report of State Supervisor of Oil Inspection. N. J. Hyde, pp. 299–321.

Petroleum in Indiana. A. C. Bendict, pp. 306–325.

Report of Supervisor of Natural Gas. E. T. J. Jordan, pp. 326–364.

A catalogue of the butterflies known to occur in Indiana. W. S. Blachley, pp. 365–408.

The Batrachians and Reptiles of the State of Indiana. O. P. Hay, pp. 409–611.

Paleontology. S. A. Miller, pp. 611–686.

————A Terminal Moraine in Central Indiana. M. Thompson's Rep. 1885–86.

Describes the physical feature and enumerates the counties throuh which moraine extends.

————Geology of Tippecanoe county. M. Thompson's Rep. 1885–86, pp. 61–96.

Describes topography, drainage, stratigraphy (Carbonif. Dev. Sil.) drift, its physical features (sections).

————Geology of Washington county. M. Thompson's Rep. 1885–86, pp. 117–153.

Describes topography and drainage; gives a connected section across the county (Quat. Subcarbonif.); gives list of fossils from the subdivisious of sub-carboniferous; describes briefly the economic value of the limestones of the county: the extent of coal, iron, drift, caves.

————Geology of Benton county. M. Thompson's Rep. 1885–86, pp. 196–220.

Describes topography, drainage; general section of the county (Quaternary, Subcar-

boniferous); describes subcarboniferous as exhibited in various quarries; nature and thickness of the drift as made out from borings.

————Wabash Arch. M. Thompson's Rep. 1885–86, pp. 228–241.

————Prehistoric Race in Indiana. M. Thompson's Rep. 1885–86, pp. 286–313.

————Geology of Miami county. M. Thompson's Rep. 1888, pp. 165–188.

Describes topography drainage; physical features and depth of the drift; clays, sand iron ore; stratigraphy (Dev. Sil.), natural gas, well sections.

————Natural gas and petroleum. M. Thompson's Rep. 1888.

Discusses origin of gas; anticlinial and sea level theories; surface indications of gas and oil; structural features of Indiana oil field; gives well sections; altitudes discusses economic use of natural gas.

————List of specimens in the State Museum. M. Thompson's Rep. 1888, pp. 383–472.

Gorby, S. S. and Lee, S. E. Geology of Boone county. M. Thompson's Rep. 1885–86, pp. 160–176.

Describes the surface features, drainage and glacial deposits, its depths as revealed by borings (no pal. formation exposed).

Grant county, Geology of. J. Collett's Rep. 1883. Gas (see Phinney, Natural Gas in Indiana.)

Greenbrier Group. (See T. J. Stevenson.)

Greene county. E. T. Cox's Rep. 1875. Coal. J. Collett's Rep. 1883. R. Owen's Rep.?

Greene, G. K. Geology of Monroe county, J. Collett's Geol. Rep. 1880, pp. 426–499.

Gives brief description of the lithological characters of subcarboniferous with numerous sections and their fossils: reference is also made lacustral and glacial deposits, iron ore, building stone, clays, etc.

Gurley, F. E. (See Miller, S. A.)

Haines, Mrs. Mary. List of Silurian fossils from Richmond, Ind. E. T. Cox Geol. Rep. 1876–77–78.

————List of plants. E. T. Cox, Geological Rep. 1876–77–78.

Hall, Dr. James. Notice of some new species of fossils from a locality of the Niagara group in Indiana. Vol. IV Trans. Albany Inst. 1862; Trans. Albany Inst. 1879; also N. Y. St. Mus. Rep. 1876.

————Description of the species of fossils found in the Niagara group at Waldron. J. Collett's Geol. Rep. 1881.

————VanCleve's fossil corals. J. Collett's Rep. 1882.

————Descriptions of fossil corals from the Niagara and upper Helder-

berg groups of Indiana. (Plates.) J. Collett's Rep. 1882.

————Descriptions of the fossil reticulate sponges, constituting the family Dictyospongidæ (4 plates). 35th Ann. Rep. N. Y. Mus. Nat. Hist., 1884.

The following genera from the Keokuk beds about Crawfordsville are figured and described: Dictyophyton, Ectenodictya, Lyrodictya, Phyagmodictya, Cleodictya, Physopongia.

————Descriptions of some new species of fossils from the carboniferous limestones of Indiana and Illinois. Trans. Albany Inst., vol. IV, pp. 1–37.

See also A. J. S., vol. XXIV (second series), p. 276.

————Notice of some new species of fossils from the Niagara of Indiana, with list of identified species from the same place. Pub. May 2d, 1883 (34 pp. 8vo).

Abstract read before Albany Inst., April 29th, 1862.

Hancock county, Geology of. R. Owen's Rep. 1859–60. M. Thompson Rep. 1885–1886.

————Gas. (See Phinney Natural Gas, in Indiana.)

Hamilton county, Geology of. R. Owen's Rep. 1859–60. Collett's Rep. 1884. (Gas, see Phinney.)

Harrison county, Geology of. R. Owen's Rep. 1859–60; do E. T. Cox, 1872; do, 1876–78; do. 1881.

Hartmann, Hugh. Manufacture of Spiegeleisen, E. T. Cox Rep. 1872, pp. 71–101.

Iron and steel industries of Rhenish Prussia and Westphalia. Germany at the Vienna Exhsbition of 1873 (with map), pp. 13–70.

Hatfield. R. S. Indiana Oolitic stone. J. Collett's Rep. 1884.

Hay, O. P. Batrachians and reptiles of Indiana. S. S. Gorby (17th annual report), 1891.

Haymond, Rufus. Notes of remains of Megathorium, Mastodon and Silurian Fossils. (General description.) A. J. S. (first series) vol. XLVI, pp. 294–296.

Hendricks county, Geology of. Owen's Rep. 1859–60.

Henry county, Geology of. Owen's Rep. 1859–60; do M. Thompson's Rep. 1885–86. (Gas see Phinney.)

Hobbs, Prof. B. C. Geological report of Parke county. E. T. Cox Rep. 1872, pp. 337–341.

Describes topography, drift deposits, stratigraphy (general sections), gives some general observations upon coal, iron ore and sand stones of the county.

Homsher, G. W. The Glidewell mounds of Franklin county, Indiana. Remains on White Water river, Indiana. Ann. Rep. Board of Regents of the Smithsonian Inst. 1882; 47th Congress, 2d session House of Representatives, Mis. Doc. No. 26.

Howard county, Geology of. Owen's Rep. 1859-60; do E. T. Cox Rep. 1872. (Gas see Phinney.)

Hubbard, George C. The upper limits of the lower Silurian at Madison, Indiana. Pr. Ind. Acad. of Sc. 1891, pp. 68-70.

Places the limit fifty feet above the favistella reef.

The Cystideans of Jefferson county, Indiana. Pr. Ind. Acad. of Sc., 1891, p. 67.

Notes their abundance.

Hudson river fossils of Jefferson county, Indiana. Pr. Ind. Acad. of Sc., 1891, p. 68.

Corrects errors in Geological Report for 1874, and gives list of orders represented.

Hunt, Dr. J. Sterry. Oil wells of Terre Haute. Geological Rep. 1870, E. T. Cox. See also A. J. S. III vol. I, p. 369, abstract of paper on oil wells of Terre Haute, presented at A. A. A. S., August 1871.

Huntington county, Geology of. Owen's Rep. 1859-60; do E. T. Cox Rep. 1875.

Hyde, N. J. Report of State Supervisor of Oil Inspection. S. S. Gorby (17th annual Rep.) 1891.

Indiana Oolitic Stone. R. S. Hatfield. (See J. Collett's Rep. 1884.)

Jackson County, Geology of. R. Owen's Rep. 1859-60; do E. T. Cox's Rep. 1874.

James, J. F. A Cave in the Clinton formation. Jour. Cin. Soc. Nat. Hist. Apr. 1890.

James, U. P. Catalogue of Lower Silurian Fossils of the Cin. Group found within 40 or 50 miles of Cincinnati with descriptions of some new species of Corals and Polyzoa. (Published in book form in Cincinnati 1875.

The new species described belong to the following genera: *Chætetes, Ceramopora, Ptelodictya, Alecto.*

Jasper county, Geology of. E. T. Cox's Rep. 1872.

————Geology. J. Collett's Rep. 1882; R. Owen's Rep. 1859-60.

Jay county, Geology of. J. Collett's Rep. 1882. Gas (see Phinney Nat. Gas in Indiana).

————Geology of. R. Owen's Rep. 1859-60.

Jefferson county. Botany. E. T. Cox. Geol. Rep. 1870.

————Geology of. (See Borden Geol. Rep. 1874); do. R. Owen's Rep. 1859–60.

————Cystidians. (See Hubbard.)

Jennings county, Geology of. E. T. Cox's Rep. 1875; do. R. Owen's Rep. 1859–60.

Johnson county, Geology of. J. Collett's Rep. 1883; do. R. Owen's Rep. 1859–60.

Johnson, H. S. Experiments upon the transverse strength and elasticity of building stone. E. T. Cox's Rep. 1881, pp. 47–54.

Jordan, E. T. J. Report of Supervisor of Natural Gas. S. S. Gorby (17th Ann. Rep.) 1891, pp. 326–364.

Describes the extent (counties) of Indiana field; its source (Trenton Rock); conditions of production; economic use; gas plants throughout the field.

Kankakee river. (See Campbell).

Keokuk Fossils. (Beachler).

Keyes, C. R. The carboniferous echinodermata of the Mississippi basin, A. J. S. III, vol 38, p. 186.

Knox county, Coals. E. T. Cox. Rep. 1870.

————Coals. Geology of. E. T. Cox Rep. 1873; Coals, J. Collett's 1883. Coals, Lesquereux.

Lagrange County, Geology of. R. Owen. 1859–60. E. T. Cox Rep. 1873.

Lake County, Geology of. R. Owen. 1859–60.

Langsdale, Geo. J. Map of Wyandotte Cave. Appendix to Rep. Ind. Geol. Surv. 1859-60.

Laporte County, Geology of. R. Owen, 1859 60; do E. T. Cox Rep. 1873.

Lawrence County, Geology of. R. Owen, 1859–60; do E. T. Cox Rep. 1873.

Lee, S. E. (See Gorby). Geology of Boone county. M. Thompson Rep. 1885 86.

Lesley J. Report on the Cannelton district, Perry county, and topographic map. Ind. Geol. Survey 1859 60. Map not published.

Lesquereux, Leo. Species of fossil marine plants from the carboniferous measures. E. T. Cox Rep. 1875.

————Principles of Paleozoic Botany (Pt. II). J. Collett's Rep. 1883, pp. 7–106.

Introductory remarks on Geological phenomena bearing upon paleo-botany classification of strata, fossilization; collecting of fossil plants; gives outline of the chief divisions of the vegetable kingdom and their distribution in geologic time; history

of plants known in Paleozoic Rocks of United States with description (plates 1–22) a few genera and species.

————Distribution of the Geological strata in the coal measures of Indiana. Ind. Geol. Surv. 1859-60.

Describes fifteen coal beds and associated rocks; gives directions for prospecting for coal; observations on the coal of each county in the coal field, on the value of the coal in general and the geological horizon of the coal.

Leverett, Frank. On the correlation of Moraines with Raised Beaches of Lake Erie. A. J. S. III, vol. 44, p. 281.

————Glacial phenomena of Northeastern Illinois and Northern Indiana. A. A. A. S. vol. 38, p. 248 (1889).

————Studies in the Indiana Gas Field. Am. Geol. vol. IV. pp. 6–20.

Describes the character stratagraphical extent and thickness of the Devonian and Silurian shales and limestones; discusses the topographic features of the "Cincinnati Axis" as brought out by the table of boreings giving altitudes, depths and thickness of the formations penetrated, also the distribution of natural gas in the Indiana field, strength of wells; difference in altitude of salt water line in Indiana and Ohio, occurrence of oil: theories explaining rock pressure as manifested by the gas flow.

————Lithographic stone. E. T. Cox Rep. 1872, pp. 77–147. (Perry county).

Levette, G. M. E. T. Cox Rep. 1875. (Depths and temperatures of lakes in Northern Indiana.)

————Observations on DeKalb, Steuben, Lagrange, Elkhart, Noble, St. Joseph, Laporte counties. E. T. Cox Rep. 1873, pp. 430–474

————Fuel values of coals. J. Collett's Rep. 1873, pp. 10–34.

Gives tabulated analysis of coals from Clay, Daviess, Dubois, Fountain, Greene, Gibson, Knox, Martin, Montgomery, Owen, Parke, Perry, Spencer, Sullivan, Vanderburg, Vermillion, Vigo, Warrick, Warren, Posey counties.

————Observations on the depth and temperature of some of the lakes of Northern Indiana. E. T. Cox Rep. 1875, pp. 469-503.

A hydrographic survey is made of the following lakes: Manitou, Fulton county; Pine, Laporte county; Stone, Laporte county; Clear, Laporte county; Centre, Kosciusko county; Syracuse, Kosciusko county; Eagle, Kosciusko county; Reservoir, Noble county; Bixell's, Noble county; Latta, Noble county; Twin Lakes, Lagrange county; Crooked Lake, Steuben county; James, Steuben county.

Lyon S. S. and Casseday S. A. Descriptions of nine new species of Crinoidea from the subcarboniferous rocks of Indiana and Kentucky. A. J. S. Ser. II. vol. 28, p. 233 and vol. XXIX, pp. 68–79.

The species described belong to the following genera, viz: Asterocrinus, Pterocrinus, Zeacrinus, Cyathocrinus, Actinocrinus, also a new genus, Onychocrinus.

Madison county, Geology of. J. Collett's Rep. 1884. Gas (see Phinney, Natural Gas in Ind.)

————Geology of. R. Owen's Rep. 1859–60.

Magee, W. J. Rock Gas and related Bitumens. 11th Ann. Rep. of director of U. S. J. S. pp. 589–616.

Discussed under the following sections: I. Development of the Bitumens. II. Constitution of the Bitumens. III. Distribution of the Bitumens (geological and geographical.) IV. The natural storage of the lighter Bitumens. V. Origin of Rock Gas and related Bitumens. VI. The future of Rock Gas and its allies.

Mammoth Cave. Faunas in. E. T. Cox Rep. 1872.

Marion county, Geology of, J. Collet's Rep. 1882. Gas (see Phinney, Natural Gas in Ind).

————Geology of. R. Owens. Rep. 1859–60.

Marshall county, Geology of. M. Thompson Rep. 1885–86; do R. Owen's Rep. 1859–60.

Martin county, Geology of. Coals, E. T. Cox Rep. 1870; J. Collett's Rep. 1883. Coal, Lesquereux.

Maxinkuckee Lake. M. Thompson Rep. 1885–86.

McCaslin, D. S. Geology of Jay county, J. Collett's Rep. 1882, pp. 153–176.

Describes surface features, Paleozoic formation (Niagara the only rock known,) gives list of fossils; notes on archæology and fossil vertebrates (mastodon.)

M'Caslin, D. S. Geology of Johnson county. J. Collett's Rep. 1883, pp. 116–137.

Describes topography, stratigraphy, (Quat. Carbon. Dev.) economic products; archæological remains.

McChesney, J. T. New Paleozoic Fossils (Chicago, 1859), 64 pp.

Describes Faunas from carboniferous rocks of western states, viz., Crinoidea, Brachispoda, Lamellibrachiata Gasteropoda, Cephalopoda. Notes in A. J. S. II. Ser., vol. XXIX, p. 285.

McGuire, Thomas. Report of the Inspector of Mines. S. S. Gorbey. (17th annual Rep. 1891.)

The condition of coal mines in the following counties are reported upon: Clay, Vigo, Owen, Vermillion, Parke, Daviess, Pike, Gibson, Perry, Greene, Spencer, Warrick, Vanderburgh, Knox, Sullivan. Tabulated statement of coal companies of Indiana, and their addresses.

McIntire, E. S. (Elrod, M. N.) Geol. of Orange county. E. T. Cox Rep. 1875.

Mecklenburg (Ky.) E. T. Cox Geol. Rep. 1875.

Meek, F. B. Descriptions of two new star fishes and a crinoid from the Cincinnati Group of Ohio and Indiana. A. J. S. III. Ser., vol. III, p. 257,

Meek, F. B. and Worthen, A. H. Remarks on the age of the Goniatite Limestone at Rockford, Indiana and its relations to the "Black Slate" of the western states and to some of the succeeding rocks above the latter. A. J. S. (II Ser.) vol XXXII, pp. 167–177.

————On some new Silurian Crinoids and Shells. A. J. S. Ser. III, vol. III, p. 295.

Species beloging to the following genera are described *Dindrocrinus, Lepocrinites;* remarks on *genus Lichenocrinus.*

————On the Punctate Shell structure of Syrimyotheris. A. J. S. II Ser. vol. 43, p. 407.

Species described from Floyd county, Ind.

Meteorites. Harrison county. E. T. Cox Rep. 1876–77–78.

Miami county, Geology of. E. T. Cox Rep. 1872. M. Thompson's Rep. 1888. R. Owen's Rep.1859–60. Gas. (See Phinney, Natural Gas in Indiana.)

Miller, S. A. Catalogue of fossils from Hudson river, Utica and Trenton, in S. E. Indiana, S. W. Ohio and northern part of Kentucky. E. T. Cox Geol. Rep. 1876–77–78.

————S. S. Gorby (17th Ann. Rep.) 1891. Paleontology; Protozoa, Cœlenterata, Echinodermata and Mollusca.

Descriptions and plates.

————The structure, classification and arrangement of American paleozoic crinoids into families. M. Thompson's Rep. 1888, pp. 302–326.

Miller, S. A. and Gurley, F. E. Descriptions of some new genera and species of *Echinodermata,* from the coal measures and sub-carboniferous rocks of Indiana, Missouri Iowa. M. Thompson's Rep. 1888, pp. 327-382.

————Descriptions of some new genera and species of Echinodermata from coal measures and sub-carboniferous rocks of Ind. Journ. Cin. Soc. Nat. His. Apr. 1890.

Miller, S. A. The structure, classification and arrangement of American Pal. Crinoids into families. Am. Geol. vol. VI, Nov. 1890, p. 275.

Monroe county, Geology of. J. Collett's Rep. 1880; do R. Owen's Rep. 1859–60.

Montgomery county, Geology of. E. T. Cox Rep. 1875. Coal. J. Collett's Rep, 1883. Keokuk rock at Crawfordsville. (See Beachler; do S. S. Gorby's Rep. 1888.)

Moore, Joseph. Description of a new species of Rodent. Journ. Am. Society Nat. Hist., Apr. 1890.

Moore, D. R. Two hours among the fossils of Franklin county. Bull. Brookville Soc. of Nat. Hist. No. 1. Richmond, Ind. 1885, pp. 44–45.

Gives eighteen common species of Low. Sil. fossils.

————Fossil Corals of Franklin county. Bull. Brookville Society of Nat. Hist. No. 2, pp. 50–52.

Twenty-seven species of Upper and Lower Silurian Dev. and drift.

Morgan county, Geology of. J. Collett's Rep. 1883; do R. Owen's Rep. 1859–60.

Newberry J. S. Fossil fish teeth. E. T. Cox, Geol. Rep. 1876, '77, '78.

————Drift deposits of Indiana. J. Collett's Rep. 1884, pp. 85–98.

Describes climatal conditions previous to and during the glacial period; traces the "marginal line" through Indiana and Ohio; describes the nature of the drift materials, manner of accumulation and sources from which it was derived.

Newton County, Geology of. J. Collett's Rep. 1882; do. R. Owen's Rep. 1859–60.

Noble County, Geology of. E. T. Cox's Rep. 1873; do. R. Owen's Rep. 1859–60.

Novaculite. Mine Resources of the United States 1885, p. 435; do. 1886, p. 592.

Ohio County, Geology of. Richard Owen. Rep. 1859–60.

————E. T. Cox Rep. 1872.

Ohio river Floods. Collett's Rep. 1884.

Orange county, Geology of. Geological Rep. 1875.

————Geology of. Richard Owen. 1859–60.

Orton, Edward. Gas, Indiana and Ohio. (See gas and building stone under Econ. Geol.)

Owen County, Coal. Lesquereux.

————E. T. Cox Geol. Rep. 1875; J. Collett's Rep. 1881; do coal, 1883.

Owen D. D. Sketch of the life of Am. Geologist, vol. 4, pp. 65–72.

————Meteorlogical notices in Indiana. A. J. S. (Ser. 1) vol. 29, p. 294.

————Analysis of coals of Indiana (1838), J. Collett's Rep. 1883.

Owen, David Dale and Norwood, T. G. Description of a new fossil fish from the paleozoic rocks of Indiana (figures). A. J. S. (new series) vol. 1, pp. 367–371.

————A Report of a Geological Reconnoisance of Indiana for 1859 and 1869, pp. 365, 2 pls. Indianapolis, 1862.

Reports on "A Reconnoisance of the State," by Richard Owen; on the "Chemistry of Soils," by Robert Peters; on "Coal," by Leo Lesquereaux; on the "Cannelton

Coal Field," by J. Lesley; also an appendix with table of altitudes, etc.

Owen Richard. A Geological Reconnoisance of Indiana. Indiana Geological Survey, 1859–60.

Gives an account of the more prominent geologic features of each county and the age the rocks.

————Table of altitudes in Indiana—extralimital altitudes.

Hydraulic lime stone analysis from Madison and Cass counties. Plates and descriptions of eleven Silurian and Carboniferous fossils. Appendix to Geol. Surv. of Ind. for 1859–60.

————Analysis of Indiana coals. J. Collett's Rep. 1883.

Parke county, Geology of. R. Owen's Rep. 1859–60; E. T. Cox Rep. 1872; do 1875; J. Collett's Rep. 1883—coal. (See Lesquereux, coal).

Perry county, Geology of. Owen's Rep. 1859–60; E. T. Cox 1872; do 1870; coal—J. Collett's Rep. 1883. (See also Lequereux.)

————Topographic map of. (See J. Lesley.)

Peter Robert. Chemical analysis of Indiana soils. Ind. Geol. Surv. 1859–60.

Gives an analysis of soils and subsoils from each of the principal geological formations of the state.

————Analysis of Louisville and Jeffersonville limestone. Appendix to Ind. Geol. Survey 1859–60.

Phinney, A. J. Geology of Delaware county. J. Collett's Rep. 1881.

————Catalogue of the flora of Central-Eastern Indiana. J. Collett's Rep. 1882.

————Geology of Henry county and portions of Randolph, Wayne and Delaware counties. M. Thompson Rep. 1885–86.

Describes topography, stratigraphy (Niagara), glacial river channels, Kames asars Discusses the nature and extent of the terminal moraines of the second glacial epoch (?); the direction and extent of the bowlder tract; archæology.

————Geology of Randolph county. J. Collett's Rep. 1881, pp. 177–195.

Discusses surface features, extent of quaternary deposits, paleozoic rock; gives notes on economic products; archæology.

————Geology of Grant county. J. Collett's Rep. 1883.

Describes surface features, quaternary deposits, silurian (Niagara) rocks; gives sections from quarries; refers to clay and archæology.

————The Natural Gas Fields of Indiana. U. S. Geol. Survey (11th Ann. Rep. of Director) 1889–90, pp. 617–742.

Under the heading "The Geological Structure of Indiana," the following topics are discussed:

A. General Structure. I. *Stratigraphy*—Giving a general section and brief outline of the extent, thickness and character of each rock-series—(map); also a table showing the total thickness of the drift as obtained from borings. II. *Altitude of the strata*—Views concerning the nature and extent of the Cincinnati arch; topography of Trenton limestone, as made out from well-borings. (Hypsographic map and cross-sections of Trenton limestone.) The hypothetic "Wabash *arch*" is briefly described. Prof. S. S. Gorby's views, as contained in 15th Ann. Rep. Geol. and Nat. Hist of Indiana, are quoted.

B. Conditions of Gas Accumulation. Sec. I. Conditions of rock structure. II. Conditions of rock texture.

C. Gas Pressure and Measurement. Defines I. Static pressure. II. Open pressure. III. Retained pressure. IV. How to measure the amount (cubic feet) of gas yielded; gives tables showing capacity of wells.

D. The Gas Field and the Borings Within it. I. The area yielding gas and oil. II. Records of borings within the main field reviewed by counties—(Blackford, Jay, Delaware, Randolph, Wayne, Madison, Grant, Howard, Tipton, Hamilton, Hancock, Marion, Miami, Wabash, Henry, Rush, Shelby, Decatur, Franklin, Dearborne, DeKalb) giving number of wells in each county and aggregate daily flow, etc.

E. Record of Borings Outside of the Gas Field. Gives record of borings in the following counties: Union, Fayette, Bartholomew, Jennings, Jefferson, Clarke, Floyd, Harrison, Washington, Jackson, Johnson, Hendricks, Montgomery, Parke, Boone, Clinton, Carroll, White, Pulaski, Cass, Miami, Fulton, Porter, Lake, Laporte, St. Joseph, Marshall, Elkhart, Kosciusko, Whitley, Noble DeKalb, Allen, Wabash, Huntington, Wells and Adams.

F. The Care of Gas Wells.

Pike county Coal. Geology. Owen's Rep. 1859–60; Cox 1872, do 1870; coal, J. Collett's Rep. 1883. (See also Lesquereux.)

Pitman's Cave. Description of. E. T. Cox Rep. 1872.

Pocono. (Group.) See J. J. Stevenson.

Patton A. Antiquities of Knox county, Ind., and Lawrence county, Ill. Anual Rep. of the Board of Regents of Smithsonian Institute, 1873. Forty-third Congress, first session. Senate Mis. Doc. No. 130, 1874.

Pigeon W. Ancient burial mounds of Indiana. Annual report of the Board of Regents of Smithsonian Institute, 1867; also Fortieth Congress, second session. Senate Mis. Doc. No. 86, 1868.

Posey county, Geology of. Owen's Rep. 1859–60; E. T. Cox's Rep. 1875; do. (coal) J. Collett's Rep. 1883; (coal) see Lesquereux.

Pulaski county, Geology of. M. Thompson's Rep. 1888; do. R. Owen's Rep. 1859–60.

Putnam county, Geology of. R. Owen's Rep. 1859–60; E. T. Cox's Rep. 1870; E. T. Cox's Rep. 1875; J. Collett's Rep. 1880; do. 1881.

————University cave. J. Collett's Rep. 1884.

Quaternary. T. C. Chamberlain. Glacial boundaries in Indiana and adjacent states. Bull. No. 58, U. S. G. S.

E. T. Cox's Geol. Rep. 1870. Sullivan, Daviess, Martin counties.

E. T. Cox's Geol. Rep. 1873. Warren county.

E. T. Cox's Geol. Rep. 1875. Vigo, Huntington, Jennings, Ripley, Vanderburg, Owen, Montgomery, Clay counties.

E. T. Cox's Geol. Rep. 1876. Boone county (Ky.), Wayne county, Harrison, Crawford counties.

J. Collett's Geol. Rep. 1880. Putnam and Monroe counties.

J. Collett's Geol. Rep. 1881. Shelby, Delaware, Bartholemew (Collett's glacial river).

J. Collett's Geol. Rep. 1882. Newton, Decatur, Jay, Randolph counties.

J. C. Collett's Geol. Rep. 1883. Posey, Morgan, Rush, Johnson, Grant counties.

J. Collett's Geol. Rep. 1884. Hamilton, Madison, Fayette, Union counties.

J. Collett's Geol. Rep. 1884. Drift deposits of Indiana. J. S. Newberry.

J. Collett's Geol. Rep. 1884. E. D. Cope and J. L. Wortman.

S. S. Gorby's Rep. 1891. (Moraines of Steuben county.)

M. Thompson's 15th Ann. Rep. 1885–86. Glacial deposits of Indiana.

M. Thompson's 15th Ann. Rep. 1885–86. A Terminal Moraine in Central Indiana, by S. S. Gorby.

M. Thompson's Rep. 1888. Drift beds of Indiana (DeKalb, Allen, Pulaski, White, Miami counties).

Quick, E. R. Alluvial Terraces, Bull. No. 3. Brookville Society of Natural History, Brookville, Ind., 1888.

Describes four terraces of the White Water Valley.

————Alluvial terraces. Bull. No. 3 Brookville Soc. Nat. Hist. 1888.

————Stone mounds on the White Water. Bull. No. 1, Brookville Soc. Nat. Hist. pp. 3–5.

Ripley county, Geology of. R. Owen's Rep. 1859–60. E. T. Cox's Rep. 1875.

Randolph county, Geology of. Owen's Rep. 1859–60. J. Collett's Rep. 1882. M. Thompson's Rep. 1885–86.

————Geology of. Gas (See natural gas in Indiana) Phinney.

Robertson county, Geology of. E. T. Cox's Rep. 1875 (lignite) pp. 79–115.

Rowley, R. R. Some observations on the natural casts of crinoids and blastoids from subcarboniferous limestone, Indiana, Iowa, Illinois, Kentucky, Alabama.

Rush county, Geology of. R. Owen's Rep. 1859–60. J. Collett's Rep. 1883.

————Oil and gas. (See A. J. Phinney, natural gas in Indiana.)

Schneck, J. S. Catalogue of the flora of the Wabash Valley below the mouth of White river and observations thereon. E. T. Cox's Rep. 1875.

Scott county, Geology of. R. Owen's Rep. 1859–60; do. Geol. Rep. 1874. (See Borden.)

Seely, H. M. The genus strephochetus: Distribution and species. A. J. S. Ser. III, vol. 32, p. 31. (Sponge found at Madison, Ind.)

Shelby county, Geology of. R. Owen's Rep. 1859–60. J. Collett's Geol. Rep. 1881.

————Gas and Oil. (See A. J. Phinney, Natural Gas in Indiana.)

Silurian (lower). Correletion of the Cincinnati and Hudson river group in Indiana, with the Trenton and Nashville series of Tennessee, Kentucky and their equivalents in Ohio, Illinois, Iowa and Wisconsin and Minnesota, New York and Canada. (See E. O. Ulrich.) Am. Geol. vol. 1 p. 100 and vol. 2 p. 39.

Smith, S. J. Notice of fossil insects from the carboniferous formation of Indiana. A. J. S. Ser. III, vol. I, p. 44.

Wing of insect from collection in Hanover College Museum, and found in the carboniferous rocks (whetstones) near Paoli, Orange county.

Spencer county, Geology of. R. Owen's Rep. 1859–60; do coal, E. T. Cox, 1873; do 1870; coal, J. Collett's Rep. 1883; coal (see Lesquereux).

Starke county, Geology of. R. Owen's Rep. 1859–60; do M. Thompson's Rep. 1885–86.

Stein, Fredrick. Synopsis of the Molluscus faunas of Indiana. J. Collett's Geol. Rep. 1880.

Steuben county. Flora of. E. T. Cox Geol. Rep. 1873.

————S. S. Gorby's Rep. 1891.

Stevenson, J. J. Report of the Sub-Committee on Upper Paleozoic (Carbonic). Am. Geologist, vol. II, pp. 248–256.

Gives classification of the carboniferous rocks as known in U. S.

Indiana classification as follows:

Upper Carbonic.	Upper coal measures	Merome Sand stone. Upper coal measures.
	Middle coal measures	Lower coal measures.
	Lower coal measures	Conglomerate or millstone. Grit.
Lower Carbonic.	Greenbrier	Mountain Limestone.
	Pocono	Knobstone group in part.

St. Joseph county, Geology of. R. Owen's Rep. 1859–60; do (peat), E. T. Cox Rep. 1872–73.

Sutton, George. The Gold bearing rocks of Ind. A. A. A. S., vol. 30, p. 177, 1881.

————Glacial or ice deposits in Boone county (Ky.) of two distinct and widely distant periods. E. T. Cox Geol. Rep 1876–77–78.

Sullivan county, Geology of. R. Owen's Rep. 1859-60; (Coal) E. T. Cox, 1872; do 1873; do (coals) E. T. Cox, 1870; do 1875. J. Collett's Rep. 1883; coal (see Lesquereux).

Switzerland county, Geology of. R. Owen's Rep. 1859–60; do E. T. Cox Rep. 1872.

Thompson, Maurice. Fifteenth Annual Report Dept. of Geology and Natural History, 1885-86.

Compendium of Geology and Mineralogy of Indiana, pp 10-25.

Gives a sketch of the geographical extent of the Sil. Dev. Subcarb. and Coal-measure rocks of Indiana.

Indiana Building Stone, pp. 26–33.

Describes the qualities and extent of I. limestones in general. II, oolitic limestones. III, sandstones.

Clays of Indiana, pp. 34–40.

Describes the nature, composition and mode of formation. Describes endianite (analysis) and compares it with analysis of clays from other countries.

Indiana Chalk-beds, pp. 41–43.

Describes the probable modes of formation; gives analysis (by Dr. Hurty) of samples from Lake Maxinkuckee and Kosciusco county.

Glacial deposits in Indiana, pp. 44–56.

Discusses Glaciers and their action; the glacial period, its extent and effect; descriptions of the drift deposits of Ind.; describes briefly sections and borings showing the interior of the drift deposits; also special features of the drift.

A Terminal Moraine in Central Indiana, pp. 57–60.

Henry county and portions of Randolph, Wayne and Delaware counties, Geology of. A. J. Phinney, pp, 97–116.

Washington county, Geology of. S. S. Gorby, pp. 117–153.

Clinton county, Geol. Survey of. W. W. Thompson, pp. 154–159.

Boone county, Geology of. S. S. Gorby and S. E. Lee, pp. 160–176.

Marshall county, Geology of. W. H. Thompson, pp. 177–182.

Maxinkuckee lake. W. H. Thompson and S. E. Lee, pp. 182–186.

Hancock county, Geology of. R. T. Brown, pp. 187–197.

Benton county, Geology of. S. S. Gorby, pp. 198–220.

Starke county, Geology of. W. H. Thompson, pp. 221–227.

The Wabash Arch. S. S. Gorby, pp. 228–241.

Geographical Botany. W. W. Thompson, pp. 242–252.

Origin of Indiana Flora. J. M. Coulter and H. Thompson, pp. 253–282.

Fossil Mammals of the Post-Pliocene of Indiana, pp. 283–285.

Pre-historic Race in Indiana. S. S. Gorby, pp. 286, 313, 334.

Natural Gas (what is it?) pp. 314.

Dissimilarities in composition, origin and accumulation; where found. "Surface signs" of its existence.

Gas Wells and Oil in Indiana. Outline of well sections. Character of the gas. Glossary, S. E. Lee.

————Geology and Natural History with natural Gas map (Sixteenth Annual Report, edited by S. S. Gorby) 1888.

Drift beds of Indiana, pp. 20–38.

Describes the changes and modifications of the drift since its deposition; direction and force of the glacial ice; depth and structure of the drift in Ind.; minerals and fossils of the drift.

The Wabash Arch. p. 41.

Fossils and their values. W. H. Thompson, pp. 54–74.

Outline sketch of the most valuable minerals of Ind. W. H. Thompson, pp. 77–85.

Gold, silver and precious stones, pp. 87–92.

The formation of soils and other superficial deposits, pp. 93–96.

DeKalb county, Geology of. C. R. Dryer, pp. 98–104.

Allen county, Geology of. C. R. Dryer, pp. 105–129.

Pulaski and White counties, Partial report of the survey of the western division including sketches of. W. H. Thompson, pp. 131–151.

Preliminary sketch of the characterestic plants of the Kankakee region, pp. 153–161.

Preliminary sketch of the aquatic and shore birds of the Kankakee region, pp. 162–165.

Miami county, Geology of. S. S. Gorby, pp. 165–188.

Natural Gas and Petroleum. S. S. Gorby, p. 189.

The structure, classification and arrangement of American paleozoic crinoids into families. S. A. Miller, 302–326.

Descriptions of some new genera and species of *Echinodermata* from the coal measures and sub-carboniferous rocks of Indiana, Missouri and Iowa. S. A. Miller and F. E. Gurley, pp. 327–373.

Dearborn county, Flora of. S. H. Collins, pp. 376–382.

List of specimens in the State Museum. S. S. Gorby, pp. 383–472.

————A report upon the various stones for building and found in Indiana. S. S. Gorby (17th Rep.) 1891, pp. 18–113.

Discusses hindrances to the early development of building stone; kinds of building stone; names geological formations of Indiana yielding building materials; discusses the geology distribution and architectural qualities of Indiana sandstones, limestones and oolitic limestone deposits; hydraulic cements; reviews briefly the quarrying industry in Indiana and enumerates the quarry companies of Indiana. with items concerning capital, equipment and amount of stone handled.

————Geology and Natural History of Carroll county. S. S. Gorby (17th Rep.) 1891, pp. 171–191.

Describes topographic features, character of soils, stratigraphy (Dev. Sil.), gas; gives list of the plants of the county.

Describes surface features, the nature and extent of the drift.

Thompson, W. W. Geology of Marshall county. M. Thompson's Rep. 1885–86, pp. 177–182.

Describes briefly the drainage and drift which covers the entire county; mention is made of iron ores, clays and lake basins.

————Geology of Starke county. M. Thompson's Rep. 1885–86, pp. 221–227.

Describes topography character of glacial deposits; soundings of Cedar lake.

————Fossils and their value. M. Thompson's Rep. 1888, pp. 54–76.

Discusses the use, nature and distribution of fossils; how fossils should be collected; enumerates fossil localities and horizons; describes vertebrate and invertebrate fossil beds; gives list of fossils found at Crawfordsville (by C. Beachler); describes archæological relics and sub-fossil remains.

————Outline sketch of the most valuable minerals of Indiana. M. Thompson's Rep. 1888, pp. 77–85.

Mentions kaolin, building stone, coals, iron ore, chalk, etc.

————Partial Report of the Survey of the Western Division, including Sketches of Pulaski and White counties. M. Thompson's Rep. 1888, pp. 121–151.

Gives a general outline of the importance and kind of work which the survey is doing, viz: On gas developments, the tracing of morainic deposits; discusses also methods of drainage, formation of sand ridges, extent and nature of bowlder drift, stratigraphy, gas (Pulaski) oil and iron; describes Tippecanoe river.

————Geology of Clinton county. M. Thompson's Rep. 1885–86, pp. 154–159.

Describes surface features, nature and extent of drift.

————Geographical Botany. M. Thompson's Rep. 1885–86, pp. 242–252.

Tippecanoe county, Geology of. R. Owen's Rep. 1859–60; S. S. Gorby. M. Thompson's Rep. 1885–86.

Tipton county, Geology of. R. Owen's Rep. 1859–60. Gas (see Phinney "Natural Gas in Indiana.")

Ulrich, E. O. A correlation of the lower silurian horizons of Tennessee and of the Ohio and Mississippi valleys with those of New York and Canada. Am. Geol. vol. 1 pp. 100–110 and 179–190.

————New Lamellibrachiata. Am. Geol. vol. 6, Sept., 1890.

Union county, Geology of. R. Owen's Rep. 1859–60. J. Collett's Rep. 1884.

Vancleve's Fossil Corals. J. Collett's Geol. Rep. 1881.

————J. Collett's Geol. Rep. 1882.

(Described and compiled by James Hall.)

Vanderburg county, Geology of. (Coal) R. Owen's Rep. 1859–60; E. T. Cox's Rep. 1870; do 1875. Coal, J. Collett's Rep. 1883.

Vermillion county, Geology of. (Coal) R. Owen's Rep. 1859–60; E. T. Cox's Geol. Rep. 1875. Coal, J. Collett's Rep. 1883.

Vigo county, Geology of. R. Owen's Rep. 1859–60. (Coal) see Lesquereux. Mineral springs, coal, E. T. Cox's Geol. Rep. 1870; do Rep. 1875; coal, J. Collett's Rep. 1883.

Wabash county, Geology of. (See Phinney, natural gas in Indiana.)

————R. Owen's Rep. 1859–60; E. T. Cox's Rep. 1892. Geology of, S. S. Gorby (17th Ann. Rep.) 1891; flora of S. S. Gorby (17th Ann. Rep.) 1891.

Wabash Arch. M. Thompson's Rep. 1885–86, do. 1888.

Waldo, C. A. The petroleum belt of Terre Haute, Ind. (Abst.) A. A. A. S. vol. 38 p. 250 (1889.)

Wallace, S. W. On the geodes of the Keokuk formation and the genus Biopalla with some species. A. J. S. Ser. III, vol. 15 p. 366. (1878.) See Ind. Geol. Rep. 1873, p. 278.

The species described are chiefly from Iowa, Illinois and Misouri.

Warren county, Geology of. R. Owen's Rep. 1859–60; E. T. Cox's Rep. 1873. Coal, J. Collett's Rep. 1883. Coal, see Lesquereux

Warrick county, Geology of. E. T. Cox's Rep. 1870; do. 1875. Coal, R. Owen's Rep. 1859–60; do J. Collett's Rep. 1883.

Washington county, Geology of. R. Owen's Rep. 1859–60; J. Collett's Rep. 1881; do. Thompson's Rep. 1885–86.

Wayne county. Gas (See Phinney natural gas in Indiana).

————Geology of. R. Owen's Rep. 1859-60; E. T. Cox's Rep. 1876–77–78; M. Thompson's Rep. 1885–86.

Wells county, Geology of. R. Owen's Rep. 1859–60.

Wetherill, C. M. Analysis of white sulphur water of the artesian well of Lafayette, Ind. A. J. S. (second series) vol. 27, pp. 241–249.

Gives history of the well, rocks pierced by the well, qualitative and quantitative analysis of water.

White, C. A. Fossils of Indiana Rocks (No. 3). J. Collett's Rep. 1883.

Discusses the growth and development of organisms as affected by stratigraphic growth, or organism as affected by environment. Faunas of coal-measures. (Description [plates 23-38].)

————Fossils of the Indiana rock. J. Collett's Rep. 1881.

————Fossils from Sil. Dev. Carb. rocks of Ind. rock. J. Collett's Rep. 1880. Plates and descriptions pp. 468–522.

White county, Geology of. R. Owen's Rep. 1859–60; E. T. Cox's Rep. 1872; M. Thompson's Rep. 1888.

Whitfield, R. P. Black shale fossils, Scott county, Ind. Geol. Surv. 1874.

————Remarks on the dictyophyton and descriptions of new species of allied forms from the Keokuk beds at Crawfordsville, Ind. Am. Mus. Nat. Hist. Bull. 1, 1881.

————Notice of a new cephalopod from the Niagara rocks of Indiana. Bull. Am. Mus. Nat. Hist. Oct. 10th. 1885, vol. 1, No. 6, pp. 192, pl. 21.

Desribes *Libulites Bickmoreanus* from Niagara limestones at Wabash City, Ind.

Whitley county, Geology of. R. Owen's Rep. 1859–60.

Whittlesey, Chas. Notes on the drift and alluvium of Ohio and the West. A. J. S. (new series) vol. 5 pp. 205–217.

Williams, H. S. Rep. of the subcommittee on the upper paleozoic (Devonic). Am. Geol. vol. 2 p. 232.

Describes the Devonian areas of North America.

Williams, Jesse L. Altitudes in Wayne county. E. T. Cox's Rep. 1876–77–78.

Winchell, A. Vegetable remains in the drift deposits of Indiana. A. A. A. S. (Proceedings) vol. 24, B. Nat. Hist. p. 49, 1875. Vegetable deposits were noted in the counties of Franklin, Vermillion, Clay, Dubois, Park, Ohio, Dearborn, Switzerland, Clarke, Warren and Knox.

Winchell, N. The surface geology of Ohio. A. A. A. S. vol. 21, p. 152. Surface deposits of Indiana are referred to, and a classification of such deposits suggested and the various forms described.

Wortman, J. L. (E. D. Cope.) Post-pliocene vertebrates of Ind. J. Collett's Rep. 1884.

Wright, G. F. The glacial boundary in Western Pennsylvania, Kentucky, Indiana and Illinois. Bull No. 58, U. S. G. S.

————Man and the Glacial Period. (Published in book form.)

Contains references to the work of Mr. Cresson, who discovered in Jackson county "human works and remains under strata considered of glacial date, or in others ascribed to preglacial time." See "Some Recent Criticism." Am. Geol. vol. XI, p. 110.

Wyandotte Cave. E. T. Cox's Rep. 1872.

————Fauna of. (See E. D. Cope.)

Young, A. H. Manual of Botany of Jefferson County. E. T. Cox's Rep. 1870.

SUGGESTIONS FOR THE BIOLOGICAL SURVEY.

By John M. Coulter.

[Abstract.]

In studying the flowering plants of any region, they are naturally divided into two categories, namely, (1) those that are indigenous, and (2) those that are introduced. Each one of these groups presents its own special problems in addition to those which are common to both. In the modern study of collected material it has become more and more evident that collectors ought to be trained. It is not sufficient to merely collect specimens

and give an approximate station, for biological investigation demands far more accurate and complete information. In the development of this work by the Indiana Biological Survey it would be well to issue a circular of instruction to collectors, calling their attention definitely to the proper methods of work. It would be well in the training of collectors to definitely divide their work for the season into two parts, namely, (1) the work of collecting all the plants of their district, together with suitable field notes, and (2) the detailed study of one or more of their most interesting plants. In work of this kind the following points must be especially made out:

(1.) *Mass distribution.* It is not sufficient to know that a plant is to be found in this or that part of the county, but it must be known where it occurs in the greatest abundance, and where in the least, and where not at all. The most convenient way to make observations of this kind is to use outline maps as large as possible of the county and upon this jot the occurrence of the plant observed. At the end of the season's work with one or two plants in this fashion, it will be discovered whether one is dealing with a comparatively even distribution throughout the county, or one that follows certain lines, or is restricted to certain localities. It is also easily seen whether the plants mass together in certain places and thin out in others.

(2.) *Topographical distribution.* Under this head is to be considered whether plants are inhabitants of uplands, swamps, prairies, etc. If they occur in all situations, which do they seem most to affect and in what respect are their characters modified by such changes of surface?

(3.) *Geological distribution.* This must take into consideration the soils upon which the plant grows. This part of the study is one that takes considerable knowledge of geology, for it is not always easy to tell the real nature of a soil, whether it is one *in situ*, or an artificial soil. For instance, the soil of the valley may not at all represent the disintegration of rocks that border the valley, but may have been transported from some distance. Great care must be taken in the determination of this drifted soil.

(4.) *The effect of man's presence.* Indiana may be new enough for something to be done in the way of discovering the distribution of most plants before man's invasion. The former distribution of plants, which are now confined to uncultivated areas, should be made out as far as possible. It should also be distinctly noted what effect the presence of man has had upon the occurrence of plants and what plants are able to adapt them-

selves to cultivated ground and what must confine themselves to strictly wild lands.

These facts should be noted not only in reference to the indigenous plants, but so far as they are applicable to introduced plants also. In reference to this latter class, the following points ought to be noted in addition: (1.) The time and circumstances of introduction so far as this can be ascertained. Many of our most notable weeds have long been under the observation of farmers and it is often possible to obtain from them valuable information as to the invasion of certain weeds. (2.) The vigor of introduced plants as compared with native plants ought always to be noted. This, of course, will involve an investigation as to what foreigners have been able to successfully make their way against what natives. (3.) Under the head of economic importance, the introduced plants are to be considered in relation to their injury to crops.

In Indiana not only should these general features of native and introduced plants be studied, but also certain special problems which belong to the state in its relation to other states and to the general topography of the Mississippi valley. The biological survey should have in view some of these special problems whose answer will probably contribute more to real botanical knowledge than the more general study of the state flora. Certain problems are here suggested to which many more may be added:

(1.) The eastward extension of the prairie flora.

(2.) The southern extension of the flora of the Great Lakes.

(3.) The northern extension of the southern flora.

(4.) The "Knob" flora.

(5.) Flora of the limestone cliffs.

(6.) The floras of various soils.

Under the last head Dr. Scovell suggested the "sand-bar flora" along large streams, and W. P. Shannon suggested the flora of the "white clays."

THE PHANEROGAMIC FLORA OF INDIANA.

By Stanley Coulter.

The knowledge of the phanerogamic flora of Indiana while somewhat extended is far from satisfactory. Many excellent and some few noteworthy regional lists have been published as well as a provisional state catalogue, yet all leave much to be desired. It is unnecessary in this connection to deal in detail with the bibliography, since it is treated in an

earlier paper in this volume by Dr. Underwood. The following features however may be noted which will serve to show what is yet lacking for a complete knowledge of the phanerogamic flora of the state

All of these lists, with perhaps the exception of those of Dr. J. Schneck, and Dr. A. J. Phinney, are limited by *political* instead of *natural* boundaries. It is evident that while such limitation is popular and apparently in some cases necessary, it cannot result in publications which will furnish a basis for any useful generalizations without the most painstaking and arduous comparisons. Many apparent anomalies in distribution would doubtless be explained were the lists based upon natural divisions. In the exceptional lists referred to above, that of Dr. Schneck treats of the flora of the lower Wabash valley, thus necessarily including certain counties in Illinois as well as in Indiana, while that of Dr. Phinney refers to the Alpine region of Indiana and includes the four counties of Delaware, Wayne, Randolph and Jay. In both these lists, however, the political boundary is the final limitation. In the rather picturesque language of Prof, MacMillan —"Just as we should not attempt to interpret the laws governing the action of a constitutional convention by periodic examinations of a mercury-barometer, no more should we attempt to investigate the laws of plant distribution by adhering to the artificial lines which separate from adjacent commonwealths, or divide into counties or sections." The seven botanical regions indicated in Coulter and Thomson's Origin of Indiana Flora (vol. XIV., State Geol. Rep. pp. 256–7), while not perhaps strictly natural in all particulars will at least serve as a basis for present work, being established upon topographical and geological features.

A second feature to be noted in the lists mentioned above is, that in no single instance, so far as come to my knowledge, can the list be authenticated by herbarium specimens. In most cases the belief in the existence of a plant in any given locality rests solely upon the word of the collector. Those of us who know the necessity for critical study and careful comparison which obtains in so many species, recognize at once the unsatisfactory nature of such data. Given a sufficient paucity of specimens added to a desire to make as large a local list as possible and the factors are present for the introduction of many species "new to the state." I examined last year a bundle of seventeen plants "new to the state," and found eleven of them incorrectly determined. I do not mean to depreciate in the slightest the valuable lists already published, or to question the botanical knowledge and acumen of their authors. I only wish to empha-

size the fact, that in many forms an acurate determination is almost utterly impossible without opportunity for extended comparison. And the more extended the worker's experience in systematic research, the more convinced is he of this fact.

By an examination of the State Catalogue supplemented by lists, published and unpublished, most of which are in my hands, I estimate the phanerogamic flora of the state at between 1,300 and 1,400 species, excluding plainly evident "escapes" and the ferns and their allies, both of which are usually included in the totals furnished in the lists. Of this number I very much doubt if 900 species can be authenticated by all the herbaria of the state combined, including in this estimate all forms in private herbaria. This condition of affairs, if my estimate is correct, certainly shows the need of a careful and scientific revision of our state flora.

The criticism of existing catalogues is not made in a captious spirit, but for the sole purpose of showing how much is yet to be desired in the way of absolute facts before any satisfactory report of the phanerogamic flora can be made.

A critical examination of the various publications bearing upon this subject will indicate that many regions of the state have not been investigated in a way at all commensurate with their botanical importance. Of these regions I will only mention a few specifically: The "Knob" region, studied somewhat extensively by Dr. Clapp of New Albany, 1834-38, but since that time practically untouched. Many species in the State Catalogue rests solely upon the collections of Dr. Clapp, and can, I believe, in most cases be authenticated by herbarium specimens. This whole range of hills should be carefully investigated. The swamp and lake region in the northern central portion of the state has been almost untouched, if we except some few collections from the borders of prominent lakes and the researches of E. J. Hill in the district south of Chicago. To these might be added the tier of counties abutting upon Michigan and the western tier of counties from Vermillion northward. To one at all acquainted with the topography of Indiana it is evident that most promising fields still remain open for investigation.

The main purpose of a catalogue of the phanerogams of the state, is not the list, however complete and accurate this may be, but the data accompanying each form, which aid in determining the principles governing plant distribution, or serve, at least in some slight way, to resolve into simpler terms some of the complex factors of this problem.

An examination of the conditions affecting plant distribution, as has been admirably shown by F. V. Coville, U. S. Botanist (Botany of the Death Valley Expedition, pp. 10–19), from a utilitarian point of view, is of the greatest importance. In speaking especially of trees and shrubs he says: "They therefore stand as the most complete summation that can be attained of the natural light, heat, moisture, food, air and mechanique of any area: in other words, a sure index of the natural agricultural capacity of the soil upon which they grow. * * * It has been the practice of agriculturalists to gauge the capacity of soils, in regions new to the plow, by observations on rainfall, temperature, cloudiness, chemical composition of the soil, drainage, and many other phenomena, or by the even more laborious process of experimenting on every farm with each kind of cultivated product; ignoring the fact that this determination can be greatly hastened, cheapened, and authenticated by correlating the natural vegetation, especially that made up of the trees and shrubs, with that of other regions whose agricultural capacities are known." The list then is merely incidental, and its accompanying data furnish the only scientific or economic reasons for its preparation.

With this in mind it is evident how completely our existing local lists fail in furnishing facts from which any useful conclusion can be drawn. In most cases nothing beyond the words "common," "not rare," "abunbant," "very rare," are given, and in some of the lists even these are omitted. In one list only, which at the moment I recall, are any facts bearing upon the *habitat* given. It is true that in exceptional forms, such as *Sullivantia Ohionis*, T. and G. or *Brachychæta cordata*, T. and G., valuable notes may occur, but the instances are exceptional.

That the proposed biological survey of the state may fully accomplish its purpose, the work upon the phanerogamic flora should in the future proceed under certain definite conditions and for the accomplishment of certain definite results. Primarily the data collected should be of such nature and in such form as to be readily correlated with similar work done in other states. That this may be accomplished it is necessary that similar data be collected and terms technically employed shall have an uniform meaning.

The words which have given rise to perhaps the greatest confusion by lack of uniformity in meaning, are the words: *range, locality, station and habitat.* I quote from F. V. Coville (Botany of Death Valley expedition, pp. 10), "The meanings that should logically be attached to these words are as follows:

"*Range*—The region over which a type spontaneously grows.

"*Locality*—The approximate geographic position of an individual specimen.

"*Station*—The spot upon which the specimen has been collected or observed.

"*Habitat*—The character of the place in which a type occurs."

To illustrate the use of these terms Mr. Coville takes *Juncus cooperi* and the particnlar specimens of it collected under No. 204 of the report, tabulating the data as follows:

"*Range*, in the lower Sonoran zone from Vegas Wash, Nevada, westward in California through the Amargosa valley, Death valley and Panamint valley, and again at Borrego Springs in the Colorado desert.

"*Locality*, Death Valley, California.

"*Station*, edge of salt marsh about 400 meters east of Bennett Wells, Death Valley, California.

"*Habitat*, densely alkaline moist soil, apparently only that containing compounds of boracic acid."

I have given this extract in full for the purpose of showing what a complete record is essential to the fullest knowledge of a flora, and also to emphasize the importance of "mass distribution" embraced under the head range, a fact rarely given by untrained collectors. As this series of definitions proceeds from the office of the Government Botanist they may be used in full assurance of their ready correlation. In the collection for the purposes of the proposed biological survey then, collectors should as far as possible, record in a concise and systematic manner, the following data: 1. Range, 2. Locality, 3. Station, 4. Habitat, 5. Local peculiarities, 6. Name, if known, 7. Date, 8. Abundance.

All notes should be kept in a note-book, the plant being known by a serial number, and the name of the collector.

Serial numbers should be carried forward from season to season. Thus if the last serial number of 1893 was 378, the first number of 1894 should be 379. Plants then are known by the number, the name of the collector and the date, as "2162 Jones 1893." By this means plants are readily identified wherever they may be distributed, and provision made for future revision and correction.

Should a special collecting trip be made, the following additional notes should be recorded: 1. Itinerary, 2. Weather, daily, 3. Noteworthy plants observed but not collected.

In all cases as far as possible such œcological notes as are of value should be entered in the record. The note-book should also show under the proper serial number, the quantity of that form collected.

It is of course too much to expect in a voluntary work such as that proposed by the State Academy that every person who aids in the work will be able to keep typical records, for that is possible only in the case of specially trained collectors, but with a full knowledge of the facts needed each person contributing to this work can add some fact not definitely known concerning our state flora.

In a general way collectors should secure a sufficient quantity of any given form to admit of distribution into sets, a fact which should be especially observed in the case of rare plants or those of local distribution. This advice does not point in the direction of the extermination of such forms, for in all cases the collector, inferentially at least, is supposed to be free from any tendency to vandalism. They should also be careful in all cases to make *complete* specimens, a work that will necessitate some preliminary study of the different groups. Perhaps the most valuable sets of directions which we have for collectors are to be found in the publication of F. H. Knowlton of the Smithsonian Institute, and the collector's number of the Botanical Gazette (vol. 11 No. 9). An examination of either of these publications will serve to assist the collector in his work and also add much to the value of his collection. Those intending to collect should notify the person in charge of the phanerogamic flora, in order that he may suggest to them special points for investigation and study. Through these special studies much of value may be accomplished.

It is evident from the preceding pages that in my opinion, the work, as far at least as the phanerogams are concerned, should be placed in the hands of one person. He should assign special groups for determination to those specially fitted for the work and should indicate as far as possible the regional problems for investigation. It would, under such conditions, be possible to effect such co-ordination of work that the results would be not only of scientific but of economic value.

Material should be collected, so that complete and authenticated sets could be distributed to each college maintaining a herbarium, and from which duplicates of special noteworthy forms could be furnished to the specialists of the country. It should be a great, working herbarium, thoroughly representative of the state, and sufficient for all the demands that would naturally be made upon such a collection.

It was my purpose to consider in this paper the various collections of the state, private as well as those owned by the various colleges, but the necessary data are not yet in my possession. I trust however at the spring meeting of the Academy to present a tabulated statement covering these points.

This paper, submitted to the Academy at the request of the directors of the state biological survey, is merely an expression of my own personal views, the exact form which this work may take lying wholly in their hands.

THE RELATIONS OF THE HIGH SCHOOLS OF INDIANA TO THE PROPOSED BIOLOGICAL SURVEY.

By W. S Blatchley.

In my opinion the high schools of the state could, in the presence of the proper conditions, be made a most important factor in the prosecution of the proposed survey, and could themselves derive much benefit from it. But, in probably the majority of cases, the conditions are lacking, and before they can be brought about I am afraid the survey will have long since been completed.

It is to the teacher of biology, if to any one in the faculty of the high school, to whom the survey must look for aid. He, or she, alone of the faculty, is supposed to be interested in birds, bugs and flowers to such an extent that they can readily instill in the minds of their pupils that desire to know more of the secrets of nature and of the life history of her varied objects which will cause those pupils to be on somewhat intimate terms with their local fauna and flora, and so be able to note to some degree the more rare and interesting forms of animal and plant life about them, to be able to record the abundance of these forms, their local distribution and the causes thereof, in short all facts which may afterwards be of aid to the directors of this survey and their assistants.

Only teachers who are themselves enthused with the subject can beget the necessary enthusiasm in their pupils, and it is to such teachers as leaders, therefore, to whom the survey must look for aid.

Let us consider then the high school biology teachers of the state as a class, and see whether much should be expected of them by the survey.

We may classify them roughly into three great groups, which, for want of better terms, I shall designate as "fossils," "special microscopists," and "all around biologists." In the brief time at my command I have not been able to gather the statistics concerning these three groups, but Prof. B. W. Evermann, in 1891, wrote to the different high schools of the state for information on this subject and the answers he received disclosed the fact that to the class I designate as "fossils" belongs as yet a very large number, rather let us say a large majority of the high school biology teachers of the state; but, and let us be devoutly thankful, their number is steadily decreasing.

They teach Steele's Zoology by rote. They never see or use a specimen unless it be a horned toad from Texas or a dried sea urchin from Buzzard's Bay. They have no zoological works of reference except the pictures in the back of Webster's unabridged dictionary. They spend days in descanting with their classes upon such important biological facts as the "comparative length of the tail in the different species of monkeys;" or, as in a case gone down into history from one of the leading high schools of the state, "on which foot of the Ornithorhyncus does the webbing extend past the toes?" That I am not using hyperbole in speaking of their teaching, let me read you verbatim from their standard author, Steele, the sole fact which he gives concerning the leading family of one of the seven great orders of insects. Here it is:

ACRIDIDÆ.

"The grasshoppers or locusts of the western states belong to this family. They come in such multitudes as to give the sunlight the yellow tinge of dense smoke and to eat a large field of grain in an hour."

And yet, as proven conclusively by Prof. Evermann, the great majority of the high schools of the state, where zoology is taught, use Steele's book alone and teach such bosh by rote. What a travesty upon nature teaching! What a blot upon our boasted advanced scientific methods!

As, yielding to the demands of the times, the "fossil" steps aside, he often makes way for the "special microscopist." The latter is a product of the one sided development theory at present so conspicuous in some of our higher institutions of learning. He is an evoluted histological and embryological specialist with a B. S. after his name, and a summer or two's experience at some seaside laboratory to give him added prestige. He is an expert in the use of the microscope and microtome. He knows every detail concerning the embryology of the sea-squid and the develop-

ment of the amphioxus, but he don't know a jumping mouse from a long-tailed shrew, an oriole from a cat bird, nor a Hessian fly from a chinch bug. The only field of nature which he has ever explored, or which he deems worthy of exploration, is the field beneath the lenses of his microscope.

When he assumes the biological chair he does so for two reasons; first, to replenish his exchequer; second, to use his position as a stepping stone to a higher one, where his methods are in vogue.

He finds on entering the high school no equipments for teaching zoology, no collection except a worm-eaten, dried sea urchin and a half rotten, alcoholic horned toad, no library except a worn copy of Steele's zoology. He appeals to the school board for aid. Their belief in the potency of his sheep skin and other credentials cause them to allow him $300 for supplies. Two-thirds of this he expends for compound microscopes, a microtome and reagents; one-sixth of it he sends to a marine supply house for sea urchins, star fish and amphioxus, and with the remainder he purchases a few standard reference works on embryology and morphology; and then settles down to teach his pupils of fourteen and fifteen years of age in the high school, the same facts according to the same methods which he learned in the great universities where he received his special training.

His pupils bring in for a time birds, reptiles and insects from their native heath, but their instructor can tell the youthful collectors nothing of the habits, life history, or classification of their specimens. Their natural desire for collecting and observation, which, with a little encouragement, would soon have resulted in much good both for themselves and for the high school collection, is soon chilled.

They cease to notice the animals and plants about them, and in a month or two settle down under the teacher's guidance and study, for a year, sections one-three thousandth of an inch thick of some half dozen marine forms, and perhaps, if they know where to find them, of the eggs or tadpoles of a frog or salamander.

At the end of the year they can talk smatteringly of ectoderms, blastospheres, actinial filaments and calycoblasts. They can make fair diagrams of the sections they have studied, but they know little of morphology, less of adaptation and correlation of organs, and absolutely nothing of the classification of animals.

They graduate from the high school and go out into the world. One

out of ten goes to a normal school, college or university. One out of a hundred of these makes zoology a specialty and perhaps follows in the footsteps of his former preceptor. The other ninety-nine become artisans, merchants, professional men or farmers; or, if of the gentler sex, the wives of the above. They go through life meeting daily nature's objects on every hand, yet seeing them not; surrounded by problems interesting and instructive, yet knowing nothing of the problems themselves or of the method of their solution.

They see no order, no relations among the animals and plants around them. Knowing nothing of classification, they are unable to find the name of any plant or animal, which, from some conspicuous external character, attracts their attention. If they should happen upon Kirtland's warbler they would never know but what it was the common "yellow-rump."

Taking all these facts into consideration it is obvious that the proposed survey can expect little or nothing from those high schools where "fossils" or "special microscopists" are at the head of the work in biology. In such schools the "proper conditions" are lacking.

The "all around biologist," if I may term him such, at times succeeds the "fossil." With the money received from the school board, usually a much smaller sum than that secured by the "special microscopist," he purchases one or two compound microscopes, a number of sets of dissecting tools, ten or fifteen gallons of alcohol, some fruit jars, etc., and expends the remainder for general reference works on biology, especially those treating of the morphology, physiology and systematic position of the more common forms of life. These works of reference are in an ascending series, beginning with the more simple, as Huxley and Martin's Biology, Huxley's "Crayfish," Hyatt's "Insecta," etc., and advancing to the more complex.

The instructor begins his teaching at the very bottom of the work, with a few simple talks, illustrated by common specimens picked up in the neighborhood, in which he develops the distinctions between organic and inorganic objects, and between plants and animals. A week or two is then spent upon the elements of histology, explaining, by the use of typical sections, the parts of a cell, cell multiplication and the structure of the primary animal tissues. The pupil is then put to work for himself, with Colton's or some similar zoology in hand, upon a grasshopper as a type of arthropoda and insects. Three weeks are spent upon this, and a week each upon typical examples of the other six orders of insects.

After a careful examination of the structure of each type, including accurate drawings of the principal organs of each, and the reasoning, led by skillful questions put by the teacher, from structure to function, the teacher himself gives for one to two days a talk upon the systematic position of the common representatives of the order, illustrating the remarks by fifteen or twenty examples from the fauna of the home county. Questions of adaptation, local distribution and the causes thereof, come up in such talks and are discussed by both pupil and teacher.

After the insects comes a study of a mussel and snail as types of mollusks, and a crayfish as a type of crustaceans. In this way the first half year is spent upon invertebrate forms of life.

After the pupils begin to understand something of the scope of the work a certain group of animals belonging to the county, such as beetles, crickets, snails, batrachians or mammals, is assigned to each one to be worked up during the year outside of school hours. As full a collection as possisible of the group assigned is to be made by the pupil. Full notes are kept on local habitat, distribution and the causes thereof, habits, food and so on, these notes to be incorporated into a paper to be read before the class at the end of the year, which paper, together with the collection, shall be graded as part of the year's work.

The teacher goes with the class into the field on a number of occasions in fall and spring, helps each collect in his or her special line, instructs them in the preparation of specimens for a permanent cabinet, cites them to works of reference on their respective groups, etc. All duplicates collected are deposited in the high school collection which thus increases rapidly in size. The "all around biologist" has for his school room motto the following: "He is a good naturalist who knows his own parish thoroughly."

In the work proper the second half of the year is devoted to vertebrates, modifying this work so that after dissecting a type of each class of vertebrates the pupil is required to draw up an accurate description of each of three or four members of the class and from the description determine the systematic position of each by the aid of Jordan's "Manual of Vertebrates."

Following this course of instruction the average pupil, at the end of the year's work in zoology, will have something of a knowledge of the relationship existing between animals and plants and between the different groups of animals themselves.

He will have a knowledge of the gross anatomy of the principal organs of at least a type mollusk, crustacean, insect, fish, reptile, bird and mammal. He will be able to reason from structure to function and to understand at least the principles of adaptation and correlation. He will have gained a certain power of comparison and the power of grasping the leading distinctions between the principal groups of animals. He will be able to go into the field, observe, record and collect the animals of any group in which he may be especially interested. He will be able to take a manual and find for himself the name and systematic position of any animal which he will be likely to meet in his after life.

Morphology, physiology and systematic zoology are then, in my opinion, the three divisions of zoology which should be particularly dwelt upon in high school work; while embryology, advanced histology and microscopic technique should be relegated to the higher institutions of learning.

The "all around biologist" at the head of the work in the high school, constitutes, then, the "proper conditions" to which I referred at the beginning of this paper. Where such conditions exist the biological survey of the state can reasonably expect much aid. There, collections of the local fauna and flora have been made, and can be studied by the specialists on the survey who are interested in them.

There, observers, former pupils or present advanced pupils, can be found, who, when fully informed of the objects of the survey, will be both willing and able to observe, collect and record for the survey. Due credit should be given in all publications of the survey to the high school and to such individual collections. As a further reward, after the work is practically finished, typical collections of duplicate mollusks, insects, fishes, etc., from different parts of the state could be presented to those high schools which have aided materially in the survey. Moreover, copies of all publications of the survey could be furnished them to be added to their reference library. In this way the future biological work of the high school would be more easy and more valuable, and thus both school and survey would derive a mutual benefit from the work in hand.

WINTER MEETING.

INDIANAPOLIS, DEC. 27 and 28, 1893.

PRESIDENT'S ADDRESS.

THE SPECIAL SENSES OF PLANTS.

BY J. C. ARTHUR.

We are told by Louise Michel, a woman of remarkable, if somewhat eccentric intellectual powers, that when in Australia sitting at her window one day her attention was attracted by the slow but regular movements of a climbing plant. Its long free end swept slowly around, like an outstretched arm reaching for something to cling to. Does it feel? is it moving in response to some inward desire? are the questions she asked herself; and thought it not improbable that an affirmative answer might be truthfully given. The last number of *Meehan's Monthly*, a journal of considerable scientific pretention, gives editorial endorsement to essentially the same views. To what extent plants have senses or sensibility is a question that thoughtful people have asked, and will continue to ask, and is indeed a subject well worthy of attention.

In the days of Aristotle plants as well as animals were distinguished from the inanimate world by the possession of a soul, to which the characteristic features of the organism as a living object, were ascribed. Aristotle's theory of a soul in plants was ably expounded by the distinguished Italian scholar, Cesalpino, in the sixteenth century. He entered into lengthy arguments regarding the seat of the soul, and concluded that it must reside in the pith, particularly in certain portions of it. With a philosophy of this nature there was nothing incongruous in the popular notion of the times that some plants were endowed with properties akin to human. Some exercised wonderful spells over persons coming into their presence, and some would "shriek like mandrakes torn out of the earth, that living mortals hearing them, run mad," as Shakespeare puts it.

This doctrine of a biologic soul, which was, however, more materialistic than spiritualistic in its application, helped to shape botanical philosophy from the time of Aristotle and earlier down to the middle of the eighteenth century, having had much to do even with determining the views of Linnæus. In its strictest form, as expounded by Cesalpino, the doctrine is

not particularly startling even at the present day, for he taught that plants possess "only that kind of soul, by which they are nourished, grow, and produce their like," the capacity for sensation and movement being denied to them. If I mistake not, the popular notion of plants in our own day does not differ essentially from this scholastic philosophy of several centuries ago.

The second period of development of the ideas respecting sensation in plants, or we might better say the want of sensation in plants, was opened by the famous dictum of Linnæus that, "minerals grow, plants grow and move, animals grow, move and feel." Linnæus' great prominence as a systematist gave to this dogma special force, although in reality it was but a slight modification of the teaching of Cesalpino, already referred to, and of his successor Jung. Much of the controlling opinion of the greatest philosophical botanists down to the present century can be traced back to these two scholastics. Jung was a contemporary of Kepler, Galileo and Descartes, and dominated botanical thought in Germany, as Cesalpino had done in Italy. He expressed his view in the sentence: "*Planta est corpus vivens non sentiens.*"

The force of Linnæus' aphorism was more in its form than in its newness, in spite of the fact that he ascribed motion to plants, for it seemed to separate nature into three sharply delimited kingdoms: mineral, vegetable and animal. Botanists and zoologists have from that time to within a few years of the present been fruitlessly attempting to find infallible characters for distinguishing animals and plants. The discovery of protoplasm in 1846, of its identity in the animal and vegetable organism somewhat later, and the publication of the origin of species in 1859, brought an end to the old order of things, gave rational unity to the organic world, founded a science of biology, and converted the scholastic method of studying nature into the dynamic method. At the present time the motto of the botanist is "the study of plants as living things," and by acting upon it the science has been redeemed from the lethargic state of being "a chronicle of the dead," as Julian Hawthorne characterises it, into a subject of immediate and vital interest.

The fact that plants possess sensibility, or as the text-books now say, irritability, was made conspicuous and put beyond all doubt, even with the unlearned, when the sensitive plant (*Mimosa pudica*) was discovered in America and taken to the gardens of Europe. A plant of such easy culture in either the garden or the conservatory, and possessing such wonderful

sensitiveness to touch, attracted general attention. In 1848 Brücke's memoir upon the sensitive plant appeared. It was a model for thoroughness, for ingenious methods, and lucid deduction. From this clear and unequivocal starting point it was comparatively easy to pass to the less obvious forms of irritability, and since then many kinds of reaction to stimulation in plants have been brought to light and made the subjects of investigation.

But admitting that plants have sensibility, that is, are capable of responding to stimuli, is far from admitting that they have senses. Active protoplasm is always sensitive to some form of stimulation. If a bit of fresh striated muscle, from the leg of a frog for instance, be struck, or pricked with a needle, or shocked with a current of electricity, it will respond by contraction; and so will the protoplasm in the cells of an onion or other plant. Contractility is a universal property of living matter, although different cells of the vegetable and animal structure display it in varying intensity. There is, however much disparity between contractility and sensation. Whether this disparity is real, that is whether there is actual discontinuity, or whether it is only seeming, being the expression of extremes, is an important inquiry.

If we approach the subject from the opposite direction, we shall have a very different point of view. There is no way of securing a just conception of the extent and relations of an object, as of a house or a tree, like viewing it from different sides. To consider the contraction of the muscles of the arm when the hand has touched an uncomfortably hot surface, is to study the physiology of the movement, but to consider the mental disturbance produced by the perception of heat, is to take a very different point of view and study its psychological relations. One is the objective and the other the subjective method; both have advantages. But both methods should lead to a unity of conception; and this should be a more complete conception, than either method could give pursued by itself; just as viewing a house from the east side and from the west, is better than viewing it from one side alone. So far as I am aware, no writer has presented the psychological side (if the expression may be used) of the movements of plants, although the foremost investigators, Darwin, Sachs and Frank, make the presentation of their physiological studies attractive by use of psychological expressions. Darwin, in his work on climbing plants, describes the behavior of a plant, which failed to secure a hold upon a tall stick placed at a certain distance, the free end of the twiner,

as it swept around in a circle, each time sliding past the support after being pressed against it for some time; and adds that "this movement of the shoot had a very odd appearance, as if it were disgusted with its failure, but was resolved to try again." In summing up his studies on the root tip in his volume on the power of movement in plants, the same author states that the tip of the root "acts like the brain of one of the lower animals." But we are not supposed to interpret these expressions to mean that a climbing plant has feeling or that a root thinks.

As our knowledge of nature is dependent primarily upon our powers of cognition, it is not strange that students of subjective phenomena should, like Descartes and Leibnitz, in the earlier days of the science of mind, and Hegel and Locke in more recent times, refuse to entertain any connection between mind and matter, except that of association. With the gradual unfolding of a knowledge of physiology, and the adoption of its revelations and methods, a gradual extension, overlapping and fusion of the spiritual and material, the subjective and objective, manifestations of living nature have taken place. But if we examine the writings of Bain, Carpenter or Herbert Spencer, of the English school, or Herbart, Lotze or Wundt, of the German school, or other representatives of the present liberal movement, we shall find that activity has only been transferred from the cerebral hemispheres to the ramification of the nerves, and from a search for the seat of conciousness to a study of the transmission of impulses. But it is to be remembered that the brain and nerves are the telegraphic lines and relay stations for communicating intelligence of the condition of the outside world to the sensient organism, and furthermore that many of the lower animals and all the world of plants are without nerves; they are like society before the advent of the telegraph, telephone and postal system. This large part of animate nature is, for the most part, ignored by the psychologists, and treated by the physiologists only objectively. In fact, subjective, that is obverse, physiology is in need of devotees.

There is great diversity in the use of the terms sensitiveness, sensibility and sensation, when applied outside the domain of human psychology. We are inclined to accept for our present purpose the usage adopted by Maudsley, who makes the term "sensibility" generic, and divides it into irritability, reflex action, sensorial action, and idealistic perception. In this classification organisms without nerves, which are the only ones we are now interested in, are only capable of sensations due to irritability.

An eminent Bavarian botanist, Nägeli, has philosophised upon the subject of universal sentience. "In the higher animals," he says, "sensation is distinctly present in the movements consequent upon irritation. We must therefore credit the lower animals with it as well, and we have no reason to deny it in the case of plants and inorganic bodies." This claim for continuity is attractive, but is much too sweeping, and not sufficiently logical. No good purpose can be subserved by crediting minerals with feeling, which we find Nägeli has done because their molecules exhibit the attracting and repelling forces of chemical affinity. His assignment of sensation to plants rests upon no better basis. Probably no author has given more earnest attention and study to this subject than G. H. Lewes, the distinguished English psychologist. He has told us, in his volume on the object, scope and method in the study of psychology, that he was at one time fascinated with the idea of a comparative psychology, which should begin with simple organisms and thereby gain in strength of interpretation upon reaching man. He began to collect materials with this view, but afterward abandoned the project as impracticable. We may parenthetically remark that his failure to secure material in this way to interpret human action does not disprove the feasibility and usefulness of a comparative psychology in which man shall receive only the share of prominence due him as a member of the organic series. However, his studies made possible a far clearer insight into the distribution of sensibility in organisms. One of his illustrations, very familiar to every laboratory student, is especially pertinent. He says: "Touch the eye of a frog, and there is at once the response of a reflex closure of the eyelid. Touch the hairs of a Venus fly-trap (*Dionœa muscipula*), and there is at once the response of a reflex closure of the leaf. Confine the frog and the dionœa under a glass shade, and place there a sponge, over which ether has been sprinkled. Both plant and animal breathe this air in which there is vapor of ether, and as this vapor penetrates to their tissues we observe a gradual cessation of all sensibility; first the reflex actions cease, then the irritability of the particular tissues ceases. Stupor has supervened for both. Now remove the glass shade; the vapor dissipates, the fresh air penetrates to the tissues in exchange for the vitiated air, and both frog and dionœa slowly recover their sensibility." From this experiment he justly concludes "that the animal and plant organisms have with their common structure common properties, and that if we call one of these properties sensibility in the animal, we must call it thus in the plant."

This, and many other equally satisfactory observations, appear to lay so good a foundation for a proper appreciation of the scope of sensibility that we are surprised and disheartened to find him finally in a hopeless muddle of plants, monads and molecules, and when he has affirmed that "sensibility stands for the objective phenomena exhibited by an organism under stimulation," he must needs add, to save himself from possible entanglement, "or, more definitely, for the reaction of a neuromuscular mechanism." No great progress can be hoped for in the study of nerveless organisms by a constant comparison of their behavior with that of organisms with nerves and nerve centers. There is need of a different method.

This review of the present state of knowledge regarding the relations of sensibility in plants and animals shows an astonishing absence of agreement and a total lack of a rational basis. The confusion, it seems to me, is due to a disregard of the conditions under which sensibility has been developed in the two divisions of the organic world. Knowing that irritability is a fundamental property of all living matter, let us ask ourselves what advantages the animal or plant could secure by its special development. That is, given this universal property of organisms, how could it be developed into special senses? It is unquestionable that the paramount necessity of the organism is self-preservation. To secure food, to keep out of harm's way, to obtain the proper supply of air, moisture and heat, may be considered the fundamental necessities of every organism, whether man or monad, tree or microbe. Considering for the present only the higher organisms, we note that, if an animal desires food, its sight and scent aid in searching for it, if in danger its sight and hearing enable it to escape, when food is obtained taste and smell indicate whether it is to be eaten or rejected, while touch gives a variety of sensations relating to food, bodily comfort and protection. Our present purpose does not require any mention of intellectual sensations. All the lower animals, down to the simplest unicellular forms, "the little lumps of protoplasm" described by Hæckel, possess one or more of these senses, and some animals may possibly possess other kinds in addition. The point to be especially noted here is that each individual animal (with a few exceptions among the lowest forms) has the power to flee when its senses indicate danger, or to advance when desirous of food, or to seek another place if the present one is too wet or too dry, too hot or too cold.

Let us examine plants in a parallel way. If they need food do they have sight and scent to aid them in searching for it? No, because they are

firmly attached to one spot; roaming about is impossible, and to see and smell would be useless. If they were in bodily danger, no acuteness of sight or hearing would avail them in the least. Were the aspen quaking through fear of some horrible calamity, it could not move an inch out of the path of destruction. Again, plants take no solid food, and have no use for a sense of taste. In short, animals are endowed with a set of senses which would be practically useless to plants, from the fact that the latter are, with very few exceptions, fixed instead of being locomotive organisms.

But are there no movements within the power of a fixed organism that can be brought about by the action of stimuli, which may aid in self-preservation or improving the conditions of existence? I think that a little reflection will show that there are; and if we can find that plants have developed special mechanism in connection with a superior localized sensitiveness to enable them to take advantage of the conditions of their existence, we shall have demonstrated the possession of special senses.

There is no requirement for plants more universal or more necessary than that their roots should penetrate the soil and their foliage be spread to the air. Yet the root or shoot has no more power to deviate from extension in a straight line unless acted on by some external force, than a cannon ball or other moving body has to vary *its* course from a straight line. If a seed in germinating should lie in such a position that the roots point upward and the stem downward, some device is needed by which the plantlet may readjust itself, by either turning over bodily, or changing the direction of its growing parts. As everyone knows the latter alternative is adopted, and the roots bend down and penetrate the earth, while the stem bends up and lifts its foliage into the air. It is so apparently a matter of course that stems grow up and roots grow down, that we may never have given a thought to an explanation of the process. Even botanists have only recently felt the full necessity for accounting for the fact, as it has been only a decade since Vöchting announced his theory of rectipetality, or the inherent tendency of growing organs to extend in a straight line unless acted upon by outside forces.

There is only one force known that acts uniformly in the direction of the center of the earth, that is gravity; and it was the genius of Andrew Knight, an Englishman, to demonstrate as long ago as 1806, that this force does furnish the directive influence in securing verticality to plants. He grew plants on revolving wheels, and found that they responded to centrifugal force, and that when the wheel was placed horizontally and re-

volved at a speed that made the centrifugal force equal that of gravity, both roots and stems grew obliquely, taking the position of a resultant of the two forces, that is, of forty-five degrees to the vertical.

But this discovery of Knight's was not very fruitful, for no one could tell how gravity could produce the effect ascribed to it. If it pulled the root down, why did it push the stem up? The stem is as heavy as the root, why are not both attracted toward the center of the earth? It was a curious paradox to say that the same force acted now one way and now exactly the reverse on different parts of the same plant; as if pulling and pushing were the same thing. It was supposed that gravity acted upon the root as it does upon a mass of taffy candy, drawing it downward. But Sachs showed in 1873 that the root of a bean fixed horizontally over mercury could penetrate the mercury in assuming a vertical position. As mercury is thirteen and a half times as heavy as water, or the tissue of a young root, it is evident that far more force was expended in penetrating the mercury than could have been derived from the physical action of gravity, that, is, from the simple weight of the root. The experiment has since been tried in another and more obvious way by harnessing a root tip lying horizontal to a weight suspended over a pulley, the weight being raised as the root bends downward in response to gravity. From these experiments we must conclude that gravity does not act physically but physiologically to induce the curvature, that is, it acts as a stimulus. It is a small spark that fires the gun. The same spark will fire a pistol or a cannon, the result depending solely upon the amount and arrangement of the explosive material. So in the root, if there is the proper mechanism and storage of force, gravity will release this force and cause the bending, the amount of work done being enormously out of proportion to the initial expenditure of energy. But when the bending takes place, will it be upward or downward? If it were a purely mechanical device, it is evident that by knowing the structure of the organ, one could predict the direction of movement under stimulation. But we shall have to look beyond and above simply mechanical laws for an explanation. The wooden horse could not have destroyed Troy without a guiding principle within more intelligent and effective than mechanical force.

But in attempting to solve the problem, do not let us attempt too much. Let us accept such an explanation as we would consider satisfactory in case of a similar problem regarding the behavior of an animal. To see with our eyes and not with our fingers, to hear only with our ears, taste

with the tongue, and so on for the other senses, seems like a matter of course. But to explain why the nerves of the eye are only sensitive to light, of the ear to sound, of the fingers to impact and temperature, and so on, there being no structural differences detectable between the various sets of nerves that bring about such diverse results, we are content to say that it is due to a specialization of sensibility. The nerves at the tips of the fingers are more sensitive to touch than those at the back of the hand. The fingers have nerves that respond when stimulated by heat, but in the eye the nerves will not respond to heat but will respond to light. We do not marvel at this, it is everyday knowledge. We put it in scientific language by saying that irritability, a universal property of living matter, has been developed and specialized in different organs so as to respond differently to different stimulation. Fundamentally there is agreement, but the results of specialization are diverse. In the plant the root has a special sensitiveness to gravity, which is manifested by causing it to bend earthward, the stem possesses a sensitiveness which causes it to bend skyward. To meet its conditions of existence the plant has developed a special sense, that of geotropism, by which it is enabled to take advantage of the directive influence of gravity to place and keep itself upright in the world. It has a sense which animals, with their freedom of movement, appear to be nearly or entirely without. Animals assume an upright position, not in response to a direct gravity sense, but to secure the most comfortable adjustment of the weight of the parts of the body. Uprightness is a question of weight in the animal, a question of special sense in the plant.

It may be objected to this designation of the gravity sense in plants as a special rather than a general sense, that it is diffused throughout the plant and not confined to particular, specialized organs. This objection has some show of validity, but is not formidable. The apparent difference is not fundamental, but necessitated by certain structural features. Animals have a jointed, or wholly mobile body. In the jointed forms, and often in the others, there is an arrangement of muscles, with a communication of nerves with which to bring about movement as a response to stimulation. Plants, on the contrary, have a rigid body; the sensitive protoplasm being divided into innumerable minute particles, each little mass separated from its neighbors by thick, nearly rigid walls of wood or cellulose. It used to be a favorite illustration to say that a plant was like a great prison, with innumerable cells separated by thick walls, each cell occupied

by a prisoner. Although the individual prisoners may be strong men, and be in a frenzied state of activity, beating the sides of rooms, yet a spectator looking at the outside of the prison would see no movement of the walls, no evidence of life. With the discovery of continuity of protoplasm between plant cells, an English discovery of 1882, we have learned that to have our illustration really accurate, we should suppose all the cells of the prison to be connected by telephone. We must furthermore provide towers, with walls that are thinner and of flexible material. Now, if an alarm is given, all the prisoners being apprised at once, or nearly so, act in concert. The spectator on the outside sees no movement in the thick-walled part of the structure, but he sees the towers sway. We must further suppose that the men in the thick-walled cells, finding their efforts are useless, no longer make any response when the alarm is given, while those in the thin-walled cells, finding their efforts rewarded, become constantly more active and learn how to combine their efforts for greater efficiency.

The application to the plant is obvious. Although the force which a plant can exert amounts to several atmospheres, it is only in the young tender portions, usually at the ends of the branches of the stem and root, that this force can be successfully applied to secure movement of the whole organ. It therefore comes about that movement in plants is oftenest associated with growth. This arrangement permits each root tip and growing stem to have its own kind and degree of sensitiveness. Thus we find by experiment that while the first root which starts from a seed, the tap root, is sensitive to gravity in such a way that it places itself parallel to to the direction of the impinging force and points directly downward, the secondary roots, which branch from it, are sensitive after a different fashion, and instead of growing parallel to the force, grow at an angle to it, the exact angle being different for different kinds of plants. The tertiary roots, or next set of branches, are usually very little sensitive to gravity, or if they are sensitive they assume a nearly horizontal position. The stems react in a similar way, except that the general direction is upward instead of downward, and in consequence of the diversity of sensitiveness of the primary and secondary shoots, the branches are spread out to the air and light, imparting to each species of the tree and herb its characteristic appearance.

But if there is no nerve-like communication between one root tip and another, or between one stem end and another, there is sometimes a dis-

tinct transmission of impulse from the cells receiving the stimulation to the cells a short distance away where the movement is consummated. Thus, in the tip of the primary root Darwin found that only the cells at the very tip were sensitive. If so small a piece as the twentieth of an inch be removed from the end of the root by cutting or burning, all power of movement is lost. This remarkable localization has been denied by Sachs and Detlefsen, who characterize Darwin's claim as sensational, but the fact has quite recently been fully verified by Wiesner, who finds that if the root is weakly sensitive, the seat of irritability coincides with the zone of most rapid growth, but if highly sensitive, it will be at a distance.

To sum up the characteristics of the gravity sense: It is localized in or near the ends of growing roots, stems and other organs of the plant; it is developed in varying strength in different organs; it sets up movement of the organ in response to stimulation; the direction of movement will depend upon the specific kind of sensibility acquired by that organ; the direction of the movement will always bear some definite relation to the vertical without regard to the position of the plant.

But, what other senses have plants? Next to a proper position, most plants need a suitable exposure to light. I shall not attempt to show the numerous and wonderful ways in which plants respond to light. Everyone knows how plants lighted from one side, as when placed before a window, bend toward the light. This is a true sensitiveness, for it results in bringing about definite movement. It is not, however, at all like seeing, for it will be noticed that it is not the amount of light, but the direction of light to which the organs respond. The stems place themselves parallel to the direction of the incident rays—that is, point toward the window, while the leaves place themselves at right angles to the direction of the light—that is, with their upper surfaces to the window. Leaves and stems, therefore, show a sensitiveness characteristic of each. Some stems, however, like those of the Virginia creeper, turn away from the light, enabling them to cling to dark walls. Roots, which are generally buried in the soil, rarely exhibit sensitiveness to light, and when they do, it is usually to turn from it. If light comes to the organ from two directions, it will bend toward the source of the stronger light, and differences which will affect the plant are far more minute than can be detected by the eye.

As in the case of roots, certain stems place themselves, not parallel with the direction of the light, but at some particular angle to it, in accordance

with some inherent necessity. Not as many parts of the plant, as a rule, are sensitive to light as to gravitation, but the degree of development of the sense is often greater.

Some plants also show a sensitiveness to moisture, especially in their roots, causing them to bend toward or away from the moist surface. Certain molds are remarkably sensitive in this way. Errara presented a paper before the British Association, last year, in which he gave the results of his experiments with *Phycomyces nitens*, a tall-growing mold. It proved to be so sensitive that the experimenter was enabled to detect the hygroscopic character of certain substances not before known to be in the least degree hygroscopic. Thus it bent toward alum, and careful physical tests showed that alum was truly hygroscopic to a minute degree, although the property had never before been ascribed to it.

Certain plants are also sensitive to heat. Here, again, it is the direction of the radient energy, rather than the amount, to which they respond. In my own laboratory, experiments have shown that young plants of corn will bend toward the source of heat, which in this case was a lamp placed behind a screen of blackened tin, while beans bent away from it.

But probably the most varied and wonderful of all the plant senses is the sensitiveness to contact. In the animal the somewhat similar sense of touch is more diffused over the body, and takes on more variety than any of the other senses, and in plants it has even greater diversity than in animals. In the tendrils of certain plants, notably in the passion vine (*Passiflora cærulea*) "this sensitiveness is often exquisitely fine, indeed, it seems more delicate than the tactile sense of animals." Unlike the other plant senses, it has risen above the necessity of being confined to young, growing parts, and sometimes resides in special organs, as in the cushions on the leaves of the sensitive plant, by which they are able to suddenly shut up tightly when touched, or in the prehensile-like tentacles of the leaves of sundew, which shut over and catch a live insect and secure it for digestion by the plant.

Plants are thus seen to react sensitively to gravity, light, moisture, heat and contact. Each is a special kind of sensitiveness, having its own method of reaction. Two or more kinds of sensitiveness may reside in the same organ, when its position will be a resultant of the several forces. There are, consequently, no exclusive organs of sense, although there is more or less localization in certain parts; and there are no nerves, although the motor impulse may be transmitted some distance, even as

far as twenty inches or more in very vigorous sensitive plants, that is, in Mimosa.

To complete the comparison I should say there are no muscles in plants, although they execute movements of very considerable amplitude. The real mechanism by which the movements are accomplished, is not well understood. There is agreement, however, in assuming it to be due to the movement of water. Herbs, and the soft parts of all plants are kept distended and firm by internal water pressure, just as a rubber bag would be filled and made tense if tied to an open faucet of the city water works. Each cell acts like a separate distended bag. By stimulation the water is made to flow from the various cells in one side of the organ into the empty spaces surrounding the same and contiguous cells; the pressure is released on one side and the organ bends over in that direction. But this process is much complicated by growth, and other conditions too recondite to be explained here.

There are some peculiarities of plant senses which need special emphasis. All the senses, except that of contact, have for their end the adjustment of the plant as a whole, and of each of its organs, in a suitable position for best development. The contact sense has been more variedly developed, aiding the plant to climb, to catch insects for food, and if we are to accept Darwin's suggestion, to enable the sensitive plant in particular to escape the injury of hail storms. All the movements are very slow, except a few like the insect-catching and hail-avoiding movements, and their wonderful diversity and extent are only realized by instituting carefully devised experiments, and the use of delicate instruments.

It is also to be noted that the same organ always responds to the same stimulus with the same corresponding movement. If, for instance, the light strikes a shoot from the east, it bends toward the east, if possessed of positive direct irritability. There is no opportunity for choice. The plant secures a diversity of movement by having each set of organs endowed with their own specific form of irritability. As there is no choice in the character of the response, so there can be no volition, and consequently no mental activity, no psychic life, even of ever so humble and rudimentary nature.

This brings us back to our starting point. When we trace the development of irritability as a universal property of protoplasm into its various phases of sensibility, and mental activity, the first and fundamental division of organic life is into fixed and motile organisms, without regard to

its animal and vegetal nature. To the motile forms belongs a psychic or mental character, whether they be animals or plants. A most interesting exposition of the psychic development attained by motile plants, like the pandorina, volvox, and other small (essentially microscopic) forms, comparing them with animals of a similar degree of complexity, is given in Binet's work on the psychic life of micro-organisms, a work without sensational features, and with many suggestive and interesting statements. But fixed plants have no psychic life; their sensibility does not rise above that of specific irritability, although often attaining a marvelous development. Aristotle's notion, which is still too prevalent, of an ascending complexity in vital phenomena from plants to man, should be wholly abandoned. The only way of viewing nature, to secure proper interpretation, is that of two parallel lines of development, one through motile forms, and the other through fixed forms. Each line of development has worked out peculiarities of its own—in fact, there is little agreement. If the special senses of man and the higher animals show wonderful adaptations, the special senses of plants, although very dissimilar, will, when well known, appear quite as remarkable.

The observation of Sachs, the venerable professor at Würtzburg, and one of the most far-seeing of physiological botanists, is particularly pertinent in this connection. "We have no necessity," he says, "to refer to the physiology of nerves in order to obtain greater clearness as to the phenomena of irritability in plants; it will, perhaps, on the contrary, eventually result that we shall obtain from the process of irritability in plants data for the explanation of the physiology of nerves, and this, although it is as yet a distant hope, gives a special attraction to the study of the irritable phenomena of plants." The attitude of botany as a science in its historical development toward plants as objects of study, has been most happily characterized by Professor Patrick Geddes, of the University College, Dundee, whose words I shall use in my closing remarks: "To the dawning intelligence of the race, the forest is vaguely astir with a life which man does not clearly separate from his own—a mystery of growth which has left its mark deep in the history of all religions. A later and more self-conscious mind molds this omnipresent life into anthropomorphic shapes; so a Dryad hides in every tree, while Pan roams through the glade. These anthropomorphic shapes are next formalized away from the living realities they symbolize; they become mere shadowy gods, then fairies and fables. The tree (or what remains of it) is now something

economically useful; it has also a popular and a systematic name; but to utilitarian and Linnæan alike, the form and substance seems the main thing, not the life. 'Great Pan is dead,' the botanist is as prosaic and unseeing as the woodcutter, in fact, essentially is one; at best with finer tools, and like him does his best work away from the wild wood altogether. But as the ages of fetishism, of Hellenic anthropomorphism passed away, so now the formal and utilitarian and analytic spirit is passing also in its turn. Science is entering a new and brighter Hellas; the Dryad, living and breathing, moving and sensitive is again within her tree; nay, better, the plant is herself the living Dryad, her beauty radiant in the sun."

PAPERS READ.

GEOLOGY.

ON THE INDURATION OF CERTAIN TERTIARY ROCKS IN NORTHEASTERN ARKANSAS. By R. ELLSWORTH CALL

In northeastern Arkansas, west of the St. Francis river, stretching from the Missouri line to the Mississippi river at Helena, is Crowley's Ridge, the only pronounced topographic feature in the region. The width of this particular ridge varies from six or seven miles to a half mile, the northern portion being the widest. The general geological features of Crowley's Ridge have been elsewhere given* and need not be rehearsed at this time. It will be sufficient to say that the ridge is the remains of a plateau to the westward of which once flowed the Mississippi river which cut out the great valley now occupied by the White and Black rivers and other streams of the region. Later its channel was changed to the eastward by the penetration of the previous barrier near Cape Girardeau, in Missouri; it still occupies a portion of that ancient valley across which it has several times shifted its course. It has resulted from these great changes that the eastern valley has been dug deeper and wider than was the ancient channel on the west. Crowley's Ridge, therefore, stands as a residual product of erosion.

Vide Geological Survey of Arkansas, report for 1889, Vol. II, "The Geology of Crowley's Ridge," by R. Ellsworth Call.

The investigation of the ridge, which was undertaken under the direction of the Arkansas geological survey, revealed its general geological structure to be about as follows: The top of the ridge is, in portions of its extent, capped with pleistocene deposits of relatively both early and late epochs. The newest deposit of value is the loess which caps or lines the highest portions of the ridge; this material shows a bi-partite character which is believed to be connected with at least two glacial epochs the facts concerning which have been collated and discussed by Messrs. Chamberlain and Salisbury in several papers in the geological journals. Below this material, where it crowns the ridge, is a heavy deposit of a cherty gravel, much ferruginized, water-worn, not well assorted, and of varying thickness. This is elsewhere shown to be of tertiary age. Below this member is a great thickness of tertiary sands, usually non-indurated and soft, yielding readily to erosive action. The lowest member disclosed to the observer is made up of alternating pure and sandy clays, with much lignite in masses or disposed in great beds often many feet in thickness. Towards the base of the exposed clays many localities have yielded large numbers of fossil leaves which determine the age of the clays as early eocene. Added to their evidence is that furnished by the rather rare localities where fossil shells have been found. These are all marine and are unequivocally eocene. At numerous localities in the northern half of the ridge the gravel member alone forms the highest points of the hills the loess, if it ever existed there, having been entirely eroded away. The gravels often have small masses of a very compact and fine grained quartzite and much rarer large masses often weighing several hundred pounds. These increase in frequency along the west side of the ridge until near the Missouri line, some twenty-five miles south of it, where they no longer appear. They are usually quite white in color but in the gravels the smaller ones seem to have acquired the characteristic ferruginization of the gravels of the orange sand.

It happened that one of the problems connected with these nodular or pebbly quartzites related to their origin. They presented nothing in common with such quartzites as are familiar to all students of the northern drift and were to be in no way connected therewith. It was noticed that they became more and more abundant as progress was made towards the northern portions of the ridge, but this fact only added another phase to the riddle to be solved. Dr. D. D. Owen, whose geological work needs no introduction or word of commendation to an Indiana scientist, had years

before our visit made some hasty examinations of this portion of Crowley's Ridge. On pages 28–29 of his report on his work in this section he called attention to* a low "range of quartzose sandstone" which had "all the lithological characters of the Potsdam * * *, as it occurs on the Minnesota and Wisconsin rivers in the northwest." Two localities had been noticed by him both of which were in Craighead county. The reference of these rocks to the Potsdam or to any part of the paleozoic made the locality one of great interest, occurring, as it does, in the heart of a region of pleistocene soils underlain by rocks known to be of tertiary age. There was a peculiar satisfaction when Mr. William Lane piloted me to the very spot where, forty years before, he had piloted Dr. Owens and placed me on the pinnacle of the very rock from which that eminent geologist had looked over the heavily forested valley of the Cache. It is not surprising that these rocks were with some hesitation referred by Owen to the Potsdam. They present every characteristic of the Potsdam of northern New York except that they are entirely devoid of fossils, or at least this locality yielded none. His reference was plainly made from lithologic characters and though wrongly made was excusable for his time. This particular locality is at the foot of a high spur of the ridge forty feet or more above the Cache bottoms. The hills are high and are crowned with heavy beds of gravel which, in turn, are overlain by a thin sandy and gravelly soil supporting a strong growth of the common short leaved pine (*Pinus mitis*) and much scrub oak. At this point the quartzose bed is a huge mass of very hard rock, ringing like clinkstone when struck with the hammer, having its sand grains and the few accompanying pebbles well waterworn and exhibiting the characteristic structural features of sandstones deposited in swiftly running waters or tide swept shallows. The dip that appeared so patent to Owen developed into simply planes made by false bedding. A few hundred feet north of the roadway across which this mass of rock extends, in a deep ravine in which the rock is exposed to excellent advantage, the sandstone outcrops as a series of ledges from near the level of the bottoms to a point two-thirds of the way up the hill, thus showing a thickness of fully ninety feet. The several starta are from five inches to five or more feet in thickness and are nearly or quite horizontal. The total exposure of the rocks in this locality is about half a mile in length. At this point the underlying strata could not be seen

*First annual report of a geological reconnoissance of the northern counties of Arkansas. Pp. 28–29.

but a section beneath non-indurated sandstones of the same age exposed on a small stream about three miles south of this locality discloses the horizontally stratified clays of the tertiary. From Lane's to the southernmost part of the county where the outcrops cease two or three less important exposures occur.

Several other outcrops are to be found in Crowley's Ridge but with one or two exceptions, they are all on the west face of the ridge. The most important are all in Greene county and all present practically the same characters and vertical distribution. The northernmost exposure is in R. 19 N., 6 E., section 19, where they appear for the last time as indurated sandstone. They here outcrop in and extend across the road and disappear to the west in a low hill which rises a few feet above the Cache bottoms. To the east the outcrop extends for several hundred feet into the ridge, as traced in a deep ravine, where it is surmounted by a two foot layer of exceedingly hard, fine-grained, flint-like sandstone. The highest point above the valley which is crowned by these rocks has a barometric elevation of about one hundred and fifty feet above the lowermost rocks and these are in turn some forty feet above the valley. In but one locality on the west side did fossil plants or fossils of any sort occur in this sandstone. This was in 17 N., 4 E., in section 10, where after a long and difficult search a small fragment of a plant was found deeply imbedded in the very hardest rock which here caps the hills. It possessed very little structure but it was quite sufficient to determine the rocks to be of tertiary age. However, the form was not sufficiently well preserved to tell us exactly to what part of the tertiary the rock belonged but the evidence which was wanting here was later supplied a little further on. We now had the necessary clew and now the work of unravelling the mystery of the ridge was play! To make a long story very short these sandstones of supposed paleozoic age, standing isolated in the midst of tertiary rocks through which they boldly protruded their waterworn and time begrimmed tops were found to be themselves tertiary and to share in the common history of the region.

A secondary problem now concerned the process or cause of induration; a process which had been so complete and left so little traces that a score or more geologists had been puzzled into determining these rocks as of paleozoic age. So to this task were the succeeding investigations directed.

All of the outcrops of quartzitic sandstone occur in about the same vertical position in the hills. They are to be found as spurs, extending in

various directions from the main axis of the ridge, or at the heads of ravines. They may extend from the bottom of the hills to near their top, or they may form a layer of only a few feet in thickness at the very top. In every case the outcrops are found to be surmounted with a series of very hard layers which are usually from one to three feet in thickness. In several places they pass into the soft sands beneath and these in turn give way to the ordinary tertiary clays still further down. In nearly every case the rocks weather greenish and are irregularly stratified. In one locality, near Hardy's Mill, in Greene county, occurred numerous fossil leaves among which there have been determined *Magnolia* and *Kalmia* leaves; the entire absence of beech, chestnut and hornbeam leaves among those found indicate the base of the tertiary rather than any portion of the tertiary above the eocene. This is the position in the geological column assigned these forms by Professor L. W. Ward, who studied the materials collected by the writer.

The result of the studies made on these irregular deposits, occurring with such extreme irregularity in the ridge and of such peculiar hardness, stated in brief, was that they were metamorphosed sandstones. The compact character of the quartzites, their glassy surface on fracture, which is remarkably conchoidal, might lead one to imagine dynamical disturbances of marked nature. But there are no attendant facts such as continuity or great extent of surface. They are exhibited in localities some distance removed from each other and with no connecting deposits that show any metamorphic characters. But that they have become indurated on exposure, here and there, and constitute immense quartzite blocks, often acres in extent, was evident. At a locality known as Lovelady's, on Beech creek, in Greene county, there are several exposures that are quite hard on the surface but are softer within, finally yielding to moderate pressure to say nothing of blows. From this point to that of greatest induration is but a few hundred yards; it was hence concluded that the metamorphic processes were still in vogue and these most certainly were not dynamical in character. In Brazil, Dr. J. C. Branner has observed similar facts of metamorphosis,* and these corroborate the view here suggested of metamorphism through weathering processes. Where longer weathering has obtained the masses are often rounded as if water worn, but in the great number of exposures this feature is scarcely apparent.

*Transactions Am. Phil. Soc., 1889, XVI., pp. 419-420.

Summing up the facts, then, in few words these rocks are of limited occurrence, covering a few hundred acres all told; they are found at rather low elevations in the hills though they sometimes occur as far as the very tops of the highest points in the ridge country; they have yielded fossils of lower or eocene tertiary age; they have probably resulted from weathering processes; are metamorphic in character; and have no history of dynamic origin or of present or past dynamic change. Their former reference to the paleozoic is no longer tenable and they stand as a unique instance of the induration of soft sandstones in the southwest.

The sketch map accompanying gives that portion of Crowley's Ridge in which indurated sandstones have been found. It will serve to indicate the relations of the ridge to the low-lying country surrounding as well as helping to make clear the geographic distribution of the quartzites.

The white clays of Indiana. By Amos W. Butler. Published in the Trans. of the Ind. Horticultural Soc. for 1893.

BIOLOGY.

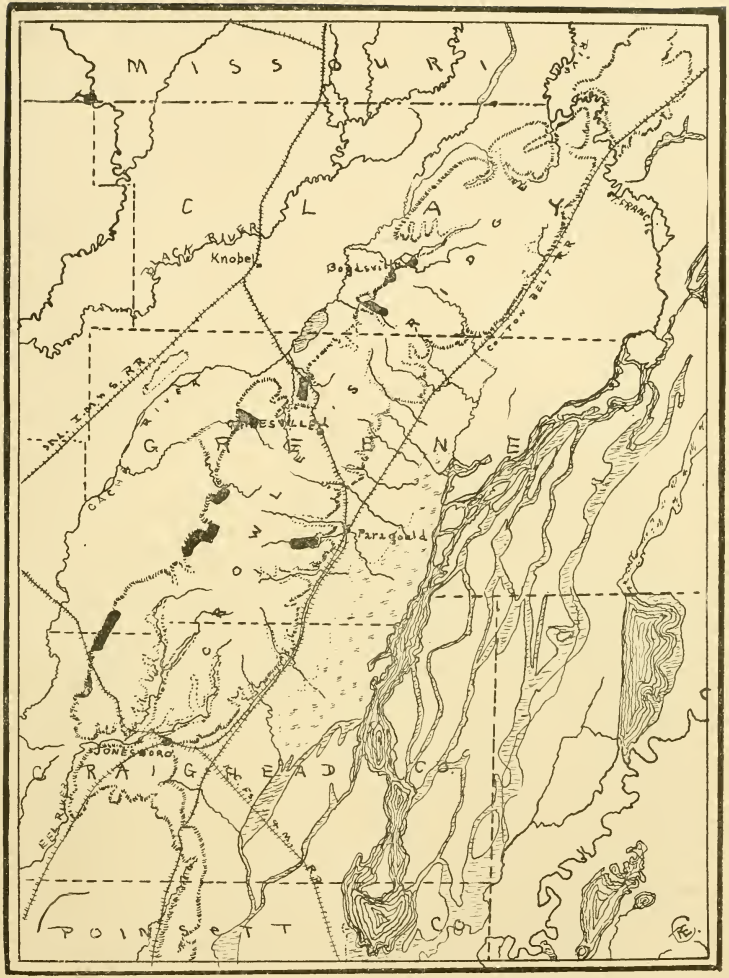
On the habits of turtles. By A. W. Butler.

[Abstract.]

In the White Water valley the soft-shelled turtles are never found active in winter. They seem to seek the deepest water and then bury beneath the surface of the mud or sand. They disappear earlier in the fall and reappear later in the spring than the hard shelled forms. They rarely appear before April 15th, and sometimes not until about May 1st. In the canal none have ever been found in winter. Possibly they seek the deeper water. The hard-shelled turtles winter in the more shallow water, and seem to prefer a mud bank where a musk rat hole has caved in. There they may be found by prodding with an iron rod.

On the occurrence of Kirtland's warbler (*Dendroica kirtlandi* Baird) in Indiana. By A. B. Ulrey.

Owing to the rare occurrence of Kirtland's Warbler in North America and the fact that its life-history is almost entirely unknown, considerable



NORTH HALF
CROWLEY'S RIDGE

Metamorphosed Sandstones. (Eocene).

interest attaches to the presence of the bird in Indiana. At the time of publication of their "History of North American Birds" in 1874, Baird, Brewer and Ridgway gave the locality as the eastern provinces of the United States and the Bahamas. "It must be considered" they state "as one of the rarest of American birds. Kirtland's Warbler is so far known by only a few rare specimens as a bird of North America and its biography is utterly unknown." Three specimens are then recorded as taken, two from Cleveland, O., and one at sea between the islands of Abasco and Cuba.

Dr. Elliott Coues in his "Key to the Birds of North America" published in '84 gives the locality as "Eastern United States." Of its occurrence he states that it is "the rarest of the Warblers; only about a dozen specimens known thus far."

Its habitat is given as "Cuba" by Ridgway in his "Manual of the Birds of North America" published in 1887.

Because of its occurrence in the adjoining states, Ohio and Michigan, Mr. A. W. Butler in his "Catalogue of the Birds of Indiana" places Kirtland's Warbler in his hypothetical list.

There is no record, so far as I can learn, of its occurrence in Indiana other than the present one. The bird is known to me only by a single specimen that was taken May 4th, '93 and handed to me the following summer for identification. It proved to be the rare *D. kirtlandi*. The skin is now in the collection of Mr. W. O. Wallace, Wabash, Ind., who took the bird near his home. Concerning it habits, he says: "I took it in a thicket. It was by itself, there being no other birds in the thicket. It seemed to be an active fly catcher, not having the motions of the other *Dendroica*, being less active. It would dart off after an insect and then return to the same perch."

THE GEOGRAPHIC AND HYPSOMETRIC DISTRIBUTION OF NORTH AMERICAN VIVIPARIDÆ. By R. ELLSWORTH CALL.

[ABSTRACT.]

There are four genera of this family in American waters and these exhibit a varying number of species. The paper recognizes Campeloma, Vivipara, Lioplax and Tulotoma. There is given the general range of each

form in the various drainage systems; but little attention is paid to matters of synonymy, for these have been elsewhere treated. The main facts in geographic distribution are presented in compact form and then further illustrated by a map of distribution in which the extreme limits of range are shown.

The hypsometric facts are separately presented; the altitudes of various of the forms are given on the authority of the "Dictionary of Elevations" published by the U. S. G. S. The several ranges are compared and the facts are then generalized for the species of each group. Attention is called to the extremely limited range, both geographically and hypsometrically, of the genus Tulotoma.

This paper may be found in full in the American Journal of Science for August, 1894.

On some South American characinidæ. By A. B. Ulrey.

[Abstract.]

A study of the Characinidæ collected by Charles Frederic Hart in Brazil shows that he found 47 species, seven of which are new. Four of the new species belong to the genus *Tetragonopterus*, one to *Mylesinus* and two to *Aphyocarax*. Descriptions of the new species will be published in the annals of the New York Academy of Science, together with notes on the specimens examined and analyses of the species of *Cheirodon*, *Aphyocarax*, and *Tetragonopterus*.

The effect of environment on the mass of local species. By Carl H. Eigenmann.

Nearly every family of fishes represented on the Pacific slope of North America has one or more of its representatives modified in a certain direction as compared with its Atlantic slope relatives. The modification consists in the increase of the number of rays of one or more of the fins or in the modification of some of the rays into spines.

In most families the differences between the Atlantic and the Pacific slope representatives are just perceptible, and, were it not for the concensus of differences in all groups would stand for nothing.

The most marked difference is found in those fishes which have been separated from their Atlantic slope relatives long enough to become generically distinct. In several genera, *Meda*, *Lepidomeda*, *Richardsonius* (subgen.) *Columbia* the modifications of the fins mark the genus.

The more striking modifications are the following:

In the sub-genus *Richardsonius*, confined to the Columbia and to the Fraser systems, the number of anal rays varies from 12 to 25, which is an increase of from 2 to 15 rays over the species of Leuciscus, some of which have also (more recently) entered the head waters of the Columbia but the great bulk of whose species inhabit the Atlantic slope.

The genus of *Oncorhynchus* confined to the Pacific slope has a similar increase of anal rays over *Salmo* and *Salvelinus* which are genera of wider distribution, some of the species entering streams of the Pacific slope.

The above are examples of the addition to the number of rays in the fins.

The modification of some rays into strong spines is seen in the Minnows, *Meda* and *Lepidomeda*. Among the many Atlantic slope Minnows none have spines in their fins while *Meda* and *Lepidomeda*, confined to the Rio Colorado, have two spines to the dorsal fin, the posterior received into a longitudinal groove of the anterior.

The increase of spines is very strikingly illustrated in the Sun Fishes (Centrarchidæ) in which the single Pacific slope species, *Archoplites interruptus* (Girard), has one more dorsal spine than any of the numerous Atlantic slope relatives.

We must either assume that there has been in all the families a fortuitous variation in one direction which has enabled natural selection, which favored larger finned fishes to produce the present results, or we must admit that the environment has affected all species alike and the effect of this action has by heredity become gradually the established order of things. In other words we must either explain the conditions with the Neodarwinians through natural selection or we must with the NeoLamarckians believe in the acquisition of larger fins through greater use of these organs and the subsequent transmission of the modification to the offspring.

These modifications being in one direction are unquestionably due to one definite environmental cause. What that cause is I am unable to say. A comparatively short, swift, water course suggests itself most naturally but the species inhabiting the short, swift, streams of the western

slope of South America show no such variation from their Atlantic slope relatives. They would do so were the shortness and swiftness of the river the cause.

The most striking example is offered by the *Percopsidæ* with a single species on the Atlantic slope and another on the Pacific slope. *Percopsis* on the Atlantic slope has feeble unsegmented rays in front of the dorsal and in front of the anal which in *Columbia* on the Pacific slope are transformed into strong spines.

Similar structural peculiarities are to be observed in other regions. Mr. A. J. Woolman informs me that all the minnows of Mexico have the teeth in one row and four teeth in each row. Such uniformity is not found elsewhere in America. This peculiarity being found *in all* the species may be explained by the application of natural selection. The peculiarity of the food is probably such as to bar the road to Mexico to all but species with the teeth 4 to 4 or to kill off any that may have entered this region, the minnows of Mexico having all entered from the north.

Lake Titicaca in the high Andes of South America is inhabited by a peculiar genus of Cyprinodontidæ (*Orestias*). The numerous species all lack ventral fins. Perhaps no one would be willing to insist that each of these species formerly possessed ventral fins and lost them through environmental influences independently. The only plausible explanation seems to be that they have diverged from a parent stock which had lost its ventrals before it split into a number of species. But five other genera of freshwater fishes are known to me to lack ventral fins. They are:

Apua, a Minnow—Tennaserim.

Tellia, a Cyprinodont—Alpine pools of the Atlas.

Astroblepus—Rio de Palace near Popayan (in the Andes.)

Eremophilus—Bogota (in the Andes.)

Channa—Ceylon.

A glance at this list will show that four of these six inhabit high mountain waters. (The character of the water of the Ceylon species is not stated.)

Now, while not all mountain fishes lack ventral fins, the fact that two-thirds of the fishes lacking ventrals inhabit mountain homes, half of them living in the waters of the Andes seems to indicate that here, as in the Pacific slope fishes, we have a case of convergence—that we have to deal with a character several times produced in remote types by the direct influence of the environment. Since the genera lacking ventrals

inhabit Alpine waters in remote parts of the globe the environment which has caused this convergence is limited to the conditions obtaining in Alpine waters. A closer definition of the acting cause in the reduction of the ventrals I am unable to give.

In the last two instances I have but given facts which have forced themselves on my notice. The conditions obtaining on the Pacific slope were determined after a careful comparison of all Pacific and Atlantic slope species and the details of this comparison will appear in the publications of the U. S. Fish Commission.

On the fishes of Wabash county. By A. B. Ulrey.

The present paper is presented as a contribution to the biological survey of Indiana. It is apparent that before any complete survey of the fauna and flora of the state can be made there must be a large number of local lists of animals and plants representing the different regions of the state. While the county forms in no sense a faunal area, there are numerous obvious reasons for making county lists. It is perhaps not essential that these local lists should cover faunal areas. When sufficient data are at hand the matter can then be placed in sytematic order.

Wabash county is situated in the northern third of the state a little east of a line passing through the centre north and south. The Wabash river, flowing a little south of west, passes through the county near its centre. Eel river flows across the northwestern part and the Mississinewa crosses the southwest corner, both of which finally reach the Wabash.

The list here presented contains most of the fishes that occur in considerable abundance in the county and some that are found only occasionally. It is desired that it may be completed by some one in this region and notes made on the spawning, life-habits and environment, presenting a complete record of the ichthyology of the county.

The collections here represented are a part of more extended collections in other groups of animals and several groups of plants made by different members of the Wabash County Science Club.* A series of the fishes of the following list has been placed in the museum of Indiana University, one in the museum of North Manchester College and another in the pri-

*This material is in preparation for the biological survey of the state.

vate collection of Mr. William O. Wallace, Wabash, Ind. All of the specimens were taken in the northern half of the county in the following streams.

CATOSTOMIDÆ.

1. *Ictiobus velifer* (Rafinesque). Kentner's creek.
2. *Catostomus teres* (Mitchill). Hellem's creek; Paw Paw creek.
3. *Catostomus nigricans* Le Sueur. Eel river.
4. *Moxostoma anisurum* (Rafinesque). Kentner's creek.
5. *Moxostoma macrolepidotum* (Le Sueur). Paw Paw creek.

CYPRINIDÆ.

6. *Campostoma anomalum* (Rafinesque). Kentner's creek; Paw Paw creek.
7. *Pimephales notatus* (Rafinesque). Kentner's creek; Paw Paw creek.
8. *Notropis deliciosus* (Girard). Kentner's creek.
9. *Notropis whipplei* (Girard). Eel river; Kentner's creek.
10. *Notropis megalops* (Rafinesque). Hellem's creek; Kentner's creek; Paw Paw creek; Eel river.
11. *Notropis ardens* (Cope). Paw Paw creek.
12. *Notropis umbratilis* (Girard). Kentner's creek.
13. *Notropis atherinoides* (Rafinesque). Eel river.
14. *Ericymba buccata* (Cope). Kentner's creek.
15. *Rhinichthys atronasus* (Mitchill). Kentner's creek.
16. *Hybopsis amblops* (Rafinesque). Eel river; Kentner's creek.
17. *Hybopsis kentuckiensis* (Rafinesque). Eel river; Paw Paw creek; Kentner's creek.
18. *Semotilus atromaculatus* (Mitchill). Hellem's creek; Kentner's creek.
19. *Notemigonius chrysoleucus* (Mitchill). Hellem's creek.

ESOCIDÆ.

20. *Lucius* (Esox) *lucius* Linnæus. Paw Paw creek.

GASTEROSTEIDÆ.

21. *Eucalia inconstans* (Kirtland). Kentner's creek.

CENTRARCHIDÆ.

22. *Ambloplites rupestris* (Rafinesque). Eel river; Paw Paw creek.
23. *Chænobryttus gulosus* (Cuv. and Val). Loc.?
24. *Lepomis cyanellus* (Rafinesque). Paw Paw creek; Hellem's creek.
25. *Lepomis pallidus* (Mitchill.) Loc.?

26. *Lepomis megalotus* (Rafinesque). Paw Paw creek; Kentner's creek.

27. *Lepomis gibbosus* (Linnæus). Paw Paw creek.

28. *Micropterus dolomieu* (Lacépède). Eel river; Paw Paw creek.

PERCIDÆ.

29. *Etheostoma pellucidum* Baird. Eel river.

30. *Etheostoma nigrum* Rafinesque. Paw Paw creek; Eel river; Kentner's creek.

31. *Etheostoma blennioides* Rafinesque. Eel river; Paw Paw creek.

32. *Etheostoma aspro* (Cope and Jordan). Paw Paw creek.

33. *Etheostoma flabellare* Rafinesque. Eel river.

34. *Etheostoma coeruleum* Storer. Eel river; Paw Paw creek; Kentner's creek.

COTTIDÆ.

35. *Cottus richardsoni* Agassiz. Kentner's creek.

AN ALPHABETICAL AND SYNONYMICAL CATALOGUE OF THE ACRIDIDÆ OF THE UNITED STATES. By W. S. BLATCHLEY.

VARIATIONS IN THE COLOR-PATTERN OF ETHEOSTOMA CAPRODES. By W. J. MOENKHAUS.

[ABSTRACT.]

In examining a representative number of *Etheostoma caprodes* from localities covering practically all the territory of its distribution. It was found that there existed a great variation in the color-pattern and that this variation showed a definite line of development.

The simplest coloration consisted of alternate long and short vertical bars developed on the body from the head to the base of the caudal. This simplest coloration was the prevailing pattern of the specimens taken from the streams of Indiana. Four specimens from the Alabama river differed only in that the bars were very much broader and more intensely colored.

In the specimens taken from certain tributaries of the Cumberland and

Tennessee rivers there was developed between each of the above long and short bars a still shorter and narrower bar, so that the coloration here consisted of whole, half and quarter bars. The Arkansas river also afforded exact representatives of this pattern.

Between the two patterns described every possible gradation was found. The quarter bars made their first appearance between the fifth and sixth whole bars. The whole bars toward the posterior end of the body increased in width and intensity of color near their ventral limit so as to give rise to an incomplete longitudinal series of lateral spots. These spots were more evident in the pattern consisting of whole, half and quarter bars.

Specimens from Texas showed the bars less regularly developed with a corresponding increase in the extent and distinctness of the series of lateral spots.

A great number of specimens taken from other tributaries of the Cumberland and Tennessee rivers all showed the longitudinal series of nine, almost confluent black lateral spots very highly developed, while the bars had become so modified as to form quite a close network over the dorsal half of the body. The young of this pattern had the spots less strongly developed, and the original bars could be easily traced.

It seems, thus, that the variations in the color patterns in *E. caprodes* are by no means promiscuous, but that they show a serial passage from one form, that consisting of alternate whole and half bars, through the form consisting of whole, half and quarter bars, and having the incomplete longitudinal series of lateral spots more highly developed to the reticulated form having a very prominent longitudinal series of dark lateral spots. I was unable to discover any relation between these variations and the latitude in which they occurred.

SOME QUERIES RELATIVE TO A SUPPOSED VARIETY OF SOLANUM DULCAMARA. By R. W. McBRIDE.

The books describe the flower of the common Bitter Sweet, *Solanum Dulcamara*, as being purple in color. This, as is well known, is the usual color of the flower of this plant. Some six or eight years ago, however, I found in DeKalb county a specimen, which, while it in all other respects

resembled the common *Solanum Dulcamara*, had pure white flowers instead of purple. I sent a specimen of the plant with flowers to Prof. J. M. Coulter as a variety which I had not previously seen described, and asked for information. He informed me in reply that it was merely an albino sport. Silenced, but not quite satisfied, I continued my observations and learned that from the seeds of this plant were produced plants bearing white flowers only. I also found several other specimens in DeKalb and Steuben counties. In 1890, I changed my home to Elkhart, and there along the banks of the St. Joseph river, I found *S. Dulcamara* growing commonly, and also discovered that at least thirty per cent. of the plants bore pure white flowers. I am not a botanist, but a mere layman with the habit of occasionally using my eyes and thinking at the same time, and now appeal to this learned body for information. If I am not mistaken in my facts, and if in several counties of the state a large per centage of the plants of *S. Dulcamara* are white instead of the commonly purple color, should not the white specimen be denominated a variety? also is not the white variety a new and hitherto undescribed variety of *S. Dulcamara?* What does it take to constitute a variety of a species? How may we be assured that we have discovered a distinct variety and not a mere sport?

Work of the Botanical Division of the Natural History Survey of Minnesota. By D. T. McDougal.

Notes on an Embedding Material. By John S. Wright.

[Abstract.]

A report was made of experiments upon a commercial "glycerine jelly," for embedding purposes. The jelly, a translucent glassy material, remains solid at temperatures below about 97° C. It is composed of glycerine, Na_2CO_3, and stearic acid, united at a temperature of 25° C. By adding alcohol in varying quantities four solutions were made which were used in infiltration of tissues. The experiments were not sufficiently extensive to establish the preparation as a valuable embedding material. All tissues used were vegetable.

NOTES ON SECTIONING WOODY TISSUES. By JOHN S. WRIGHT.

[ABSTRACT.]

The preparation of hard, woody tissues for sectioning is accomplished by heating the pieces to be sectioned a few minutes in a test tube containing a 75 per cent. or 50° glycerine solution. The woods may thus be quickly brought into condition for sectioning. In some instances the glycerine and heat distort the tissues, while in other cases, if carefully applied, they may restore cells, which have shrunken, to nearly their original outline. By this method, however, all starch grains of the cells are destroyed, and when it is desired to study cell contents fresh material must be secured.

CONCERNING THE EFFECT OF GLYCERINE ON PLANTS. By JOHN S. WRIGHT.

[ABSTRACT.]

Various potted plants were experimented with, particularly geraniums. Glycerine was administered to them in the water. 10, 20, 25 per cent. solutions were used. In some cases wilting was soon effected by the application of water containing glycerine. Some cases showed a temporary revival from the first noticed effects, again in other cases the plants died. Chemical tests were made of leaves of treated plants and of untreated ones (those of control experiments) and in nearly all instances treated plants were discovered to have contained glycerine in their tissues.

CONTRIBUTIONS TO THE HISTOLOGY OF THE PONTEDERIACEÆ. By E. W. OLIVE.

[ABSTRACT.]

Pontederia crassipes, a cultivated form, is taken as a representative of the order and its histological structure compared with the other species. It, however, is not typical, because of its higher differentiation. The diaphragm, of stellate tissue of these aquatic monocots furnish very interesting studies. These probably serve other more important functions than that of mere mechanical support. The active nuclei indicate a close connection with the vital processes of the plant.

The diaphragms in *Pontederia cordata* and *P. crassipes* are pierced by long spear-like crystals of calcium oxalate. Each of the latter are enclosed in a thick-walled sac. Also a secretion of a fatty-oil nature was abundant in all the partitions except those of *Pontederia crassipes*. Concentrated sulphuric acid placed on a section showed a beautiful example of continuity of protoplasm in the cells of the diaphragm.

GROWTH IN LENGTH AND THICKNESS OF THE PETIOLE OF RICHARDIA. By KATHERINE E. GOLDEN.

The subjects of growth and tension have such a close inter-relation that it is difficult to separate them in order to determine how much of the expansion taking place in a plant organ is due to growth and how much to tension. It is well to understand first what is meant by growth and what by tension.

Growth is a permanent change that takes place in an organ, usually accompanied by a change in bulk, and is dependent on constructive and destructive metabolism, an adequate supply of moisture, and a temperature between certain definite degrees. Tension, on the other hand, is a state of turgidity of the cells, *i. e.*, the cells are capable of absorbing water in such quantities that it causes considerable stretching of the cell walls; this will cause a pressure from within on the cell-wall, and where a cell forms part of a tissue, there will also be a pressure from without from the surrounding cells, thus setting up tensions in the various tissues. These tensions will, of course, cause the dimensions of an organ to change.

From work done by Kraus* it has been determined that organs diminish in bulk (estimated on diameters) from morning until afternoon, and increase until towards dawn. This depends upon the quantity of water which the organ contains, and again on gain by absorption and loss by transpiration.

To determine the laws governing some of these changes I made a set of experiments upon the petiole of Richardia. The petiole is made up of thin-walled parenchyma, having large, regular, inter-cellular canals and small, fibro-vascular bundles scattered through it, and enclosed by somewhat smaller parenchyma cells containing chlorophyll, alternating with groups of collenchyma cells, the whole being surrounded by the epidermis which has very thick outer walls. It can be seen from its structure that it would necessarily contain much water and air, and respond very readily to tensions.

To show how much water the plant may contain a set of experiments made by Unger† who replaced the root pressure by a column of mercury in one case gave 26.5 grms. of water from 6 leaves in 11 days, and in another 36 grms. from 4 leaves in 10 days.

In my work I used self-recording auxanometers to make measurements,

*Kraus. Quoted in Vines Physiology of Plants, p. 405.
†Unger. Quoted in Physiology of Plants, Vines, p. 92.

the petiole being measured in diameter and length at the same time, so that there would be exactly the same conditions affecting the growth of the two dimensions. The plant was placed at a north window, and, while not receiving direct sunlight, had abundant light; the pot containing it was set in a saucer kept filled with water, thus providing a constant supply of moisture. The purpose was to keep the plant, as nearly as possible, under normal conditions while being measured.

The measurements of length show that a constant growth takes place, there being two periods in most cases during the 24 hours in which the growth was much greater than at other times, the maximum period of growth occuring from 12 o'clock midnight to 8:00 A. M., the lesser great period, where occurring, being in the evening. The growth in thickness was constant from day to day, as can be seen from the curves, but there were times during the 24 hours in which a contraction took place. The measurements, in every case, show that the diameter would increase gradually until a maximum point was reached, then diminish gradually, but not the entire amount that it had increased, thus proving that the increase in diameter was due to both growth and tension combined. The amount of growth is estimated for 24 hours by subtracting the sum of the increments of contraction from the total increase, thus leaving the sum of the increments of increase of the organ due to actual growth.

The measurements show that there were invariably two points of greater growth, the maximum occurring between 12 midnight and 9:00 A. M., this being the same time as the maximum period of growth in length occurs; the lesser great period occurring from 1:00 to 11:00 P. M.

These show a wider range in the occurrence of the greater and lesser points of growth than is found in woody stems, but is probably due to the nature of the structure of Richardia, which allows a ready response to variations in tension. This ready response was also shown by withholding water from the plant until the leaves become flaccid, then giving an abundant supply, when the leaves became turgid in about a half hour.

The curves show that the plant responds in expansion to an increase in temperature, though in two cases where the temperature went to 34° and 35° C. a contraction followed in one case, and a very slow growth in the other, seeming to indicate that a temperature of that extent was detrimental to the growth of the plant. This point would, of course, have to be worked out much more fully before anything positive could be deduced.

Theoretically growth in length and thickness should have their maxim-

um at the same point, but the measurements of Richardia show that while the maximum for each dimension occurred between midnight and the middle of the morning, it did not occur at the same time, sometimes there being a difference of 4 or 5 hours between the maximum for length and that for thickness. The curve for length shows that considerable growth took place, but as this is the result of the growth for the entire petiole, which consists of the sum of the increments of growth of its zones, while the growth in thickness is but that of a single zone.

The curves are constructed having the abcissæ represent periods of one hour each, the ordinates representing growth. One division of the ordinates is used as a unit for the curve of length; 3 being used for the curve of thickness that the changes may be seen more readily as they are so minute. The measurements were taken in millimeters, and as the instrument recording growth in length multiplied 8 times, if the number of spaces traversed by the curve be divided by 8, the quotient will be the number of millimeters of actual growth. The instrument for thickness multiplied by 40, and as three spaces were used as a unit, the number of spaces traversed would have to be divided by 120 to give the growth in millimeters.

THE EFFECT OF LIGHT ON THE GERMINATING SPORES OF MARINE ALGÆ. By MELVIN A. BRANNON.

NOTES ON SAPROLEGNIA FERAX. By GEO. L. ROBERTS.

As to the sporangial development in the Saprolegnieæ, two important theories have been presented—that of Strasburger and the more recent one of Rothert.

The former holds that the partition wall of the sporangium, in *Saprolegnia ferax*, forms at a thickened place in the protoplasm. This changes into a cell-plate of varying thickness. The cell-plate is formed from a strong light-refracting substance, yellowish in color, which is apparently the same substance that is distributed in small granules in the protoplasm of the thread. From this cell-plate, after a time, arises the limiting

membrane. Later the partition wall becomes arched from the sporangium contents, and shortly, two membranes are formed, the one belonging to the sporangial portion of the thread, the other to the basal part.

The view of Rothert, confirmed by Berthold, Hartog, and others is, that at the arrest of the apical growth of the hypha, the protoplasm continues to flow in from the base, usually producing an ovoid enlargement. For a time the thick protoplasm of the sporangial part of the hypha passes gradually into the basal part, but the contrast soon becomes abrupt and well-defined. Then the granules disappear from the protoplasm, so as to form a somewhat elongated, transparent plasma ring, which increases at its inner circumference until it forms a transverse disk, that extends across the hypha from wall to wall. It is sharply marked on the basal side, but on the sporangial side passes gradually into the granular protoplasm. Within a very short time (about one-half minute), the transverse septum appears at the base of the disk. This septum is at first pale but soon becomes strongly defined.

Rothert thinks it probable, that the material for the formation of the septum is derived from the Pringsheim's cellulin corpuscles, consisting of a very soluble form of cellulose, that accumulate about the limiting area.

For the purpose of verifying one or the other of these theories, I made many serial cultures of *Saprolegnia ferax* on the bodies of dead flies, wasps, spiders, and crickets. By this means I was enabled to watch the development of the partition-wall. The time at which this was formed, in each instance observed, was in the morning. As to whether any especial significance attaches to this fact in this case, I can not say. In all cases the partition wall was formed as set forth by Rothert, and not as formerly suggested by Strasburger.

Another point first stated by Rothert was also confirmed; namely, that fragments of a healthy culture of Saprolegnia may be cut off and will continue to thrive in the hanging drop and are much more normal than the fly-leg cultures usually used. I found that fragments thus treated continued to grow and develop from day to day.

To make a study of the nuclei, I placed flies bearing *Saprolegnia ferax* in different stages of development, in a one per cent. solution of chromic acid for two hours; washed this material two days in distilled water; placed it in alum-cochineal twenty hours; and after again washing for a short time, brought it gradually into seventy per cent. alcohol, for preservation. By this process the nuclei are stained very nicely, and their

arrangement and development can be determined very satisfactorily.

In the vegetative portion of the hypha, the nuclei are of considerable size and lie in the inner part of the wall-lining of protoplasm. They are united by peculiar plasma threads, that run parallel or obliquely to the long axis of the hypha. The nuclei are ellipsoidal, elongated in the direction of the long axis of the hypha. One can determine the existence of a small nuclear body in each nucleus. In the hypha-ends the nuclei are nearer together. Here they are found somewhat closely connected in pairs, and lying entirely imbedded in the wall-lining of protoplasm. After the formation of the partition wall, they increase in numbers, by division, in the sporangial portion, and in the mature sporangium each zoospore contains a nucleus.

Contributions to the life-history of notothylas. By D. M. Mottier.

[Abstract.]

This paper embodies the results of a study of the development of the sporogonium and sex-organs of *Notothylas orbicularis* together with that of *Anthoceros*. These results may be summed up as follows:

The capsules of *Notothylas orbicularis* possess a columella varying in size with that of the capsule.

The columella is developed, as in *Anthoceros*, primarily in the young sporogonium with the archesporium and independent of it, and is not a secondary differentiation inside the spore chamber.

The archegonium of *Notothylas* resembles more closely that of the ensporangiate ferns than does the archegonium of *Anthoceros*.

The antheridium arises from an hypodermal cell, thus differing in this respect from all other known *Bryophytes*.

The ash of trees. By Mason B. Thomas.

The object for which this investigation was undertaken was to show by chemical analysis the amount of food a tree or shrub takes from the soil in its yearly growth. The method employed was to determine by a quantitative analysis of the ashes of trees and shrubs, the proportion of the mineral constituents of the soil that are found present in them. It seems

evident that such an investigation would be of importance to the cultivator of trees, and more particularly to the fruit grower, since by determining the drain upon his land he would have a knowledge of the needs and conditions of orchard soil, and also be furnished with some valuable information regarding the care of land on which trees are to be grown. There are but few fruit growers who know with any degree of certainty regarding the exhaustion of orchard soil, in consequence of which they apply fertilizers that may or may not be for the good of the soil, and an application of a surplus of fertilizers is not only a waste of money but is found to be actually injurious. It may often be that much money is wasted in the purchase of fertilizers rich in potash salts when the less expensive sodium salts would answer as well. An analysis of the soil on which an orchard is to be planted would at once show its condition, and knowing the proportion of mineral constituents taken from the soil in the yearly growth of trees, the fruit grower would be furnished with accurate information regarding the suitableness of his land for orchard purposes, and would also know the exact constituents he could most profitably apply in his fertilizers. An analysis of the ash of two trees of the same variety, one of them attaining yearly a very vigorous growth, and the other, as it were, starving, would show, unless the stunted growth was due to a lack of proper drainage, the food that should be given to the exhausted tree for its support.

The work done by chemists upon the subject under consideration is comparatively little. Much has been done upon the amount of nitrogen and ammonia assimilated by trees, but little upon the amount of mineral constituents taken from the soil. More prominent among those who have worked upon the former subject are Justus von Liebig, Messrs. Veille and Blossingault. Some results upon the analysis of apple twigs have been published by Prof. G. E. Patrick, of the Iowa Exp. Station, but few results regarding their mineral constituents were given. Much has been done by Schroder, H. C. White of Georgia, and others upon the analysis of the mineral constituents of forest trees, but no results are given regarding fruit trees or shrubs.

An exhaustive investigation has been made of the amount of mineral constituents taken from the soil by tubers, cereals, etc., and valuable conclusions drawn. The best of these results can be found in the Journal of the Royal Agricultural Society, series 11, vols. 7, 8 and 13.

COMPOSITION OF TREES AND SHRUBS.

All vegetable productions may be divided into two great classes. First,

special productions of certain peculiar plants and sometimes of particular organs in those plants. Second, those substances which are always found present in all vegetable life and which make up a greater part of the solid portion of every tree or plant. With the latter division we are to deal and for our purpose we will consider it under two heads; first, those organic constituents that are found in all trees and shrubs during their growth, and second, those mineral constituents that remain after the combustion of the wood of the plant. The organic constituents were always held to be necessary to the growth of the tree while the inorganic, since they varied with the nature of the soil, were thought to be accidental, but this idea has long since vanished and now the mineral constituents are recognized as being of the first importance to the vegetable world.

Prof. Liebig has said "every vegetable requires for its fullest development and the fulfillment of its vital functions the presence of certain organic acids, of the use of which, however, we are ignorant, but farther it also requires that these acids be *in union with a base.*"

It appears from experiment that such substances as $\left(\frac{\text{soda}}{Na_2O}\right)$, $\left(\frac{\text{potash}}{K_2O}\right)$ and $\left(\frac{\text{magnesia}}{MgO}\right)$ can, to a certain extent, act as substitutes for each other, but if it so happens that the supply from the ground is insufficient for the purpose of the tree it cannot thrive unless it has the power of secreting an organic base for its own use, and with trees this is seldom possible. Prof. Liebig further shows that a certain degree of consistency attends the quantity of bases in combination with organic acids present in the same plant grown on different soils, although the proportion of bases may of themselves be very different. An analysis of two pine trees grown under very different conditions showed the quantity of oxygen present in the carbonate to be nearly the same, thus proving that the proportional quantities of organic acids in the two trees must have been united with equivalent quantities of bases. The same was also observed in two fir trees, one of which was grown in Norway and the other in France. The question now arises, Is each of the mineral constituents present in the tree essential to its development? Stohmann has shown by direct experiment that all the mineral food elements have an independent value to the growth of the tree. Potash can not take the place of soda, nor can calcium take that of magnesium. Though they are all necessary for the growth of the tree, for it has been shown conclusively by experimental investigation that the growth of a tree is a function of its *mineral* food elements, they do not all have an equal value as factors of nutrition. The growth of a tree would

therefore always be proportional to the quantity of mineral constituents of nutrition present in the soil in a soluble or available form. This would of course always be more or less influenced by accidental conditions in the surroundings. With the organic constituents of trees we are not to deal, but much has already been done on this subject.

THE WATER IN TREES.

The average amount of moisture in some of the more common trees may be seen from the following:

Ash 28.7 per cent., beech 29, birch 31, elm 44.5, pine 50, oak 40, maple 34, hemlock 45, pear (Howell) 53.7, apricot (Russian) 44.4, cherry (Winslow) 51.8, cherry (May Drake) 50.1, poplar 51.1.

The samples of fruit trees were all taken on the same day, cut fine, dried at 110° C. until constant weights were obtained. The per cent. of moisture is much lower in trees than in grasses, cereals or tubers.

There is a considerable variation in the per cent. of moisture in different parts of the same tree as is shown by the following determination given by Stockhardt. Fir tree cut May 20:

Tree trunk with bark, 36.15 per cent.; thin end of trunk, 50.8; branches over 1 c. m., 47.95; branches under 1 c. m., 51.56; leaves, 52.49.

According to Galesnoff the per cent. of water after increasing from below upwards diminishes again at the summit of the trunk. Not only does the average per cent. of water vary in different parts of a tree but also in the same part there is a variation during different seasons of the year, as shown by the following table also from Stockhardt:

BEACH TREE.

	LOWER.	MIDDLE.	UPPER.
Winter	50.5	41.5	39.3
Spring	43.7	42.8	47.
Summer	42.1	44.1	48.
Autumn	39.	40.1	40.1

In ordinary dry wood there is about 15 per cent. of water.

THE ASH OF TREES.

Experiments show that while different trees and different parts of the same tree vary much in their proportion of ash, yet in the same parts of a given species of trees, the quantity of ash remains about the same and its chemical composition though widely varying in different trees is similar for the same parts of the same species, although the soils on which they are grown may differ much in character. Each individual tree seems to make

not only a qualitative but a quantitative selection of the mineral food constituents best adapted to its development. *It does not follow then that out of a given mixture a tree will absorb to the largest extent the mineral constituent that is present in greatest abundance.*

The per cent. of ash found in some of the more common trees and the variations in different parts of the same tree is seen below:

PART OF TREE.	LOWER.	MIDDLE.	UPPER.
Beech wood . . .	.43	.45	.47
Beech bark	3.90	3.30	3.00
Larch wood . . .	.27	.30	.37
Larch bark	1.25	1.75	2.15
Spruce wood . . .	.35	.39	.47
Spruce bark . . .	4.77	4.29	4.53

An analysis of a Larch tree 40 years old gave the following per cent. of ash in its different parts:

Heart wood, .14; Sap wood, .30; last year's ring, .48; Cambium ring, 5.17; leaves, 5.36.

Other trees often contain a much larger per cent. of ash as in the Plum (Malabel) the bark contains 11.2 per cent. while the fruit of the tree contains only .72 per cent.

The following figures will show the per cent. of pure ash as I have found it in some of our common fruit trees, wood and bark of the tree being taken together. The composition of this ash will be found later:

Pear (Howell), .27 per cent.; Cherry (May Drake), .20 per cent.; Cherry (Winsor), .23 per cent.; Apricot (Russsan), .22 per cent.; Poplar, .31 per cent.

It can be clearly seen that there is a marked difference in the per cent. of ash in different trees and in different parts of the same tree. This is also found to vary with the seasons of the year as is seen by the following:

PART OF TREE.	LOWER.	MIDDLE.	UPPER.
Spring Beech wood	.41	.46	.67
Summer Beech wood . . .	.45	.43	.47
Autumn Beech wood . .	.44	.46	.55
Winter Beech wood . . .	.43	.46	.62
Spring Larch wood . . .	.25	.32	.41
Summer Larch wood . . .	.27	.33	.38
Autumn Larch wood . . .	.25	.26	.33
Winter Larch wood . . .	.29	.36	.41

THE ASH OF LEAVES.

The per cent. of ash in leaves and the variation during the year is worthy of special attention.

The following figures illustrate these points:

Mountain Ash, 6.42 per cent.; Cherry, 6.70 per cent.; Beech, 5.21 per cent.; Maple, 4.68 per cent.; Elm, 6.82 per cent.

The ash of leaves like that of wood is found to vary during different seasons of the year.

	ROBINIA.	CHERRY.	BIRCH.	CHESTNUT.
May	6.25			6.40
July	7.75	7.30		
September . .	8.22		4.36	4.75
October . . .	11.74	4.68	7.24	4.55
April		7.80	3.84	

It can thus be seen that the variation in the per cent. of ash in different parts of the tree during the year is very marked; the upper portion being subject to the greatest change. The ash is at its maximum in the sap wood in autumn and winter, and in the heart at its minimum. In the spring the ash in the sapwood falls, at the same time it rises in the bark. By summer both the sapwood and the bark have reached their minimum and the ash constituents go to the leaves. At all seasons of the year however the cambium and bast portions of the tree contain three-fourths of the whole amount. We have every reason to believe that every part of the tree contains a certain invariable amount of mineral matter which is absolutely essential to its existence and that besides this there may be present an inessential and variable amount of the same ingredient. The substances usually found in the ashes of all trees when burned at a low temperature are potash, soda, lime, magnesia and iron (K_2O, Na_2O, CaO, MgO, Fe_2O_3) in combination with phosphoric acid (P_2O_5), sulphuric acid (SO_3) chlorine, (Cl.) carbon dioxide (CO_2) and silica (SiO_2); iodine (I), aluminum (Al.) and manganese (Mn.) are often present. One portion of these mineral constituents exists in solution in the sap and the other in the tissue of the plant in the solid form. In burning, portions of sulphur, chlorine, phosphorus and alkalies may be lost under certain conditions, by volatilization.

The ash remains as the skeleton of the plant, and often actually retains the microscopic structure of its tissues.

THE FORM IN WHICH THE MINERAL ELEMENTS EXIST IN THE PLANT.

If we take a living tree, whose ashes are rich in carbonates of potash, and test its sap, we find instead of the usual alkaline reaction of the salts a strong acid reaction, due to the presence of vegetable acids—oxalic, tartaric, citric or malic, so united with the alkaline potash as to form an acid salt which is held in solution in the sap of the tree. Combustion converts the vegetable acids into carbon dioxide, and the latter unites with the bases.

HOW HAVE THESE SUBSTANCES BEEN ASSIMILATED BY THE TREE?

It must be remembered that the sap of the tree is charged with carbon dioxide and often sodium chloride, therefore the double silicates of ammonia and aluminum in the soil, which are somewhat soluble in such water, are furnished to the tree in sufficient quantities for its development. The silicates of iron are decomposed at ordinary temperature by carbon dioxide. They are, therefore, made soluble in water charged with carbon dioxide and exist in solution in the sap. The alkaline carbonates also bring about many decompositions in the mineral matter of the soil. It is by the introduction of atmospheric oxygen that many of the compounds entering into the double silcates of aluminum are gradually decomposed, and the alkalies—potash, soda and lime, are rendered capable of assimilation and pass in solution in the sap of the tree.

The relative proportion of the constituents of the ash of trees is found to vary in different trees, and also in different parts of the same tree. The following analyses were made of the ash of the young and thrifty shoots which represent a fair average of the proportion of the mineral constituents of the soil that are assimilated by the tree in a year's growth:

	SiO_2	Fe_2O_3	SO_3	MgO	CaO	P_2O_5	K_2O	Na_2O	Total.
No. 1—Pear, Duchess	.74	4.29	1.37	10.21	38.52	9 72	30.96	2.71	98.52
No. 2—Pear, Anjou	.87	3.15	1.90	9.32	31.88	13.66	26 93	9 60	97.31
No. 3—Pear, Sickles	.89	5.14	1.59	1.39	51.20	14.14	25 45	trace.	99.81
No. 4—Pear, Bartlett	2.31	4.18	1.60	2.02	36.15	11.46	29.99	10.74	98.47
No. 5—Pear, Duchess	.13	2.14	2 27	8.88	36.03	9.41	35.89	4 01	98.76
No. 6—Pear, Vicar of Wakefield	.34	1.39	2 57	45.29	4.96	10.03	37.98	trace.	100.41
							Cl'ds by diff		
No. 7—Pear, Howell	.81	5 47	.18	52 98	4.17	20.61	15.78		100.00
No. 8—Plum, Lombard	.38	4.35	1.79	2.55	36.89	8 86	31.02	12.43	98.27
No. 9—Plum, Lombard	.40	1.21	1.27	5.79	41.40	20.77	24.43	3.86	99.17
No. 10—Plum, Lombard Roots	4 45	3.87	3.48	5.15	29.44	17.00	31.39	4.45	99.32
No. 11—Peach, Late Crawford	.97	5.39	2.12	5.84	59.22	7.02	2 19	17.34	100.09
No. 12—Osage, Orange	.97	2 28	2.12	4.75	30.10	13 35	34.78	11.06	99.41
No 13—Cherry, Winslow	.65	1.84	. . .	. . .	54.20	17.64	. . .	. . .	. . .
							Cl		
No. 14—Cherry, May Drake	1.84	2.21	1.61	3.17	54.20	12.92	.50	. . .	76.55
No. 15—Cherry Wood	2.1	.07	3.3	9 2	28.7	7.7	20.8	8.4	. . NaCl
No. 16—Cherry Bark	20.	.2	.8	5.1	42.	3.3	7.5	14.5 NaCl.5	.6
No. 17—Apple tree	1.3	1.7	.9	7.5	63.5	4.9	19.2	$Na_2O.5$	100.1

The analyses 1 to 14 were made by myself, and in each case parallels were carried through. The samples for the complete analyses were nearly all taken at the same time, and therefore no variation need be allowed in the different analyses for a change in the per cent. of ash or ash constituents due to its variation at different seasons of the year. The samples being all young and thrifty twigs of one year's growth, the per cent. of ash is consequently low. The analyses 8 and 9 were made from young trees growing a few rods apart; but one sample was taken three months later than the other. The sample for analysis No. 10 was taken from the roots of sample 9. The tree being only three or four years old the whole top was incinerated. The high per cent. of silica (SiO_2) in No. 8 is probably due to the fact that the sample was not thoroughly cleaned, the roots being quite knotty.

In the peach the per cent. of lime (CaO) is higher than for any other tree, but the potash is correspondingly lower.

The variation in the per cent. of mineral constituents in the ash of the two plum trees is quite marked, but this is not strange when we consider the effect of the difference in soil and of difference due to the variation in the time of collecting the samples.

It is quite noticeable that the per cent. of potash (K_2O) in the top and roots of the plum (samples 6 and 8) is nearly the same, while the per cent. of lime (CaO), though varying much, is yet quite low for both root and top. In all of the samples chlorine was found, but not in weighable quantities.

Although at first the variation in the per cent. of ash constituents in the different pears seems strange, it is nevertheless found to be true to experience, for it is well known that land on which some varieties can be grown would not answer for other varieties of the fruit.

It will be seen by the tables that a tree without fruit is not very exhaustive to the land.

The method of analysis was in the main that found in Prof. G. C. Caldwell's Agricultural Chemistry, but some modifications of it were deemed necessary for practical working. The value of these results will be shown by a little explanation.

Subsequent calculations are based on figures given by a prominent fruit grower, modified by experiment and approved by several horticulturists. It is estimated that pear trees such as those from which the samples were taken (six inches in diameter) will add to their growth in a year 10 pounds

of wood above ground, and an equal amount below. Experience shows that the sum of these will not vary more than from 16 to 24 pounds for the total weight of wood added to the entire tree in a year's growth. The trees in question yield on an average 3 bushels of fruit each year, weighing 45 to 50 pounds per bushel. The weight of leaves produced on the same tree is about 20 pounds, and varies in about the same proportion as the wood. The number of dwarf trees (10 by 12 feet apart) on an acre is 363.

The following tables will show the exhaustion of the mineral constituents of the soil by weight in pounds, in the yearly growth of wood above ground on an acre of orchard in which the arrangement of trees is as above indicated:

The pure ash of the wood of the pear we found to be .27 per cent.

	SiO_2	SO_3	Fe_2O_3	CaO	MgO	P_2O_5	K_2O	Na_2O
No. 1—Pear, Duchess	.07	.13	.43	3 88	1.03	.98	3.11	.27
No. 2—Pear, Barre Anjou	.09	.19	.34	2 22	.93	1.38	2.68	.98
No. 3—Pear, Sickles	.09	.16	.52	5.17	1.40	1.43	2.57	. . .
No. 4—Pear, Bartlett	.23	.16	.42	3.65	.20	1.16	3.02	1.08
No. 5—Pear, Duchess	.01	.23	.22	3.64	.90	1.20	3.63	.40
No. 5—Pear, Vicar of Wakefield	.34	.11	.26	4.47	.5	1.01	3.83	. . .
							cl'ds by diff.	
No. 7—Pear, Howell	.08	.02	.55	5 35	.42	2.08	1.59	
No. 8—Plum, Lombard	.14	.67	.16	1.38	.56	.33	1.16	.47
No. 9—Plum, Lombard	.15	.45	.49	1.53	.22	.78	.90	.15
No. 10—Plum, Lombard Roots	.17	.13	.15	1.1	.19	1.18	.16	.64
No. 11—Peach, Late Crawford	.03	.07	.13	1.6	.16	.21	.48	.06

These tables give quite an accurate idea of the amount of mineral constituents a tree takes from the soil and also of the exhaustion of orchards to the land.

The amount of lime (CaO) taken up by the trees on an acre varies from 3.6 lbs. to 5.3 lbs. The potash (K_2O) from 2.5 lbs. to 3.6 lbs. and the variation in the other mineral constituents taken from the soil can be seen in the tables. The Bartlett pear is the least and the Sickles pear the most exhaustive to the land. Plum trees are not one-half so exhaustive as pears while the peach tree is less exhaustive than either.

The figures regarding the number of trees on an acre, also the yield of fruit per tree and its weght, are taken from Prof. Bailey's Horticulturist's Year Book. The weight of wood added to a standard pear tree is five times that added to a dwarf tree, but the number of trees on an acre is one-fifth as many, therefore the exhaustion to the land would be about the same. It is interesting to compare the amount of mineral constituents required for the yearly growth of trees, with that necessary for some of the more common field crops.

The following analyses were made by Thos. Way and G. H. Ogston and will give an idea of the drain upon land which is used for cereals, hay, &c. Pounds per acre:

CROPS.	SiO_2	P_2O_5	SO_3	CaO	MgO	Fe_2O_3	K_2O	Na_2O	NaCl	KCl
Oats	69 8	22.3	5.8	12.	9.1	2.7	36.5	3.6	3.8	6.3
Barley	107.2	24 3	4.3	15.6	8.8	1.6	38 3	2.6	.6	.7
Hay	184.7	57 3	31.3	74.	19.7	7 4	273.3	.3	21.1	77.8
Flax	22.1	25 6	8 2	51 1	12.1	9.7	59 5	6.	18.3	2.2
Hops	47.6	28 4	6 6	60.4	11.4	.9	44 6	none	6.1	15.0
Corn	36.4	31.4	6.5	13.5	12.4	3.	56 6	.9	.3	none.

It must be remembered that there is added to the roots of a tree an amount of wood equal to that added to the top, the composition of which as compared with the top may be seen in analyses Nos. 9 and 10, but since the wood of the root is never taken from the ground the mineral constituents which are a part of its composition can never be said to be taken from the field, yet in a growing tree the fact must be remembered and a rate of exhaustion allowed for the roots equal to that of the branches.

There is also taken up by the leaves an amount of mineral constituents, the per cent. of which is shown by the following table taken from Dr. Wolff's ash analysis.

	LEAVES OF				
	APPLE.	CHERRY.	BEECH.	MAPLE.	ELM.
K_2O	24.75	23.23	21.83	25.41	23.67
Na_2O	2.67	9.60	3.26	.93	2.16
CaO	53.39	42.64	44.37	30.89	29.31
MgO	5.56	12.33	7.29	10 49	8.41
Fe_2O_3	1.08	.91	2.37	1 98	6.86
P_2O_5	6.71	6.36	7.83	9.56	7.63
SO_3	3.32	2.21	2.49	9.67	2.05
SiO_2	2.31	2.73	10.56	11.07	19.91
CO_2	22.02	23.29	11.59	14.08	11 38

Much of this material, however, returns to the land and need not be considered as very important in the calculations.

The only part of the mineral constituents absorbed by the tree that are carried away from the field is that portion contained in the fruit. The amount of fruit grown on different trees varies within such wide limits and its mineral constituents vary so much with the quality of the fruit that only very general conclusions can be given.

The results below, taken from Dr. Wolff's ash analysis, show the composition of the ash of some of the common fruits:

FRUITS.

	APPLE.	PEAR.	CHERRY.	PLUM.
K_2O	35.68	54.69	51.85	59.21
Na_2O	26.09	8.52	2.19	.54
CaO	4.08	7.98	7.47	10.04
MgO	8.75	5.22	5.46	5.46
Fe_2O_3	1.40	1.04	1.98	3.20
P_2O_5	13.69	15.20	15.97	15.10
SO_3	6.09	5.69	5.09	3.83
SiO_2	4.32	1.49	9.04	2.36
Cl			1.35	
Pure ash	1.44	1.97	2.20	1.87

These results give the amount of mineral constituents an average growth of fruit takes from the soil. The following statements, together with the previous calculations, serve as a basis in the determination of the results given in the table which follows:

APPLES.

Every alternate year a full grown tree produces 30 bushels weighing 48 pounds per bushel. There are on an average 20 trees on an acre.

CHERRIES.

The average yield of a cherry tree is 5 bushels, and the weight of a bushel 40 pounds. There are 135 trees on an acre.

PLUMS.

The average yield of a plum tree is 6 bushels, and the weight of a bushel is 55 pounds. There are 135 trees on an acre.

PEARS.

The average yield of a dwarf tree is 3 bushels, and the weight of a bushel is 48 pounds. There are 363 trees on an acre.

	K_2O	Na_2O	CaO	MgO	Fe_2O_3	P_2O_5	SO_3	SiO_2	Cl
Apples.									
Single tree	7.39	5.41	.84	1 81	.29	2.83	1.26	.89	
Acre	147.9	108.1	16.92	36.28	.58	56.76	25.25	18.29	
Cherries.									
Single tree	2 28	.69	.33	.24	.08	.70	.22	.39	.05
Acre	308.	.12	44.58	32 43	11.76	94 86	30.23	53.69	8.01
Plums.									
Single tree	3.55	.03	.60	.32	.19	.90	.23	.14	
Acre	480.	4.37	81.39	44.27	25.94	122.	31.	19.14	
Pears.									
Single tree	1.55	.24	.22	.14	.02	.43	.16	.04	
Acre	563.1	87.72	82.17	53.75	10.71	156.5	58.5	15.34	

We next consider the per cent. of nitrogen found present in trees, and also its variation in the different parts of the same tree. The following

table is from Dr. Wolff's Aschen Analysen, and shows the variation in the fir tree:

	LOG WOOD.	BILLET WOOD.	BRANCHES.	END OF BR.
Wood	.11	.11	.17	.68
Bark	.65	.59	.67	1.10
Sap	.17	.18	.32	.78

The variation during different parts of the year is also given:

	TREES—CHERRY.	BIRCH.	PINE.	CHESTNUT.
April	2.00	. .	. .	. .
May	. .	. .	3.59	2.12
June	. .	2.43	. .	. .
July	.95	2.32	2.81	. .
August	. .	1.57	. .	. .
September	.84	1.28	1.68	.70
October	.11	.49	.70	.62

The table represents the per cent. of N in wood dried at 100°C.

The source of the mineral constituents of the trees must be the soil, while the atmospheric carbon dioxide, water and ammonia, furnish the organic compounds which enter into the growth of trees. The H used by the tree comes from the water, the carbon from the carbon dioxide and the nitrogen from ammonia. There appears at present to be but little certain knowledge as to the power of trees to absorb combined N directly from the air as distinguished from that obtained from the same source through the agency of the soil. The organic materials used by trees are the remains of animals and plants, but even these must assume the mineral form before they can become food for trees. The other mineral constiuents are absorbed from the soil by the roots, after being first made soluble by the decomposition going on in the soil, which renders them capable of being taken up by the sap and distributed to all parts of the tree. NH_3 is of the first importance to the vegetable world, and for its retention in the soil four alkaline bases are made responsible. It is, therefore, always present in an available form. Usually enough ammonia and nitric acid are present in the atmosphere for vegetation, and by cultivation and accumulation may take place in the soil. The mineral constituents necessary to the growth of the tree are potash, lime, magnesia, and iron, phosphoric acid, sulphuric acid, with possibly the addition of soda.

The analyses of Bibra, Zoeller, Arendt, Bretschneider and others upon the per cent. of soda in trees and plants leads to the conclusion that in

some trees, or in certain parts of trees, it may be wholly wanting, while in others it may occur in abundance. It has not been proven, however, that soda is entirely wanting in any entire tree or plant grown on natural soil. The general conclusion is, then, that the quantity of soda present in a tree is an extremely variable one, and though generally present in some proportion, yet in some parts of a tree it has not been found present in weighable quantities.

An important question now arises: Can soda take the place of potash? The result of the investigations of Halm-Horstmar, and more recently of Knop and Schreber, have demonstrated that it cannot entirely do this, since potash is absolutely essential to the growth of the tree. Cameron concludes that soda can partially replace potash, and this appears to be indicated by many facts. It may be, however, that the soda which often appears to replace the potash is accidental, and that the replaced potash was present in the tree in an excess of that really needed for its growth. The amount of either absorbed would depend on the nature of the soil.

Potash is of the next importance to the vegetable world. The organic acids require alkalies and alkaline earths to form the salts which exist in the tree, and in most cases it would be impossible for these acids to be formed were it not for the presence of these bases. There is every reason to believe that the alkalies are peculiarly connected with the formation of carbohydrates, and that an increased assimilation of alkalies is co-ordinate with the increased formation of carbohydrates.

Lime is of the next importance. Its great abundance in nature is a guarantee of its presence in an available form for the tree.

Of the remaining ingredients, iron, is perhaps, of the greatest importance. It is abundantly proven that its presence is necessary to the development of the tree or plant. It is usually found in the greatest abundance in the bark; much of it is accidental and not necessary to the development of the tree.

Cl is never totally absent from a tree, but if necessary to its development, only a small quantity is needed. Its absence in many reported analyses is due, without doubt, to the fact that it is easily driven off from the ash when it is at the temperature necessary for the combustion of the wood.

Silica is not indispensable to the growth of trees but analyses show that it is always present in the ash of trees grown on natural soils. It is usually

found most abundant in the stem and sometimes occurs to the extent of 30 per cent., as is often the case in the pine tree. It also varies greatly with the age of the tree, and is frequently found as a coating on the bark. Halm-Horstmar's investigations seem to indicate that silica is indispensable to vegetation, but the later investigations of Sachs, Knop, Nobbe, Stiegert, Wolff and others, indicate that it is not essential to the physiological development of the plant. Its great abundance in the soil, however, accounts for its occurrence in the ash of all trees.

Lucanus' investigations show conclusively that the oxide of manganese is inessential to the development of the tree.

It must be remembered that all the ash constituents which are necessary to the growth of the tree may be absorbed by it in a much larger quantity than is essential.

The effect of an abundance of any one of the ash constituents of a tree upon its vegetable products has been given some study, but no definite conclusions have been reached. It is known, for example, that pears will flourish on ground that would yield apples scarcely palatable, but the mineral constituent wanting and necessary for the full development of the apple is not known.

Fruit growers agree that by the use of fertilizers you may affect the growth of wood very much, but not the quality or quantity of fruit. The best form to apply the mineral constituents to the soil is in the use of stable manure which has the following average composition: Water 75 per cent., organic matter 19.2, ash 5.2, nitrogen .5, potash .63, soda .19, lime .7, magnesia .18, phosphoric acid .26, sulphuric acid .16, silica .16, chlorine and fluorine .19.

The composition of the ash of trees certainly does not of itself afford sufficient data to determine, with anything like certainty, which fertilizing constituents or manuring mixtures should be applied to the various trees in order to produce the largest yield of fruit. A knowledge of the composition of the ashes of trees, however, gives us warning that our trees will become unhealthy if the soil on which they are grown is either wanting or contains insufficient quantities of one or more of the ash constituents necessary for the growth of the tree. Often the amount of growth is sought to be increased by the addition of ammonia when really the soil may be starving for mineral food. An excess of ammonia over the proper proportion of mineral constituents does not enter into the growth of the tree, or in other words, as before stated, the increase in growth in a tree is propor-

tional to the mineral elements of nutrition present in the soil in a soluble or available form, and an excess of ammonia will not supply this deficiency. The aim should be to apply enough and just those elements that will increase assimilation of mineral constituents. Often the increase of mineral food may prove effectual far beyond the increase of nitrogenous matters, but the effect will depend most closely upon the amount of CO_2 and solar energy available for use, and the reverse must be remembered, solar energy is limited by the amount of soil materials present. Endeavor also to use salts of those acids which are present in the least quantity in the soil. The effect of the addition of ammonium salts is not what NH_3 would be, for they contain an acid which acts on the constituents of the soil and renders the earthy phosphates more soluble in water.

Experiment shows that trees die if the supply of mineral food is exhausted, even though they be still supplied with organic food in abundance. It must be remembered that the roots of trees go down deep in the soil and bring to the surface much that would not be available were ordinary crops grown on the field.

An experiment made by George Ville will show the effect of fertilizers upon vegetation. The plant taken for the investigation was hemp. The characters of the plant taken into consideration are color, stature, weight: "Seven soils were used. First, intense manure (100 kilos of N); second, complete manure (75 kilos of N); third, manure without nitrogen; fourth, manure without phosphates; fifth, manure without potash; sixth, manure without lime, and, seventh, soil without manure. Plants treated with intense manure were of the deepest green, height 1.25 metres, weight 11.22 kilos; complete manure, height 1.20 metres, weight 11.15 kilos, color less deep; manure without N, height .61 metres, weight 4.74 kilos, color yellowish green; manure without phosphates, height .97 metres, weight 8.22 kilos, color medium green; manure without potash, height .40 metres, weight 5.22 kilos, color light yellowish green; manure without lime, height 1.15 metres, weight 10.57 kilos, color slightly paler than those without phosphates; plants in unmanured soil, height .18 metres, weight 2.17 kilos, color pale green."

This experiment gives us a fair knowledge of the effect of different fertilizers, and may be of some aid in the selection of those intended to be used on orchard land.

The object of this investigation has been to place at the disposal of the fruit grower some definite knowledge of the drain upon his orchard land

and also to give him an idea of how much and what mineral constituents he must apply from year to year to meet the demands of a thrifty tree.

The writer is indebted to Prof. G. C. Caldwell, of Cornell University, for the material and assistance that enabled him to carry on this investigation

---

Poisonous effects of cypripedium spectabile. By D. T. McDougal. Published in the Minnesota Botanical Studies, Part I; 32–36.

Symbiosis of isopyrum biternum. By D. T. McDougal. Published in the Minnesota Botanical Studies, Part II; 139–142.

The stomates of cycas. By Mason B. Thomas.

Our present knowledge of the distribution of pteridophytes in Indiana. By Lucien M. Underwood.

The purpose of this paper is not primarily to convey any new information although it contains reference to some plants not hitherto reported from this state; nor for the purpose of criticizing what has hitherto been accomplished though it notes the necessity of cutting out some of the plants reported from the state that never belonged to its flora. Its purpose is rather to indicate the paucity of information we have at hand regarding the distribution of even the best known groups of plants; to indicate the extensive portions of the state that are practically untouched by the hand of the collector; to indicate how futile and useless it is to publish or even make manuscript lists of the plants of any region and leave nothing to represent this information aside from a mental recollection or a printed or written line; to outline the limits of our definite in-

formation and to indicate the directions in which future observations may be made useful if accompanied by vouchers that will enable one to verify the accuracy of the information at any future time.

The fern flora of Indiana seems meagre to one familiar with the profusion that is manifested in many other parts of the country. For ferns to flourish there must be more uniformity of moisture, and less irregularity of season than have been manifested in this state in recent years. A climate interrupted by long periods of drought, swamps that lose their water during summer, a soil that is constantly being gullied by rains that flow away quickly from the surface, or areas that are likely to be covered by the alluvium of rivers at times of high water—these are not the conditions under which ferns reach a high state of development in either luxuriance or variety. The ravines along the streams where some moisture is always present, furnish the richest stations were ferns may be found within our limits; permanent swamps will also furnish their quota but the variety is there less than the profusion of certain species.

There are just 50 species of Pteridophytes that now stand on the state list either verified or with more or less probability of verification. Of these, thirty-three are members of the order Filices, and the remaining seventeen are distributed among the five related orders. Of the fifty species, we have verified, either by consultation of accessible herbaria or by personal collection during the past season, all but ten, as follows: Onoclea Struthiopteris, Phegopteris dryopteris, Cheilanthes vestita, Equisetum sylvaticum, E. laevigatum, E. robustum, E. variegatum, Lycopodium obscurum, L. inundatum, and Selaginella rupestris.

Certain species have been credited to the state that were based on errors of determination. Among these Dryopteris Filixmas (Aspidium) is most prominent; this has been variously confused with D. Noveboracensis and especialy with D. spinulosa. Its range from Lake Superior northward precludes its being found in Indiana. Phegopteris polypodioides was asserted by one correspondent to be found in Jefferson county and he reinforced his statement by the announcement that the plant had been determined at Cambridge. On sending for the plant I found it to be only a young plant of P. hexagonoptera, and not a very complete specimen at that. Lycopodium Selago was reported by two collectors from Putnam county, but the plant growing there is L. lucidulum, of which the rock forms bear a more or less striking resemblance to that alpine species. Botrychium lunaria as printed in the list of plants of Dearborn county was a

misprint for B. lunarioides as I learn from Dr. Collins himself.

Cheilanthes vestita was placed in the state list from Gibson county, presumably on the authority of Dr. Schneck's Wabash flora, but in a recent letter Dr. Schneck informs me that it does not grow in his vicinity but farther to the southwest in Illinois. There is therefore no certainty that it belongs to our flora.

The only other doubtful plant is Equisetum sylvaticum, which seems out of place in southern Indiana. No specimens of the original collection were saved as is too commonly the case in the construction of local floras.

The published state catalogue* may be taken as a datum line for further reports; the additions to the state flora since its publication are as follows:

1. *Dryopteris spinulosa intermedia* (Muhl) Underw. Was first collected and identified by W. S. Blatchley, in Monroe county, and later in Vigo county. G. C. Hubbard collected it in Putnam county, where it is not uncommon.

2. *Asplenium ebenoides* R. R. Scott. A single spond of this species (separate from the main specimen) occurs in the Wabash College herbarium collected in Jefferson county, by J. M. Coulter. It is a rare fern and by many is regarded as a hybrid. It should be sought where its supposed parents, *Camptosorus* and *Asplenium platyneuron*, occur.

3. *Equisetum laevigatum* A. Br. Is reported by Rev. E. J. Hill, from Lake county, and its distribution is likely to be more extensive, as it might be confused somewhat easily with *E. hyemale*, which is widely distributed.

4. *Lycopodium lucidulum* Michx. Was first collected by G. C. Hubbard and D. T. McDougal, at Fern, Putnam county. It is somewhat common in the ravines at that place.

The following species, which appear in neighboring states, are to be looked for in this state:

Cheilanthes gracilis (Fee) Mett. (*C. lanuginosa*) Illinois.

Woodwardia areolata (L.) Moore. (*W. angustifolia*) Michigan.

Dryopteris cristata (L.) A. Gray (Rang includes Indiana.)

Asplenium montanum Willd. Ohio, Kentucky.

Botrychium matricariæfolium A. Br. Ohio. There would seem to be no reason why this and some of the other small species of *Botrychium* should not be found in this state. They are small and often grow in grassy woods and are, therefore, easily overlooked.

*Catalogue of the Phaenogamous and vascular cryptogamous plants of Indiana, by editors of the Bot. Gazette and C. R. Barnes, 1881.

Lycopodium clavatum L. May occur on some of the higher land of the state, though its distribution is, in general, more northerly.

Species of *Isoetes* should be found, especially in our northern lakes.

Turning, now, to the counties from which plants of this group have been reported we find that from only 31 counties have we any information whatever and from a number of these only one, or at most, a few common species. From a half dozen we have reasonably full returns and these are mostly those in which a college is located at the county seat. Jefferson leads with 31 species, followed by Putnam and Monroe with 27 each. Clark stands next with 22 and the rest are 20 or mostly much less. It will thus be seen that fully two-thirds of the counties of the state have not been explored botanically and represent the regions into which missionary work should be organized by the Survey. Of those that have been explored, certainly less than a dozen are even fairly well known in their higher or vascular flora.

The distribution of certain species has more than a local interest; this is specially true of those which reach their northern or southern limit in the state. Of these *Polypodium polypodioides* (*P. incanum*) is an example of southern form whose northern range in Indiana as known at present is in the counties of Posey, Gibson, Perry, Floyd, Clark and Jefferson. It is not unlikely that this range will be considerably extended as soon as some one with a sharp eye goes into the other counties of the southern tiers. It is an epiphytic fern growing on oaks and probably other trees. *Asplenium pinnatifidum* is another southern fern which so far has been found only in Gibson county. Of the northern species, *Woodwardia Virginica* is only found in Lake and LaPorte counties and will probably not be found far from the borders of the great lake. *Selaginella rupestris* is at present known only from Lake county,* though its limits are likely to be much extended. The various species of lycopodium are likely to show limited northern range, though *L. complanatum* has been found since the publication of the state catalogue in the counties of Putnam and Monroe, but always on the northern exposures of the hills. The further stations of any of our lycopodiums is a matter of more than local interest. Among other species that seem to have a restricted range we have *Onoclea struthiopteris* reported only from Montgomery, *Phegopteris dryopteris* from Allen, and *Asplenium*

*The reference in the state catalogue to Gibson county proves to be an error, as the plant thus referred to turns out to be a hepatic. The Montgomery county station also needs verification.

ebenoides from Jefferson. While all these need further verification, there is no reason apparent why they should be thus limited, though the last named species is always a rare and local find.

In preparing this paper the following herbaria have been examined: Purdue University, containing 22 Indiana species, many collected by Dr. C. R. Barnes, in Jefferson county; the herbarium of G. C. Hubbard, with 24 species, collected mostly in Southern Indiana; that of Wabash College, with 25 species, largely collected by Dr. J. M. Coulter; that of DePauw University, with 29 species, collected by D. T. McDougal in Putnam and by W. S. Blatchley in Monroe and Vigo; and that of the writer with 35 Indiana species collected in various parts of the state, mostly during the present season.

Valuable notes have also been sent by Rev. E. J. Hill, Dr. J. Schneck, W. P. Shannon, W. S. Blatchley and Professor A. H. Young. It is hoped that the work of a second season will give more definite and fairly complete information regarding the distribution of critical species.

The adventitious plants of Fayette county, Ind. By Robert Hessler.

During the period from 1881 to 1890 the writer kept a close watch upon the flowering plants of Fayette county, noticing particularly the arrival of plants commonly regarded as weeds. During those ten years there were at least thirty-five new arrivals; of these twenty appeared along the railroads, ten along roadsides and waste places, four in meadows, one in a cultivated field. Of the thirty-five, seven again disappeared after a year or two, eighteen merely held their own or spread only to a limited extent, while ten have swept across the county and may now (*i. e.*, 1890) be found almost everywhere.

A brief note on the main features of the county may aid in better understanding the changes in the flora. Fayette county is almost due east of the capital and is the second county from the Ohio state line. The county was for merly densely wooded. The surface, excepting the level northwest portion, is rolling and in places even hilly, especially along the southern boundary. The whole surface is covered by drift. The county is divided from north to south by a broad valley through which the White Water

river flows. The valley has a black, gravelly soil of great fertility. The White Water railroad traverses the county from north to south; the Lake Erie & Western goes north from Connersville. The Cincinnati, Hamilton & Indianapolis crosses the county from east to west, and crosses the W. W. R. R. at Connersville, and at a different level. I mention this fact because it has some bearing on the distribution of weeds.

In the following notes the plants are given in the order of arrival by years. The first two years are grouped together, as my notes do not allow me to differentiate. At that time I did not get over the county so much as in after years, and some of the plants may have appeared a year or two before this date. After the vear 1882 I traversed the ground so frequently that I am sure the dates given for the arrival of new species are correct. The nomenclature is that of the last revised edition of Gray.

The following nine plants were seen during the years 1881 and 1882, that is, when I first began botanizing systematically.

Echinospermum Lappula, seen along the W. W. R. R. near Connersville. The patch has increased only slightly, not inclined to spread much.

Arenaria serpyllifolia, a small plant first seen along the W. W. R. R. below town. Now very common in sandy or gravelly soil. Not given in Coulter's catalogue of the plants of Indiana.

Potentilla Norvegica, occasionally seen in meadows, and is now rather common.

Medicago lupulina, seen along the C., H. & I. west of town, is now frequently seen along the railroads and roadsides.

Dysodia chrysanthemoides, seen in the locality near the last, and is now common throughout the county.

Geranium Carolinianum, along the W. W. R. R. below town, and now along the whole line.

Verbena officinalis, along roadsides west of town, now frequently seen in the valley.

Montelia tuberculata (var. *submuda*), first seen along the C., H. & I. R. R. east of town, now common along that road and frequent in the valley.

Croton monanthogynus shows the rapid spread of a new arrival. In 1882 a small patch was first seen a few miles below town in an isolated meadow near a creek. The next year it appeared along the W. W. R. R. Two years later it could be found throughout the White Water valley, or whereever there was dry gravelly or sandy soil.

Beginning with the year 1883 I can give a definite date for each species.

As I have already stated, I went over the ground so frequently that I am sure the plants did not exist before the date given. The only exceptions to this statement are in the case of the *Balm* and *Poison Hemlock*, these grew in isolated places not frequently visited.

1883.

Cassia Chamaecrista, appeared along the W. W. R. R. south of town, now frequent along all the railroads.

Chrysanthemum leucanthemum, the Ox-eye daisy, in a meadow near town, now frequently seen.

1884.

Lactuca scariola, a rank weed, W. W. R. R. in city, spread rapidly along this railroad and is now very common along it.

Nicandra physaloides, appeared in a corn field near the railroad south of town, disappeared, again reappeared in 1888 and again disappeared.

Eragrostis major (and perhaps also *E. minor*), the only addition in the grasses appeared along the W. W. R. R., above town.

1885.

Gaura biennis in a waste place near town, now occasionally seen along the W. W. R. R.

Verbena bracteosa, along roadsides east and west of town, mainly on uplands, seldom seen in the valley.

Lithospermum arvense, the so-called Wheat-thief, along W. W. R. R., south. All plants seen were destroyed, but it reappeared the next year. Now common along the railroads, but as yet rare in fields or meadows.

Solanum Carolinense, seen along the C., H. & I. R. R., east, and destroyed; none seen for two years. It is now frequently seen.

1886.

Melilotus alba, the sweet clover, appeared along the C., H. & I. R. R., west of town. It is now a very common and rank weed.

Solidago lanceolata, along roadsides just west of town; not inclined to spread.

Rudbeckia laciniata, a tall cone-flower, appeared in the valley, and is apparently just holding its own; is not spreading.

Melissa officinalis, the Balm, is no doubt an escape from a garden. Not spreading.

Verbena stricta, first seen along the W. W. R. R., south of town; now frequent along this road and occasionally seen along the other railroads.

1887.

This year was the banner year for new arrivals, as nine new species appeared.

Conium maculatum, a few individuals of this rank poisonous plant were seen near a dwelling in an isolated region. I do not know its ultimate fate. No other specimens were found.

Saponaria vaccaria appeared in considerable numbers west of town along the C., H. & I. R. R. This is an annual plant. It appeared for one season only.

Œnothera sinuata, a few plants were found a few miles east on the C., H. & I. R. R. Three years later it had entirely disappeared.

Gaura coccinea, a far western species, appeared near the last, and after a few years died out.

Rudbeckia speciosa, a small patch of this showy cone-flower was found in a wet meadow away from all lines of travel. This patch is gradually increasing and when in full bloom presents a beautiful appearance. This plant is not reported in Coulter's Catalogue.

Cnicus arvensis, the Canada thistle, appeared at the C., H. & I. R. R. station. The attention of the railroad company was called to the presence of this pest and all specimens were thoroughly destroyed. It has not been seen since.

Plantago lanceolata had been frequently seen in the county below us, but not until 1887 did we find it in Fayette county. It is now a very common weed.

Euphorbia dentata, a few plants appeared for a season along the W. W. R. R., a mile or two below town. Has disappeared entirely.

Hypericum perforatum, a single plant was found along a roadside west of town; it was destroyed at once.

1888.

Melilotus officinalis, the yellow sweet clover, appeared along the C., H. & I. R. R., in town.

1889.

Plantago Virginica was found quite abundantly along the Ft. Wayne R.R., and the next year was quite common along all the railroads in the valley.

1890.

Very little botanizing was done this year and only one new species was found. Two or three specimens of the false flax, *Camelina sativa*, appeared along the W. W. R. R. below town.

NEW PLANTS NOW COMMON.

Out of the thirty-five new arrivals, the following nine have taken the county by storm—that is, they are now very common:

Arenaria serpyllifolia.	Lactuca scariola.
Croton monanthogynus.	Melilotus alba.
Dysodia chrysanthemoides.	Plantago Virginica.
Chrysanthemum leucanthemum.	Plantago lanceolata.

Lithospermum arvense.

SOME EVOLUTION AMONG CACTI. By JOHN M. COULTER.

[ABSTRACT.]

The nascent tubercles of *Eumamillaria, Coryphantha, Echinocactus, Anahalonium* and *Lophophora*, show in their generic characters perfectly intergrading characters, which serve to clear up certain homologies and relationships.

PHYSICS AND CHEMISTRY.

PERMANGANIC ACID. By THOS. C. VAN NUYS AND SHERMAN DAVIS.

It is the purpose of this investigation to work out, if possible, I. The exact conditions under which permanganic acid or its salt undergoes spontaneous decomposition. II. Whether it is effective as an oxidizing agent in the decomposition of organic matter.

I. For determining the exact properties of the acid or its salt, the following plan was adopted. Glass tubes, about 30 mm. and 30 cm. long were sealed at one end and carefully annealed. They were then filled with a strong H_2SO_4 sol. of potass. permanganate and heated to 100°C. for 12 hrs. This treatment completely removed any organic matter adhering to them. The distilled water was purified by boiling a strong H_2SO_4 sol. of potass. permanganate, with a condensing apparatus, for some time and then distilling the second time with $KMnO_4$. The NaOH used in making the standard alkali sol. was prepared from the pure metal and absolutely pure water. The tubes were then carefully rinsed with the C. P

water and made ready for use. After introducing a definite quantity of the standard sol. of potass. permanganate from a burette, graduated to $\frac{1}{100}$ cc, and a definite amount of the acid or alkali, the tubes were sealed, then cooled gradually to anneal them. When cold, the tubes were well shaken to mix the fluid and then introduced into a copper bath 4 in. wide and 15 in. long. When working at 100°C. pure water was used to fill the bath; for higher temperatures aniline was used. We found aniline preferable to paraffin because the heat diffused through it more readily and uniformly. Many conditions were tried to determine if possible all the factors which enter into the problem. From the data obtained there seem to be four primary factors which influence the spontaneous decomposition of permanganic acid. 1. The quantity and kind of acid or alkali used. 2. Time of heating. 3. Temperature. 4. Dilution. This is shown by the following data: I. Quantity and kind of acid used:

	No.	$SO_3\frac{n}{n}$	KOH	$KMnO_4\frac{n}{10}$	Oxalic A.	$KMnO_4$	Time	Water.	Per cent. Dec.
	1	2	x	10cc	12.00	2 25	2 hr	8cc	
	2	2	x	10cc	12.00	2 35	2 hr	8cc	3.2
100° C	3	2	x	10cc	12.00	2.22	2 hr	8cc	
	4	2	x	10cc	12.00	2.20	2 hr	8cc	
	5	2	x	10cc	12.00	2.25	2 hr	8cc	
	1	1cc	x	10cc	12.00	2.20	2 hr	9cc	1.8
	2	1cc	x	10cc	12.00	2.20	2 hr	9cc	
	3	1cc	x	10cc	12.00	2.15	2 hr	9cc	

Orthophosphoric acid shows less decomposition.

II. A. Time of heating.

No.	$SO_3\frac{n}{n}$	KoH	$KMnO_4\frac{n}{10}$	Oxal. A	$KMnO_4$	Time.	Water.	Per cent. Dec.
1	2cc	x	10cc	12 00	2.20	1 hr	8cc	
2	2cc	x	10cc	12.00	2.15	1 hr	8cc	1.6
3	2cc	x	10cc	12.00	2.20	1 hr	8cc	
4	2cc	x	10cc	12 00	2.15	1 hr	8cc	

By using 4–6–8cc of acid with constant time, temp. and dilution, we find the per cent. decomposition is almost exactly proportional to the quantity of acid used. It may be represented by the curve A.

By using constant acid and dilution and temp. the per cent. decomposition is approximately proportional to the *time* of heating. Its curve is therefore the same as that for the acid decomposition B. with NaOH.

The NaOH sol. of permanganic acid is much more stable under like conditions than the H_2SO_4 sol. This is shown by the following data:

	No.	NaOH	$KMnO_4$	Oxal. A.	$KMnO_4$	Time.	Water.	Per cent. Dec.
100°C	1	2cc	10.00	12.00	2.07	1 hr	8	0.2
	2	2cc	10 00	12.00	2.02	1 hr	8	
	3	2cc	10 00	12.00	2.00	1 hr	8	
	1	4cc	10.00	12.00	2.05	1 hr	8	0.7
	2	4cc	10.00	12 00	2.12	1 hr	8	
	3	4cc	10.00	12.00	2.05	1 hr	8	
		6	10.00	12.00	2.05	1 hr	8	0.2
		6	10.00	12.00	1.95	1 hr	8	
		6	10.00	12.00	2 01	1 hr	8	
		6	10.00	12.00	2.05	1 hr	8	

From these data we see that the amount of decomposition is within the limit of error in manipulation, for the time and temp. used.

By increasing the time to 2 hr. and dilution to 50cc there is no appreciable increase in the amount of decomposition.

If the temp. be raised to 175°C, the other conditions remaining constant, the dec. rises to 2 per cent.

	NaOH	$KMnO_4$	Oxal. A	$KMnO_4$	Time.	Dil.	Temp. 175°
1	6	100	12.00	2.20	1 hr	34	
2	6	100	12.00	2.20	1 hr	34	Per cent. $2\frac{7}{100}$
3	6	100	12.00	2.20	1 hr	34	

In all these cases we have used a $\frac{1}{10}$ Nor. sol. $KMnO_4$; if $\frac{1}{100}$ be used the decomposition especially with H_2SO_4 is much greater.

II. In studying the oxidation properties of the NaOH sol. we followed the outline given by Lentz. We find that by using a Nor. sol. NaOH, a $\frac{1}{10}$ Nor. $KMnO_4$ Sol. and diluting to a definite volume—100cc—the oxidizing properties of this acid is much greater than shown by him. We succeeded in oxidizing 97 per cent. of a standard sol. of grape sugar, even under secondary conditions and obtained constant results in each case. The work on oxidation has not been developed, but it appears from what has been done, that this method with the standard NaOH sol. and the sealed tube can be made to completely oxidize such substances as sugar and glycerine.

Detection of hydrocyanic acid in traces. By Thos. C. Van Nuys and Sherman Davis.

The detection of HCN in traces in the presence of hydroferro- and hydroferricyanic acid, according to the method of Otto, is attended with many difficulties. In our laboratory practice we have failed to find it sufficiently delicate and reliable. The distillation at 50, 60, or even at 80 per cent. often fails to drive over the free *hydrocyanic acid*. As a substitute for this method we cheerfully recommend the following method:

I. When a large quantity of organic matter in a *coarse* condition is present, introduce it into a fine-meshed silk seive. Moisten it all over with a 10 per cent. sol. tartaric acid and wash into a 500cc. cylinder, glass stoppered, with distilled water, until the total vol. amounts to 200–250cc. If the organic matter is very finely divided, introduce the substance at once into the cylinder, dilute with water to 200cc. Make acid with a 10 per cent. sol. tartaric acid, add 100cc. ethyl ether, and shake the mixture for some time. Let the ether separate and pipette it off into an evaporating dish. Repeat the process of extracting with the ether, the second, and if necessary, the third time, using smaller quantities of ether. Unite the ether extracts. Render the ether sol. *slightly* alkaline with an alcoholic solution of KOH, stir very thoroughly, and allow the ether to evaporate *spontaneously*. This leaves the trace of hydrocyanic acid in combination with potash, as, a fixed salt. Transfer the residue from the ether extract to a large test tube. The tube should be provided with a stopper with double perforations. Through one pass a *well fitting* glass tube, and terminate it at the under surface of the cork; through the other perforation pass a well fitting glass tube whose lower end is drawn out to a very fine point, and let it extend to the bottom of the test tube. Connect the tube which reaches to the bottom of the test tube with a hydrogen generator. The other and shorter tube is connected with a Liebig's bulb containing 25cc of a mixture of 3 pts. of yellow amononia sulphid and one pt. NH_4OH. Make the ether residue in the test tube acid with tartaric acid. Make the connections as above described, and pass a slow stream of hydrogen through the sol. for 30–45 min. Break the connection after the gas has passed sufficiently long, transfer the am. sulphide sol. to a large watch glass, and allow it to evaporate high over a free flame. By this process the hydrocyanic acid which passes over with the hydrogen gas is transformed into am. sulphocyanate. When the am. sulphide sol. has been completely decomposed by evaporation, take up with distilled water

(10cc), filter through a small filter, if necessary, and test the sol. for am. sulphocyanate with ferric chloride. By this process we have succeeded in finding one part of hydrocyanic acid in 200,000 parts of water and organic matter. The method is especially recommended in cases of toxic analysis, where the ferro and ferri-cyanides may be present.

1.4 DIAMINO-CYCLOHEXANE. By W. A. NOYES AND H. H. BALLARD.

[ABSTRACT.]

The chloride was prepared from succinylosuccinic ester by saponification with sulphuric acid formation of the dioxime, and reduction with sodium and alcohol. Solutions of a mixture of equivalent quantities of the amino-chloride and sodium nitrite evolve on heating nearly two atoms of nitrogen. The same is true of a solution of the amino nitrite, prepared by adding silver nitrite to the amino chloride.

The products of the reaction as deduced from their chloroplatinates are 1.4 amino-hydroxy-cyclohexane and Δ^3 tetrahydro-aniline.

ON A CASE OF STEREO-ISOMERISM IN THE HYDRAZONES OF BENZOIN. By ALEXANDER SMITH.

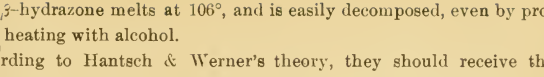
Only four or five cases of isomerism have as yet been discovered among the hydrazones. In each case the two isomers are made in a similar manner and possess similar chemical properties, indicating identity in constitution. In each case, however, the isomers may be distinguished by difference in solubility, melting point and stability. The two hydrazones of benzoin described in this paper are related to each other in the same way, and, therefore, fall into line with the previously described cases.

Both are formed when benzoin and phenylhydrazine are heated in alcoholic solution, while the β-hydrazone alone is produced when the ingredients are heated without any solvent.

The α-hydrazone melts at 158°–159°, is very stable in comparison with the other variety, and is only one-fourth as soluble in alcohol.

The β-hydrazone melts at 106°, and is easily decomposed, even by prolonged heating with alcohol.

According to Hantsch & Werner's theory, they should receive the formulæ:



α-Hydrazone—
Stable. M. P. 158°–159°.

β-Hydrazone—
Unstable. M. P. 106°.

Camphoric acid. By W. A. Noyes.

[Abstract.]

When methyl sodium camphorate is treated with phosphorus oxychloride and the product obtained is treated with ammonia, an amide having the formula $C_8H_{14}\begin{cases}CO_2CH_3\\CONH_2\end{cases}$ is obtained. When this amide is treated with a solution of sodium hypobromite, an amine, probably of the formula $C_8H_{14}\begin{cases}CO_2CH_3\\NH_2\end{cases}$ is obtained. The study of these compounds is still in progress, and it is hoped that others may be obtained from them which will throw new light on the structure of camphoric acid.

The detection of strychnine in an exhumed human body. By W. A. Noyes.

[Abstract.]

The stomach, liver, and a portion of the intestines of a child were submitted for examination on April 26th of this year. The child died on June 23d, 1892, and was buried the following day. The body was exumed on April 25th, 1893. A small amount of strychnine was recovered and was identified by the reaction with potassium pyrochromate and sulphuric acid, by the bitter taste, by the crystalline form, by the crystals obtained from the chloride with potassium chromate, and by the effect of a

small portion on a small frog, The frog died after developing the tetanus characteristic of strychnine poisoning. The case is of interest because of the length of time which elapsed before the body was exumed, there being few, if any, cases recorded where strychnine has been found in an exhumed body after so long a time; also, because a considerable portion of the strychnine was retained in the fatty matter and required different means from those usually employed for its separation. A full account of the case will appear in the Journal of the American Chemical Society.

THE ABSORPTION OF POISON BY DEAD ANIMAL TISSUE. By P. S. BAKER.

The alarming frequency of the criminal use of arsenic has led to the study of its effects on the bodies of living and dead animals.

There has been reason to believe that arsenic was introduced into the bodies of men after death, and that involved the investigations of the courts in more or less confusion. Inquiries have therefore been made as to whether arsenic may or may not be absorbed by the corpse from external sources, and the answers to these inquiries have never been satisfactory.

The author has found by numerous experiments on cats that arsenic injected under the skin, from twenty to thirty minutes after death, will penetrate to the internal organs; but if the injection be made later than seventeen hours after death, it could not be found in the internal organs.

The work is still in progress to answer several questions involved in the study.

ON THE VARIATION OF STRENGTH OF TIMBER AT DIFFERENT PARTS OF THE CROSS SECTION OF THE TREE. By PROF. T. GRAY.

[ABSTRACT.]

In Bulletin No. 8, of the Forestry Division of the U. S. Department of Agriculture, Prof. J. B. Johnston refers to this subject in connection with a series of tests on long-leafed pine. Prof. Johnston's experiments showed a variation of about 12 per cent. of the average tensile strength, the maxi-

mum being, for butt logs, at least, about one-third of the radius from the center of the tree.

A few weeks ago while making some tests of the strength of burr oak and white oak, I was rather surprised to find a variation of tensile strength of much greater amount than that obtained by Prof. Johnston for pine. In the case of the white oak the strength varied from 12,000 pounds per square inch at about one and a half inches from the surface of the tree to about 24,000 pounds per square inch at a similar distance from the center. The log was about ten inches radius and the variation was nearly uniform from the outside to the center. The burr oak showed a similar variation, but unfortunately the record of some of the tests, taken when I was unable to attend personally to the matter, have been lost. I have since made similar tests on water oak and on red oak. The results in the water oak show no decided variation across the sections. The average strength was about 14,000 pounds per square inch, and as nearly uniform as is to be expected in tests of timber. The red oak was also much more nearly uniform in strength across the sections than the white oak, but in this case there was good evidence that the outside wood was the stronger, especially on the side of the tree which had the larger growth. The variation in this case was from about 15,000 pounds on the square inch at the center to 18,000 pounds on the square inch at the outside. The stronger timber was, however, in this case, confined to about three inches of the outer end of the radius.

ON AN AUTOGRAPHIC METHOD OF TESTING THE MAGNETIC QUALITIES OF IRON.

By PROF. T. GRAY.

[ABSTRACT.]

At last Christmas meeting of the Indiana Academy I gave a brief description of some experiments which I had made on the magnetic qualities of iron and of the results I had obtained in these experiments, which were of a preliminary character. The general principle of the method was to deduce the magnetic properties of the iron from the electro magnetic inertia of a circuit composed mainly of a magnetizing coil surrounding the iron. This electro-magnetic inertia is evidenced by the relative values at each instant of the impressed e. m. f. on, and the current flowing through

the circuit when one or both of these quantities is varying. Since that meeting I have been successful in making use of an autographic device for recording the variations of the current during its rise from zero to a maximum immediately after the circuit is closed on a constant battery. The e. m. f. is in this case constant, and the variation of the current indicates the electro-magnetic inertia, and consequently, magnetic quality of the iron.

The autographic apparatus consists of a modification of the Thomson siphon recorder, used for submarine telegraphy. A rectangular coil of a few turns is suspended between the poles of a powerful electro-magnet which is separately excited. The coil is made to form part of the electric circuit containing the magnetizing coil, and hence, as the current varies in the circuit, the coil turns between the poles of the magnet. A long, glass siphon pen records the motion of the coil, or rather its position at every instant, on the record sheet of a chronograph. We thus get a curve of which the abscissæ are intervals of time from the instant of closing the circuit and the ordinate strength of the current at the end of these intervals of time. This curve must be expressed by the equation $L\frac{dc}{dt}+RC=E$ where L is the coefficient of electro magnetic inertia of the circuit, R the resistance, C the current and E the impressed e. m. f. The product RC represents the e. m. f. required to keep a constant current C flowing through the circuit, and $L\frac{dc}{dt}$ represents the back e. m. f., due to self-induction. We may put the equation in the form $L\frac{dc}{dt}=E-RC=e$, or, $Ldc=edt$. The quantity e at any instant is the difference between the ordinate at that instant and the maximim ordinate of the curve when the impressed e. m. f. curve is drawn to such a scale as to coincide with the maximum value of the current curve. We then get e readily from the curve. Also edt is the increase of induction in time dt, and therefore the area included between the current curve and the e. m. f. curve up to any instant gives, when multiplied by the proper constant, the total induction up to that instant. These different inductions, when expressed graphically, with magneto-motive forces derived from the strength of the current and the proper constants of the magnetizing coil as abscissæ, give the ordinary magnetization curve. From this curve the permeability of the material, the dissipation of energy in cyclic action, and so forth, can be readily derived in the ordinary way.

THE VALUE OF THE STEAM PIPE WITHIN THE SMOKE BOX OF A LOCOMOTIVE, AS A MEANS OF SUPERHEATING. By WM. F. M. GOSS.

The pipe connection, by which steam is conveyed from the boiler to the engines of an American locomotive, begins at the throttle valve within the dome of the boiler, and extends forward along the inside of the boiler until it finally passes out through forward head into the smoke box. Here it receives a fitting known as the "T-head," from which branch pipes leading to the cylinders on either side of the machine. The T-head and the two branch pipes are exposed to the temperature of the smoke box, which, when the engine is in action, is several hundred degrees higher than the temperature of the steam within the pipes, and it is therefore evident that the latter must receive some heat from the smoke box in its passage through these pipes. The amount of heat thus transmitted, however, has always been a matter of speculation.

Designers of compound locomotives have often arranged an enlarged pipe within the smoke box to serve in the double capacity of receiver and re-heater, the expectation being that the steam exhausted from the high pressure cylinder would be dried, or even superheated, by its passage through this pipe in its course to the lower pressure cylinder. To throw some light on the extent of the drying or superheating effect, as well as to settle another question at issue, the following experiment was made upon the Purdue experimental locomotive:

A thermometer having been inserted in the T-head, another in the middle of one branch of the steam pipe, and a third in the saddle close to the valve-box, the locomotive was run with the throttle partially open, the drop in pressure from the boiler to the pipe being sufficient to superheat all of the steam at the lower pressure. It is evident that a change in the quality of the steam as it passed from one thermometer to another in its course to the cylinders would be at once detected by a change of temperature.

The conditions of the test were maintained for half an hour or more before observations were taken, after which time the thermometers were read and other observations taken simultaneously at five minute intervals for a second half hour. The following is a summary of results:

Smoke box temperature	700. ° F
Increase of smoke box temperature over temperature of steam in the boiler	345. ° F
Temperature in T-head	335.30° F

Temperature in middle of steam pipe . . . . . 339.65° F
Temperature in saddle . . . . . 327.87° F
Pressure in dry pipe by gauge . . . . . 70 lbs
Temperature of saturated steam at pressure in dry pipe . . . . 315.68° F
Approximate time occupied by the steam in passing the steam pipe . . . . . 0.1 seconds

It will be seen that the temperature of the steam was increased 4.4° F in passing half the length of the branch pipe, which is equivalent to a gain of 8.8° F in its passage through the whole length of the branch pipe. The transfer of a quantity of heat represented by this increase of temperature would affect moist steam by increasing its dryness about 0.5 of 1 per cent., an amount too small to affect the efficiency of the whole machine to any measureable extent.

The thermometer in the saddle indicated a temperature of 9.4° F lower than the temperature in the T-head, and 18.2° lower than the presumable temperature at the end of the steam pipe, so that, from the T-head to the cylinder, there is no gain, but an actual loss of heat by the steam. This effect is to be accounted for in the fact that the mean temperature within the cylinders is much lower than the temperature of the incoming steam, which, combined with the effect of radiation from the saddle, operates to lower the temperature of the iron which surrounds the steam in its passage through the saddle. It is certainly clear that the cooling effect of the saddle more than offsets the gain in heating effect secured from the smoke box.

The conditions were varied and all of the work repeated several times with the same general results. The figures given represent the test giving the greatest heating effect.

Enlarging the pipes within the smoke box would have a beneficial effect in increasing the action herein considered, since it would add to the extent of heating surface and lengthen the time occupied by the steam in passing the same, but, as a practical matter, a limit to such enlargement is soon reached.

As affecting the reliability of results, it may be said that the thermometers used have a range of from 100 C to 200 C and read to $\frac{1}{5}$ of a degree. They were inserted in long tubes, and at the T-head and at the middle of the steam pipe these tubes were protected by allowing steam to flow past them under pressure into the atmosphere. Before being used the thermometers were carefully compared when in the identical tubes used upon

the locomotive by subjecting them to saturated steam of about the same temperature as that recorded in the experiment. The reading of one was accepted as standard, and the errors of the other two determined.

AN EXPERIMENTAL STUDY OF THE ACTION OF THE COUNTERBALANCE IN LOCOMOTIVE DRIVE-WHEELS. By WM. F. M. GOSS.

In the mechanism of the locomotive, the mass of the reciprocating parts (piston, piston rods, crosshead, etc.) is balanced to a greater or less extent, by the addition of masses to the drivers, known as counterbalances. But the counterbalances move in circular paths, so that it is only the horizontal component of the radical force derived from them that serves to neutralize the effect of the reciprocating parts; while the vertical component of these counterbalances is an unbalanced force causing the pressure of the drivers on the rails to vary with every revolution. The extent of the disturbing effects of this unbalanced vertical component has long been a question of serious concern to the locomotive designer; but in this country, at least, they have found but little light to guide them. It has been difficult to ascertain enough of the conditions existing at any phase of the wheel's motion to serve as a basis for satisfactory mathematical work, and no solution has as yet been presented which will enable the designers to anticipate effects which are incident to the action of the completed machine. Practical demonstrations, however, are not wanting. Bridges are shaken until they fall, and rails are actually crooked under the stresses brought upon them by locomotives passing at high speed.

It occurred to the writer that in the case of the Purdue experimental locomotive a study could be made of the extent of this changing pressure of the wheel upon the rail, by feeding a wire under the wheel and by making use of the resulting variations in its thickness. This was first accomplished last spring, but the most satisfactory results have been obtained during the term just closed. A light mark made with a cold chisel across the face of the wheel leaves its impression in the wire and furnishes the desired reference point, by means of which particular effects may be connected with their appropriate wheel positions.

The following, concerning one of the rear drivers, may be of interest:

The pressure which this wheel exerts upon the rail when at rest is 7 tons, and its counterbalance, reduced to the radius of the crank pin, weighs

400 pounds more than is necessary to balance the revolving weights at the crank pin, that is, so far as vertical effects are concerned, the wheel is 400 pounds out of balance.

Wires which have passed under the wheel at speeds below 30 miles do not vary greatly in thickness. At a speed of 59 miles (333 rev.) however, a very short section of the wire is left entirely round, showing clearly that at this speed there is an instant in the revolution of the wheel when it exerts absolutely no pressure upon the rail, and making it fair to assume that there is another instant when it exerts double the pressure it transmits when at rest. In other words, in half a revolution, occupying less than a fifth of a second, the wheel pressure varies from nothing to 14 tons. The increment of the pressure is really more rapid than this, for it is found that the maximum lift occurs after the counterbalance has passed the vertical by a considerable angle. During the upward action the wheel lags and during the downward action there is a corresponding acceleration.

For speeds above 59 miles the undamaged portion of the wire is longer. Thus for 65 miles it is about 45 inches, showing the wheel to be off the rail for almost a quarter of a revolution, and its return to the rail is correspondingly rapid. The destructive effect of such a blow is enormous.

Complete wires are shown, also a diagram of a typical wire taken at 65 miles in which the vertical scale is greatly increased and the horizontal scale is diminished as compared with the actual dimensions of the wire. This diagram shows, as do all the wires, the lagging of the wheel in its upward motion and the rapidity of its return to the rail.

In addition to the immediate results yielded, this experimental investigation may serve as a means to a more complete mathematical analysis of the subject. This latter phase of the work is now being very skillfully developed by Mr. Daniel Royse, M. M. E., Junior member of the A. S. of M. E., to whom, also, I am indebted for numerical results derived from a study of many wires.

THE COLUMBIAN MUSEUM. By JOHN M. COULTER.

[ABSTRACT.]

An explanation of the organization of the Columbian Museum and its scientific possibilities.

INDEX.

INDEX.

ABSORPTION OF POISON BY DEAD ANIMAL TISSUE, 268.
Acrididæ of the U. S., 231.
Adventitious plants of Fayette county, 258.
Animal Tissue, Absorption of Poison by, 268.
Arkansas, Induration of Tertiary Rocks in, 219.
Arsenic, Absorption of, by Dead Tissue, 268.
Arthur, J. C., 205.
Ascomycetes, 33.
Ash of Trees, 239.
Autographic Method of Testing the Magnetic Qualities of Iron, 269.

BAKER, P. S., 268.
Ballard, H. H., 266.
Basidiomycetes, 48.
Beeson, C. H., 68, 76.
Benzoin, Hydrazones of, 266.
Bibliography—
Botany, 20.
Fishes, 71.
Geology, 156.
Mammals, 120.
Mollusca, 142.
Ornithology, 108.
Biological Survey, 13.
Biological Survey, Suggestions for, 191.
Biology, 221.
Birds, Notes on, 116.
Bitting, A. W., 69.
Bivalves, Fresh-water, 152.
Blatchley, W. S., 69, 199, 231.
Botany, 14, 232.
Botany, Bibliography of, 20.
Branner, J. C., 223.
Brannon, M. A., 237.
Bryophyta, 61.
Butler, A. W., 68, 69, 108, 120, 224.
By-Laws, 8.

CACTI, Evolution among, 262.
Call, R. L., 69, 140, 219, 225.
Camphorie Acid, 267.
Characinidæ, South American, 226.
Clays, 168.
Clays, White, 224.
Coals, 168.
Coke, 169
Color pattern of *Etheostoma Caprodes*, 231.
Columbian Museum, 274.
Concerning the Effect of Glycerine on Plants, 234.
Constitution, 7.
Contributions to the Histology of the Pontederiaceæ, 234.
Contributions to the Life-history of Notothylas, 239.
Coulter, J. M., 191, 262, 274.
Coulter, S., 17, 193.
Counter-balance in Locomotive Drive Wheels, Experimental Study of the, 273.
Cryptogams, List of, 30.
Crowley's Ridge, 219, 224.
Cycas, Stomates of, 254.
Cypripedium Spectabile, Poisonous effects of, 254.

DAVIS, SHERMAN, 262, 265.
Dead Animal Tissue, Absorption of Poison by, 268.
Dendroica Kirtlandi, Baird, 224.
Detection of Hydrocyanic Acid, 265.
Detection of Strychnine in Exhumed Body, 267.
1.4 Diamino-cyclohexane, 266.

EFFECT OF ENVIRONMENT ON MASS OF LOCAL SPECIES, 226.
Effect of Light on Germinating Spores of Marine Algæ, 237.
Eigenmann, C. H., 14, 67, 69, 76, 226.
Embedding Material, Notes on an, 233.

Etheostoma Caprodes, 231.
Evermann, B. W., 68, 120.
Evolution Among Cacti, 262.
Exhumed Body, Detection of Strychnine in, 267.
Experimental Study of Counter-balance in Locomotive Drive Wheels, 273.

FAYETTE COUNTY, Adventitious Plants of, 258.
Fellows, 9.
Fishes, Bibliography of, 71.
List of, 76.
of Wabash County, 229.
Fresh-water Bivalves, 152.
Fresh-water Univalves, 150.
Fungi Imperfecti, 43.

GAS, 168.
Gastromycetes, 63.
Geographical Distribution of Viviparidæ, 225.
Geology, 219.
Geology, Bibliography of, 156.
Germinating Spores of Marine Algæ, Effect of Light on, 237.
Glycerine on Plants, Effect of, 234.
Gold, 168.
Golden, Katherine E., 235.
Goss, W. F. M., 271, 273.
Gray, Thomas, 268, 269.
Growth in the Length and Thickness of Petiole of Richardia, 235.

HABITS OF TURTLES, 224.
Hay, O. P., 68, 69.
Hay, W. P., 69.
Hepaticæ, 64.
Hessler, Robert, 258.
High Schools, Relation of, to Biological Survey, 199.
Hydraulic Cement, 170.
Hydrazones of Benzoin, Stereoisomerism of, 266.
Hydrocyanic Acid, Detection of, 265.
Hymenomycetes, 58.
Hypsometric Distribution of Viviparidæ, 225.

ICHTHYOLOGY, 71.
Iron, Autographic Method of Testing Magnetic Qualities of, 269.
Induration of Tertiary Rocks in Northeastern Arkansas, 219.
Isopyrum Biternum, Symbiosis of, 254.

JORDAN, D. S., 71.

KINDLE, E. M., 156.
Kirtland's Warbler, 224.

LAND FORMS OF MOLLUSCA, 148.
List of Birds, 116.
List of Cryptogams, 30.
List of Fishes, 76.
List of Mammals, 124.
List of Mollusca, 145.
Locomotive Drive Wheels, Experimental Study of Action of Counterbalance in, 273
Locomotive, Value of the Steam Pipe within the Smoke-box of, 271.

MAGNETIC QUALITIES OF IRON, Autographic Method of Testing the, 269.
Mammals, Bibliography of, 120.
List of, 124.
Marine Algæ, Effect of Light on Germinating Spores of, 237.
Marsters, V. F., 14, 156.
Mass of Local Species, Effect of Environment on, 226.
McBride, R. W., 232.
McCook, H. C., 69.
McDougal, D. T., 233, 254.
Members, 10.
Minerals, 170.
Moenkhaus, W. J., 231.
Mollusca, 140, 145.
Musci, 65.
Myxomycetes, 30.

NOTES ON AN EMBEDDING MATERIAL, 233.
Notes on Indiana Birds, 116.
Notes on Sectioning Woody Tissue, 234.
Notes on *Saprolegnia Ferax*, 237.
Notothylas, Life History of, 239.
Noyes, W. A., 266, 267.

OFFICERS, 4, 6.
Oil, 170.
Olive, E. W., 16, 234.
On the Fishes of Wabash County, 229.
Ores, 170.
Ornithology, 108, 116.
Our Present Knowledge of the Distribution of Pteridophytes in Indiana, 254.

PERMANGANIC ACID, 262.
Phanerogamic Flora, 17, 193.
Phycomycetes, 31.
Pisces, 71.
Plants, Special Senses of, 205.
Poison, Absorption of, by Dead Animal Tissue, 268.
Poison Effects of *Cypripedium Spectabile*, 254.
Pontederiaceæ, Histology of, 234.
President's Address, 205.
Pteridophytes in Indiana, 254.

QUATERNARY, 184.

RELATION OF HIGH SCHOOLS TO THE BIOLOGICAL SURVEY, 199.
Richardia, Growth in Petiole of, 235.
Ridgely, D. C., 70.
Roberts, Geo. L., 237.
Royse, Daniel, 274.

SAPROLEGNIA FERAX, 237.
Salt, 170.
Sectioning Woody Tissues, 231.
Silurian, 185.
Smith, Alex., 266.
Some Evolution among Cacti, 262.
Some Queries Relative to Solanum Dulcamara, 232.
South American Characinidæ, 226.
Special Senses of Plants, the, 205.
Sphagnaceæ, 67.
Steam Pipe, Value of, in Smoke-box of the Locomotive, 271.
Stereoisomerism, of the Hydrazones of Benzoin, 266.
Stomates of Cycas, 254.
Stone, Building, 170.
Strength of Timber, Variation of, in Different parts of the Cross-section, 268.
Strychnine, Detection of in Exhumed Body, 267.
Suggestions for the Biological Survey, 191.

TERTIARY ROCKS, Induration of, in Northeastern Arkansas, 219.
Δ^3 Tetra-hydro-aniline, 266.
Thomas, M. B., 16, 239, 254.
Trees, Ash of, 239.
Turtles, Habits of, 224.

ULREY, A. B., 224, 226, 229.
Underwood, L. M., 13, 20, 39, 254.
Univalves, Fresh-water, 150.

VAN NUYS, T. C., 262, 265.
Value of Steam Pipe in the Smoke-box of the Locomotive, 271.
Variations in Strength of Timber for Different Parts of the Cross-section, 268.
Variations in the Color-pattern of *Etheostoma Caprodes*, 231.
Viviparidæ, Geographic and Hypsometric Distribution of, in the U. S., 225.

WABASH COUNTY, Fishes of, 229.
Wallace, W. O., 70.
Ward, L. W., 223.
Webster, F. M., 69.
White Clays of Indiana, 224.
Work of the Botanical Division of the Natural History Survey of Minnesota, 233.
Wright, J. S., 233, 234.

ZOOLOGY, 67, 224.

3 2044 106 262 041