Proceedings of the

Indiana Academy

of Science

1902

PROCEEDINGS

OF THE

Indiana Academy of Science

1902.

INDIANAPOLIS, IND.
1903

INDIANAPOLIS:
WM. B. BURFORD, PRINTER
1903.

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AN ACT TO PROVIDE FOR THE PUBLICATION OF THE REPORTS AND PAPERS OF THE INDIANA ACADEMY OF SCIENCE.

[Approved March 11, 1895.]

Preamble.

WHEREAS, The Indiana Academy of Science, a chartered scientific association, has embodied in its constitution a provision that it will, upon the request of the Governor, or of the several departments of the State government, through the Governor, and through its council as an advisory body, assist in the direction and execution of any investigation within its province, without pecuniary gain to the Academy, provided only that the necessary expenses of such investigation are borne by the State, and,

WHEREAS, The reports of the meetings of said Academy, with the several papers read before it, have very great educational, industrial and economic value, and should be preserved in permanent form, and,

WHEREAS, The Constitution of the State makes it the duty of the General Assembly to encourage by all suitable means intellectual, scientific and agricultural improvement, therefore,

Publication of the Reports of the Indiana Academy of Science.

SECTION 1. *Be it enacted by the General Assembly of the State of Indiana*, That hereafter the annual reports of the meetings of the Indiana Academy of Science, beginning with the report for the year 1894, including all papers of scientific or economic value, presented at such meetings, after they shall have been edited and prepared for publication as hereinafter provided, shall be published by and under the direction of the Commissioners of Public Printing and Binding.

Editing Reports.

SEC. 2. Said reports shall be edited and prepared for publication without expense to the State, by a corps of editors to be selected and appointed by the Indiana Academy of Science, who shall not, by reason of such services, have any claim against the State for compensation. The form, style of binding, paper, typography and manner and extent of illustration of such reports, shall be determined by the editors, subject to the approval of the Commissioners of Public Printing and Stationery. Not less

Number of printed Reports.

than 1,500 nor more than 3,000 copies of each of said reports shall be published, the size of the edition within said limits, to be determined by the concurrent action of the editors and the Commissioners of Public Printing and Stationery: *Provided*, That not to exceed six hundred dollars ($600) shall be expended for such publication in any one year, and not to extend beyond 1896: *Provided*, That no sums shall be deemed to be appropriated for the year 1894.

Proviso.

Disposition of Reports.

SEC. 3. All except three hundred copies of each volume of said reports shall be placed in the custody of the State Librarian, who shall furnish one copy thereof to each public library in the State, one copy to each university, college or normal school in the State, one copy to each high school in the State having a library, which shall make application therefor, and one copy to such other institutions, societies or persons as may be designated by the Academy through its editors or its council. The remaining three hundred copies shall be turned over to the Academy to be disposed of as it may determine. In order to provide for the preservation of the same it shall be the duty of the Custodian of the State House to provide and place at the disposal of the Academy one of the unoccupied rooms of the State House, to be designated as the office of the Indiana Academy of Science, wherein said copies of said reports belonging to the Academy, together with the original manuscripts, drawings, etc., thereof can be safely kept, and he shall also equip the same with the necessary shelving and furniture.

Emergency.

SEC. 4. An emergency is hereby declared to exist for the immediate taking effect of this act, and it shall therefore take effect and be in force from and after its passage.

AN ACT FOR THE PROTECTION OF BIRDS, THEIR NESTS AND EGGS.

[Approved March 5, 1891.]

Section 1. *Be it enacted by the General Assembly of the State of Indiana*, That it shall be unlawful for any person to kill any wild bird other than a game bird, or purchase, offer for sale any such wild bird after it has been killed, or to destroy the nests or the eggs of any wild bird. Birds.

Sec. 2. For the purpose of this act the following shall be considered game birds: the Anatidæ, commonly called swans, geese, brant, and river and sea ducks; the Rallidæ, commonly known as rails, coots, mudhens, and gallinules; the Limicolæ, commonly known as shore birds, plovers, surf birds, snipe, woodcock and sandpipers, tattlers and curlews; the Gallinæ, commonly known as wild turkeys, grouse, prairie chickens, quail, and pheasants, all of which are not intended to be affected by this act. Game birds.

Sec. 3. Any person violating the provisions of Section 1 of this act shall, upon conviction, be fined in a sum not less than ten nor more than fifty dollars, to which may be added imprisonment for not less than five days nor more than thirty days. Penalty.

Sec. 4. Sections 1 and 2 of this act shall not apply to any person holding a permit giving the right to take birds or their nests and eggs for scientific purposes, as provided in Section 5 of this act. Permits.

Sec. 5. Permits may be granted by the Executive Board of the Indiana Academy of Science to any properly accredited person, permitting the holder thereof to collect birds, their nests or eggs for strictly scientific purposes. In order to obtain such permit the applicant for the same must present to said Board written testimonials from two well-known scientific men certifying to the good character and fitness of said applicant to be entrusted with such privilege and pay to said Board one dollar to defray the necessary expenses atttending the granting of such permit, and must file with said Board a properly executed bond in the sum of two hundred dollars, signed by at least two responsible citizens of the State as sureties. The bond shall be forfeited to the State and the permit become void upon proof that the holder of such permit has killed Permits to Science. Bond. Bond forfeited.

any bird or taken the nests or eggs of any bird for any other purpose than that named in this section and shall further be subject for each offense to the penalties provided in this act.

Two years.

SEC. 6. The permits authorized by this act shall be in force for two years only from the date of their issue, and shall not be transferable.

Birds of prey.

SEC. 7. The English or European House Sparrow (Passer domesticus), crows, hawks, and other birds of prey are not included among the birds protected by this act.

Acts repealed.

SEC. 8. All acts or parts of acts heretofore passed in conflict with the provisions of this act are hereby repealed.

Emergency.

SEC. 9. An emergency is declared to exist for the immediate taking effect of this act, therefore the same shall be in force and effect from and after its passage.

OFFICERS, 1902-1903.

PRESIDENT,

WILLIS S. BLATCHLEY.

VICE-PRESIDENT,

CARL L. MEES.

SECRETARY,

JOHN S. WRIGHT.

ASSISTANT SECRETARY,

DONALDSON BODINE.

PRESS SECRETARY,

G. A. ABBOTT.

TREASURER,

W. A. McBETH.

EXECUTIVE COMMITTEE.

W. S. Blatchley,
Carl L. Mees,
John S. Wright,
Donaldson Bodine,
G. A. Abbott,
W. A. McBeth,
Harvey W. Wiley,
M. B. Thomas,
D. W. Dennis,
C. H. Eigenmann,
C. A. Waldo,
Thomas Gray,
Stanley Coulter,
Amos W. Butler,
W. A. Noyes,
J. C. Arthur,
J. L. Campbell,
O. P. Hay,
T. C. Mendenhall,
John C. Branner,
J. P. D. John,
John M. Coulter,
David S. Jordan.

CURATORS.

BOTANY .... J. C. Arthur.
ICHTHYOLOGY .... C. H. Eigenmann.
HERPETOLOGY, MAMMALOGY, ORNITHOLOGY .... Amos W. Butler.
ENTOMOLOGY .... W. S. Blatchley.

COMMITTEES, 1902–1903.

PROGRAM.

MEL. T. COOK, GLENN CULBERTSON.

MEMBERSHIP.

A. W. BUTLER, DONALDSON BODINE, G. A. ABBOTT.

NOMINATIONS.

THOMAS GRAY, M. B. THOMAS, C. H. EIGENMANN.

AUDITING.

W. S. BLATCHLEY, F. M. WEBSTER.

STATE LIBRARY.

A. W. BUTLER, STANLEY COULTER, C. A. WALDO, J. S. WRIGHT.

LEGISLATION FOR THE RESTRICTION OF WEEDS.

STANLEY COULTER, JOHN S. WRIGHT, M. B. THOMAS.

PROPAGATION AND PROTECTION OF GAME AND FISH.

C. H. EIGENMANN, A. W. BUTLER, W. S. BLATCHLEY.

EDITOR.

DONALDSON BODINE, Wabash College, Crawfordsville.

DIRECTORS OF BIOLOGICAL SURVEY.

C. H. EIGENMANN, DONALDSON BODINE, M. B. THOMAS, J. C. ARTHUR, STANLEY COULTER.

RELATIONS OF THE ACADEMY TO THE STATE.

C. A. WALDO, W. J. KARSLAKE, R. W. MCBRIDE.

GRANTING PERMITS FOR COLLECTING BIRDS AND FISHES.

A. W. BUTLER, STANLEY COULTER, W. S. BLATCHLEY.

DISTRIBUTION OF THE PROCEEDINGS.

A. W BUTLER, J. S. WRIGHT, DONALDSON BODINE, H. L. BRUNER.

OFFICERS OF THE INDIANA ACADEMY OF SCIENCE.

Years.	President.	Secretary.	Asst. Secretary.	Press 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.
1894–5	A. W. Butler	John S. Wright	A. J. Bigney		W. P. Shannon.
1895–6	Stanley Coulter	John S. Wright	A. J. Bigney		W. P. Shannon.
1896–7	Thomas Gray	John S. Wright	A. J. Bigney		W. P. Shannon.
1897–8	C. A. Waldo	John S. Wright	A. J. Bigney	Geo. W. Benton	J. T. Scovell.
1898–9	C. H. Eigenman	John S. Wright	E. A. Schultze	Geo. W. Benton	J. T. Scovell.
1899–1900	D. W. Dennis	John S. Wright	E. A. Schultze	Geo. W. Benton	J. T. Scovell.
1900–1901	M. B. Thomas	John S. Wright	E. A. Schultze	Geo. W. Benton	J. T. Scovell.
1901–1902	Harvey W. Wiley	John S. Wright	Donaldson Bodine	Geo. W. Benton	J. T. Scovell.
1902–1903	W. S. Blatchley	John S. Wright	Donaldson Bodine	G. A. Abbott	W. A. McBeth.

In Memoriam.

JOSEPH EASTMAN,

BORN

Fulton County, New York, January 29, 1842.

DIED

Indianapolis, June 5, 1902.

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; to promote intercourse between men engaged in scientific work, especially in Indiana; to assist by investigation and discussion in developing and making known the material, educational and other resources and riches of the State; to arrange and prepare for publication such reports of investigation and discussions as may further the aims and objects of the Academy as set forth in these articles.

Whereas, the State has undertaken the publication of such proceedings, the Academy will, upon request of the Governor, or of one of the several departments of the State, through the Governor, act through its council as an advisory body in the direction and execution of any investigation within its province as stated. The necessary expenses incurred in the prosecution of such investigation are to be borne by the State; no pecuniary gain is to come to the Academy for its advice or direction of such investigation.

The regular proceedings of the Academy as published by the State shall become a public document.

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 there-after 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, Press 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 programs 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. The past Presidents, together with the officers and Executive Committee, shall constitute the Council of the Academy, and represent it in the transaction of any necessary business not specially provided for in this constitution, in the interim between general meetings.

SEC. 3. This constitution may be altered or amended at any annual meeting by a three-fourths majority of the 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 morning of one of the days of the meeting at the expiration of his term of office.

3. The Press Secretary shall attend to the securing of proper newspaper reports of the meetings and assist the Secretary.

4. 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.

5. No bill against the Academy shall be paid without an order signed by the President and countersigned by the Secretary.

6. 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.

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

MEMBERS.

FELLOWS.

R. J. Aley	*1898	Bloomington.
J. C. Arthur	1893	Lafayette.
George W. Benton	1896	Indianapolis.
A. J. Bigney	1897	Moore's Hill.
A. W. Bitting	1897	Lafayette.
Donaldson Bodine	1899	Crawfordsville.
W. S. Blatchley	1893	Indianapolis.
H. L. Bruner	1899	Irvington.
Severance Burrage	1898	Lafayette.
A. W. Butler	1893	Indianapolis.
J. L. Campbell	1893	Crawfordsville.
Mel. T. Cook	1902	Greencastle.
John M. Coulter	1893	Chicago, Ill.
Stanley Coulter	1893	Lafayette.
Glenn Culbertson	1899	Hanover.
D. W. Dennis	1895	Richmond.
C. R. Dryer	1897	Terre Haute.
C. H. Eigenmann	1893	Bloomington.
Percy Norton Evans	1901	Lafayette.
A. L. Foley	1897	Bloomington.
Katherine E. Golden	1895	Lafayette.
M. J. Golden	1899	Lafayette.
W. F. M. Goss	1893	Lafayette.
Thomas Gray	1893	Terre Haute.
A. S. Hathaway	1895	Terre Haute.
W. K. Hatt	1902	Lafayette.
Robert Hessler	1899	Logansport.
H. A. Huston	1893	Lafayette.
Arthur Kendrick	1898	Terre Haute.
Robert E. Lyons	1896	Bloomington.
V. F. Marsters	1893	Bloomington.
C. L. Mees	1894	Terre Haute.
W. J. Moenkhaus	1901	Bloomington.

* Date of election.

Joseph Moore	1896	Richmond.
D. M. Mottier	1893	Bloomington.
W. A. Noyes	1893	Terre Haute.
J. H. Ransom	1902	Lafayette.
L. J. Rettger	1896	Terre Haute.
J. T. Scovell	1894	Terre Haute.
Alex. Smith	1893	Chicago, Ill.
W. E. Stone	1893	Lafayette.
Joseph Swain	*1898	Swarthmore, Pa.
M. B. Thomas	1893	Crawfordsville.
C. A. Waldo	1893	Lafayette.
F. M. Webster	1894	Champaign, Ill.
H. W. Wiley	1895	Washington, D. C.
John S. Wright	1894	Indianapolis.

NON-RESIDENT MEMBERS.

George H. Ashley	Charleston, S. C.
M. A. Brannon	Grand Forks, N. D.
J. C. Branner	Stanford University, Cal
D. H. Campbell	Stanford University, Cal.
A. Wilmer Duff	Worcester, Mass.
B. W. Evermann	Washington, D. C.
Charles H. Gilbert	Stanford University, Cal.
C. W. Green	Stanford University, Cal.
C. W. Hargitt	Syracuse, N. Y.
O. P. Hay	Washington, D. C.
Edward Hughes	Stockton, Cal.
O. P. Jenkins	Stanford University, Cal
D. S. Jordan	Stanford University, Cal.
J. S. Kingsley	Tufts College, Mass.
D. T. MacDougal	Bronx Park, New York City
T. C. Mendenhall	Worcester, Mass.
Alfred Springer	Cincinnati, Ohio.
L. M. Underwood	New York City.
Robert B. Warder	Washington, D. C.
Ernest Walker	Clemson College, S. C.

* Date of election.

ACTIVE MEMBERS.

G. A. Abbott................................Indianapolis.
Frederick W. Andrews........................Bloomington.
George C. Ashman............................Frankfort.
Edward Ayres ....Lafayette.
Arthur M. Banta.............................Franklin.
Edwin M. Blake..............................Lafayette.
J. W. Beede.................................Bloomington.
Lee F. Bennett..............................Valparaiso.
William N. Blanchard........................Greencastle.
Charles S. Bond.............................Richmond.
Fred J. Breeze ....Pittsburg.
E. M. Bruce.................................Weston, Oregon.
A. Hugh Bryan...............................Indianapolis.
E. J. Chansler..............................Bicknell.
Howard W. Clark.............................Culver.
Otto O. Clayton.............................Pleasant Mills.
George Clements ....Springfield, Ill.
Charles Clickener ....Tangier.
U. O. Cox...................................Mankato, Minn.
William Clifford Cox........................Columbus.
J. A. Cragwall..............................Crawfordsville.
Albert B. Crowe.............................Ft. Wayne.
M. E. Crowell...............................Franklin.
Edward Roscoe Cumings.......................Bloomington.
Alida M. Cunningham.........................Alexandria.
Lorenzo E. Daniels..........................Laporte.
H. J. Davidson..............................Baltimore, Md.
Charles C. Deam.............................Bluffton.
Martha Doan ....Westfield.
J. P. Dolan.................................Syracuse.
Herman B. Dorner............................Lafayette.
Hans Duden ....Indianapolis.
E. G. Eberhardt.............................Indianapolis.
Frank R. Eldred.............................Indianapolis.
M. N. Elrod.................................Columbus.
Samuel G. Evans.............................Evansville.

Carlton G. Ferris............................Big Rapids, Mich.
E. M. Fisher............................Urmeyville.
Wilbur A. Fiske............................Richmond.
W. B. Fletcher............................Indianapolis.
Austin Funk............................New Albany.
Charles W. Garrett............................Logansport.
Robert G. Gillum............................Terre Haute.
Vernon Gould............................Rochester.
Walter L. Hahn............................Bascom.
Victor K. Hendricks............................Indianapolis.
Mary A. Hickman............................Greencastle.
John E. Higdon............................Indianapolis.
Frank R. Higgins............................Terre Haute.
John J. Hildebrandt............................Logansport.
J. D. Hoffman............................Lafayette.
Allen D. Hole............................Richmond.
John N. Hurty............................Indianapolis.
Lucius M. Hubbard............................South Bend.
Alex. Johnson............................Ft. Wayne.
Edwin S. Johonnott, Jr............................Terre Haute.
Ernest E. Jones............................Kokomo.
Chancey Juday............................Boulder, Col.
O. L. Kelso............................Terre Haute.
Charles T. Knipp............................Bloomington.
Henry H. Lane............................Lebanon.
V. H. Lockwood............................Indianapolis.
Dumont Lotz............................Indianapolis.
William A. McBeth............................Terre Haute.
Robert Wesley McBride............................Indianapolis.
Rousseau McClellan............................Indianapolls.
Richard C. McClaskey............................Terre Haute.
Lynn B. McMullen............................Indianapolls.
Edward G. Mahin............................West-Lafayette.
James E. Manchester............................Vincennes.
W. G. Middleton............................Richmond.
John A. Miller............................Bloomington.
H. T. Montgomery............................South Bend.

Walter P. Morgan..........................Terre Haute.
Fred Mutchler..........................Terre Haute.
J. P. Naylor..........................Greencastle.
Charles E. Newlin..........................Irvington.
John Newlin ....West Lafayette.
John F. Newsom..........................Stanford University, Cal.
R. W. Noble..........................Chicago, Ill.
D. A. Owen..........................Franklin.
Rollo J. Peirce..........................Logansport.
Ralph B. Polk..........................Greenwood.
James A. Price..........................Ft. Wayne.
Frank A. Preston..........................Indianapolis.
A. H. Purdue..........................Fayetteville, Ark.
Ryland Ratliff ....Bloomington.
Albert B. Reagan..........................Bloomington.
Claude Riddle ....Lafayette.
Giles E. Ripley..........................Decorah, Iowa.
George L. Roberts..........................Greensburg.
D. A. Rothrock..........................Bloomington.
John F. Schnaible..........................Lafayette.
E. A. Schultze..........................Ft. Wayne.
John W. Shepherd..........................Terre Haute.
Claude Siebenthal ....Indianapolis.
J. R. Slonaker..........................Bloomington.
Richard A. Smart..........................Lafayette.
Lillian Snyder ....Rockville.
Retta E. Spears..........................Elkhart.
Charles F. Stegmaier..........................Greensburg.
William Stewart ....Lafayette.
J. M. Stoddard..........................Indianapolis.
William B. Streeter..........................Indianapolis.
Frank B. Taylor..........................Ft. Wayne.
J. F. Thompson..........................Richmond.
A. L. Treadwell..........................Oxford, Ohio.
Daniel J. Troyer..........................Goshen.
A. B. Ulrey..........................North Manchester.
W. B. VanGorder..........................Worthington.

Arthur C. Veatch	Rockport.
H. S. Voorhees	Ft. Wayne.
J. H. Voris	Huntington.
B. C. Waldemaier	West Lafayette.
Daniel T. Weir	Indianapolis.
Jacob Westlund	Lafayette.
Fred C. Whitcomb	Delphi.
William M. Whitten	South Bend.
Neil H. Williams	Indianapolis.
William Watson Woollen	Indianapolis.
J. F. Woolsey	Indianapolis.

Fellows	47
Non-resident members	20
Active members	118
Total	185

LIST OF FOREIGN CORRESPONDENTS.

AFRICA.

Dr. J. Medley Wood, Natal Botanical Gardens, Berea, Durban, South Africa.

South African Philosophical Society, Cape Town, South Africa.

ASIA.

China Branch Royal Asiatic Society, Shanghai, China.

Asiatic Society of Bengal, Calcutta, India.

Geological Survey of India, Calcutta, India.

Indian Museum of India, Calcutta, India.

India Survey Department of India, Calcutta, India.

Deutsche Gesellschaft, für Natur- und Völkerkunde Ostasiens, Tokio, Japan.

Imperial University, Tokio, Japan.

Koninklijke Naturkundige Vereeniging in Nederlandsch-Indie, Batavia, Java.

Hon. D. D. Baldwin, Honolulu, Hawaiian Islands.

EUROPE.

V. R. Tschusizu Schmidhoffen, Villa Tannenhof, Halle in Salzburg, Austria.

Herman von Vilas, Innsbruck, Austria.

Ethnologische Mittheilungen aus Ungarn, Budapest, Austro-Hungary.

Mathematische und Naturwissenschaftliche Berichte aus Ungarn, Budapest, Austro-Hungary.

K. K. Geologische Reichsanstalt, Vienna (Wien), Austro-Hungary.

K. U. Naturwissenschaftliche Gesellschaft, Budapest, Austro-Hungary.

Naturwissenschaftlich-Medizinischer Verein in Innsbruck (Tyrol), Austro-Hungary.

Editors "Termeszetrajzi Fuzetk," Hungarian National Museum, Budapest, Austro-Hungary.

Dr. Eugen Dadai, Adj. am. Nat. Mus., Budapest, Austro-Hungary.

Dr. Julius von Madarasz, Budapest, Austro-Hungary.

K. K. Naturhistorisches Hofmuseum, Vienna (Wien), Austro-Hungary.

Ornithological Society of Vienna (Wien), Austro-Hungary.

Zoologische-Botanische Gesellschaft in Wien (Vienna), Austro-Hungary.

Dr. J. von Csato, Nagy Enyed, Austro-Hungary.

Botanic Garden, K. K. Universitat, Wien (Vienna), Austro-Hungary.

Malacological Society of Belgium, Brussels, Belgium.

Royal Academy of Science, Letters and Fine Arts, Brussels, Belgium.

Royal Linnean Society, Brussels, Belgium.

Societé Belge de Geologie, de Paleontologié et Hydrologie, Brussels, Belgium.

Societé Royale de Botanique, Brussels, Belgium.

Societé Geologique de Belgique, Liège, Belgium.

Royal Botanical Gardens, Brussels, Belgium.

Bristol Naturalists' Society, Bristol, England.

Geological Society of London, London, England.

Dr. E. M. Holmes, British Pharm. Soc'y, Bloomsbury Sq., London, W. C., England.

Jenner Institute of Preventive Medicine, London, England.

The Librarian, Linnean Society, Burlington House, Piccadilly, London W., England.

Liverpool Geological Society, Liverpool, England.

Manchester Literary and Philosophical Society, Manchester, England.

"Nature," London, England.

Royal Botanical Society, London, England.

Royal Kew Gardens, London, England.

Royal Geological Society of Cornwall, Penzance, England.

Royal Microscopical Society, London, England.

Zoölogical Society, London, England.
Lieut.-Col. John Biddulph, 43 Charing Cross, London, England.
Dr. G. A. Boulenger, British Mus. (Nat. Hist.), London, England.
F. DuCane Godman, 10 Chandos St., Cavendish Sq., London, England.
Mr. Howard Saunders, 7 Radnor Place, Hyde Park, London W., England.
Phillip L. Sclater, 3 Hanover Sq., London W., England.
Dr. Richard Bowlder Sharpe, British Mus. (Nat. Hist.), London, England.
Prof. Alfred Russell Wallace, Corfe View, Parkstone, Dorset, England.

Botanical Society of France, Paris, France.
Ministérie de l'Agriculture, Paris, France.
Societé Entomologique de France, Paris, France.
L'Institut Grand Ducal de Luxembourg, Luxembourg, Lux., France.
Soc. de Horticulture et de Botan. de Marseille, Marseilles, France.
Societé Linneenne de Bordeaux, Bordeaux, France.
La Soc. Linneenne de Normandie, Caen, France.
Soc. des Naturelles, etc., Nantes, France.
Zoölogical Society of France, Paris, France.
Baron Louis d'Hamonville, Meurthe et Moselle, France.
Pasteur Institute, Lille, France.
Museum d'Histoire Naturelle, Paris, France.

Botanischer Verein der Provinz Brandenburg, Berlin, Germany.
Deutsche Geologische Gesellschaft, Berlin, Germany.
Entomologischer Verein in Berlin, Berlin, Germany.
Journal für Ornithologie, Berlin, Germany.
Prof. Dr. Jean Cabanis, Alte Jacob Strasse, 103 A., Berlin, Germany.
Augsburger Naturhistorischer Verein, Augsburg, Germany.
Count Hans von Berlspsen, Münden, Germany.
Braunschweiger Verein für Naturwissenschaft, Braunschweig, Germany.
Bremer Naturwissenschaftlicher Verein, Bremen, Germany.
Ornithologischer. Verein München, Thierschstrasse, 37½, München, Germany.
Royal Botanical Gardens, Berlin W., Germany.
Kaiserliche Leopoldische-Carolinische Deutsche Akademie der Naturforcher, Halle Saale, Wilhemstrasse 37, Germany.

Königlich-Sächsische Gesellschaft der Wissenschaften, Mathematisch-Physische Classe, Leipzig, Saxony, Germany.
Naturhistorische Gesellschaft zu Hanover, Hanover, Prussia, Germany.
Naturwissenschaftlicher Verein in Hamburg, Hamburg, Germany.
Verein für Erdkunde, Leipzig, Germany.
Verein für Naturkunde, Wiesbaden, Prussia.

Belfast Natural History and Philosophical Society, Belfast, Ireland.
Royal Dublin Society, Dublin.
Royal Botanic Gardens, Glasnevin, County Dublin, Ireland.

Societa Entomologica Italiana, Florence, Italy.
Prof. H. H. Giglioli, Museum Vertebrate Zoölogy, Florence, Italy.
Dr. Alberto Perugia, Museo Civico di Storia Naturale, Genoa, Italy.
Societa Italiana de Scienze Naturali, Milan, Italy.
Societa Africana d' Italia, Naples, Italy.
Dell 'Academia Pontifico de Nuovi Lincei, Rome, Italy.
Minister of Agriculture, Industry and Commerce, Rome, Italy.
Rassegna della Scienze Geologiche in Italia, Rome, Italy.
R. Comitato Geologico d' Italia, Rome, Italy.
Prof. Count Tomasso Salvadori, Zoölog. Museum, Turin, Italy.

Royal Norwegian Society of Sciences, Throndhjem, Norway.
Dr. Robert Collett, Kongl. Frederiks Univ. Christiania, Norway.

Academia Real des Sciencias de Lisboa (Lisbon), Portugal.

Comité Geologique de Russie, St. Petersburg, Russia.
Imperial Academy of Sciences, St. Petersburg, Russia.
Imperial Society of Naturalists, Moscow, Russia.
Jardin Imperial de Botanique, St. Petersburg, Russia.

The Botanical Society of Edinburgh, Edinburgh, Scotland.
John J. Dalgleish, Brankston Grange, Bogside Sta., Sterling, Scotland.
Edinburgh Geological Society, Edinburgh, Scotland.
Geological Society of Glasgow, Scotland.
John A. Harvie-Brown, Duniplace House, Larbert, Sterlingshire, Scotland.
Natural History Society, Glasgow, Scotland.
Philosophical Society of Glasgow, Glasgow, Scotland.
Royal Society of Edinburgh, Edinburgh, Scotland.
Royal Physical Society, Edinburgh, Scotland.
Royal Botanic Garden, Edinburgh, Scotland.

Barcelona Academia de Ciencias y Artes, Barcelona, Spain.
Royal Academy of Sciences, Madrid, Spain.

Institut Royal Geologique de Suéde, Stockholm, Sweden.
Societé Entomologique a Stockholm, Stockholm, Sweden.
Royal Swedish Academy of Science, Stockholm, Sweden.

Naturforschende Gesellschaft, Basel, Switzerland.
Naturforschende Gesellschaft in Berne, Berne, Switzerland.
La Societé Botanique Suisse, Geneva, Switzerland.
Societé Helvetique de Sciences Naturelles, Geneva, Switzerland.
Societé de Physique et d' Historie Naturelle de Geneva, Geneva, Switzerland.
Concilium Bibliographicum, Zürich-Oberstrasse, Switzerland.
Naturforschende Gesellschaft, Zürich, Switzerland.
Schweizerische Botanische Gesellschaft, Zürich, Switzerland.
Prof. Herbert H. Field, Zürich, Switzerland.

AUSTRALIA.

Linnean Society of New South Wales, Sidney, New South Wales.
Royal Society of New South Wales, Sidney, New South Wales.
Prof. Liveridge, F. R. S., Sidney, New South Wales.
Hon. Minister of Mines, Sidney, New South Wales.

Mr. E. P. Ramsey, Sidney, New South Wales.

Royal Society of Queensland, Brisbane, Queensland.

Royal Society of South Australia, Adelaide, South Australia.

Victoria Pub. Library, Museum and Nat. Gallery, Melbourne, Victoria.

Prof. W. L. Buller, Wellington, New Zealand.

NORTH AMERICA.

Natural Hist. Society of British Columbia, Victoria, British Columbia.

Canadian Record of Science, Montreal, Canada.

McGill University, Montreal, Canada.

Natural Society, Montreal, Canada.

Natural History Society, St. Johns, New Brunswick.

Nova Scotia Institute of Science, Halifax, N. S.

Manitoba Historical and Scientific Society, Winnipeg, Manitoba.

Dr. T. McIlwraith, Cairnbrae, Hamilton, Ontario.

The Royal Society of Canada, Ottawa, Ontario.

Natural History Society, Toronto, Ontario.

Hamilton Association Library, Hamilton, Ontario.

Canadian Entomologist, Ottawa, Ontario.

Department of Marine and Fisheries, Ottawa, Ontario.

Ontario Agricultural College, Guelph, Ontario.

Canadian Institute, Toronto.

Ottawa Field Naturalists' Club, Ottawa, Ontario.

University of Toronto, Toronto.

Geological Survey of Canada, Ottawa, Ontario

La Naturaliste Canadian, Chicoutini, Quebec.

La Naturale Za, City of Mexico.

Mexican Society of Natural History, City of Mexico.

Museo Nacional, City of Mexico.

Sociedad Cientifica Antonio Alzate, City of Mexico.

Sociedad Mexicana de Geographia y Estadistica de la Republica Mexicana, City of Mexico.

WEST INDIES.

Botanical Department, Port of Spain, Trinidad, British West Indies.
Victoria Institute, Trinidad, British West Indies.
Museo Nacional, San Jose, Costa Rica, Central America.
Dr. Anastasia Alfaro, Secy. National Museum, San Jose, Costa Rica.
Rafael Arango, Havana, Cuba.
Jamaica Institute, Kingston, Jamaica, West Indies.
The Hope Gardens, Kingston, Jamaica, West Indies.

SOUTH AMERICA.

Argentina Historia Natural Florentine Ameghine, Buenos Ayres, Argentine Republic.
Musée de la Plata, Argentine Republic.
Nacional Academia des Ciencias, Cordoba, Argentine Republic.
Sociedad Cientifica Argentina, Buenos Ayres.
Museo Nacional, Rio de Janeiro, Brazil.
Sociedad de Geographia, Rio de Janeiro, Brazil.
Dr. Herman von Jhering, Dir. Zoöl. Sec. Con. Geog. e Geol. de Sao Paulo, Rio Grande do Sul, Brazil.

Deutscher Wissenschaftlicher Verein in Santiago, Santiago, Chili.
Societé Scientifique du Chili, Santiago, Chili.
Sociedad Guatemalteca de Ciencias, Guatemala, Guatemala.

. . PROGRAM . . .

OF THE

EIGHTEENTH ANNUAL MEETING

OF THE

INDIANA ACADEMY OF SCIENCE,

STATE HOUSE, INDIANAPOLIS,

December 26 and 27, 1902.

EXECUTIVE COMMITTEE.

H. W. WILEY, President. W. S. BLATCHLEY, Vice-President. JOHN S. WRIGHT, Secretary.
DONALDSON BODINE, Asst. Secretary. J. T. SCOVELL, Treasurer.

M. B. THOMAS,	THOMAS GRAY,	J. C. ARTHUR,	JOHN C. BRANNER,
D. W. DENNIS,	STANLEY COULTER,	J. L. CAMPBELL,	J. P. D. JOHN,
C. H. EIGENMANN,	AMOS W. BUTLER,	O. P. HAY,	JOHN M. COULTER,
C. A. WALDO,	W. A. NOYES,	T. C. MENDENHALL,	DAVID S. JORDAN.

The sessions of the Academy will be held in the State House, in the rooms of the State Board of Agriculture.

Headquarters will be at the English Hotel. A rate of $2.00 and upwards per day will be made to all persons who make it known at the time of registering that they are members of the Academy.

M. B. THOMAS,
M. E. CROWELL,
Committee.

GENERAL PROGRAM.

FRIDAY, DECEMBER 26.

Meeting of the Executive Committee at Hotel Headquarters .... 10:45 a. m.
General Session, followed by Sectional Meetings .... 2 p. m. to 5 p. m.
President's Address, Shortridge High School .... 8 p. m.

SATURDAY, DECEMBER 27.

General Session, followed by Sectional Meetings .... 9 a. m. to 12 m.

LIST OF PAPERS TO BE READ.

ADDRESS BY THE RETIRING PRESIDENT.

DR. HARVEY W. WILEY.

At 8 o'clock Friday evening, at Shortridge High School.

Subject: "Ye Shall Know Them by Their Fruits."

The following papers will be read in the order in which they appear on the program, except that certain papers will be presented "*pari passu*" in sectional meetings. When a paper is called and the reader is not present, it will be dropped to the end of the list, unless by mutual agreement an exchange can be made with another whose time is approximately the same. Where no time is sent with the papers, they have been uniformly assigned ten minutes. Opportunity will be given after the reading of each paper for a brief discussion.

***N. B.*—By the order of the Academy, no paper can be read until an abstract of its contents or the written paper has been placed in the hands of the Secretary.**

GENERAL.

1. Transmissible Diseases in College Towns, 8 m....Severance Burrage
2. Sewage Disposal at the Indiana State Reformatory at Plainfield, 10 m............................Severance Burrage
3. Some Recent Mound Investigations in Jefferson County, Indiana, 8 m...............................Glenn Culbertson
4. The Water Supply of Havana, Cuba, 10 m.........C. H. Eigenmann
5. Results of the Indiana University Expedition to Cuba, 15 m....................................C. H. Eigenmann
6. Naezhosh, or the Apache Pole Game, 8 m..........Albert B. Reagan

MATHEMATICS AND PHYSICS.

7. Geodesic Lines on the Syntractrix of Revolution, 8 m..E. L. Hancock
8. Comparison of Gauss' and Cayley's Proofs of the Existence Theorem, 10 m..................................O. E. Glenn
9. Motion of a Bicycle on a Helix Track, 8 m..............O. E. Glenn
10. A Generalization of Fermat's Theorem, 8 m.........Jacob Westlund
11. On the Class Number of the Cyclotomic Numberfield $k\left(\epsilon^{\frac{2\pi i}{p^n}}\right)$, 8 m............................Jacob Westlund
12. Photographic Observations of Comet c 1902, 10 m........J. A. Miller

BOTANY AND ZOOLOGY.

13. The Genus Puccinia, 10 m.............................J. C. Arthur
14. Forestry Conditions in Montgomery County, Indiana, 10 m.......................................S. J. Record
15. Notes on the Cleavage Plane in Stems and Falling Leaves, 8 m..................................Mary A. Hickman

16. On the Veins of the Head of the Snake (Tropidonotus), 15 m. . . . . H. L. Bruner
17. On the Maxillary Veins of Lizards, 15 m. . . . . H. L. Bruner
18. Some Rare Indiana Birds, 10 m. . . . . A. W. Butler
19. The Catalpa Sphinx, *Ceratomia catalpæ*, Destroyed by the Yellow-Billed Cuckoo, *Coccyzus americanus*, in Southern Indiana, 10 m. . . . . F. M. Webster
20. Notes on Reared Hymenoptera from Indiana, 10 m. . . . F. M. Webster
21. Preliminary List of Gall-Producing Insects Common to Indiana, 6 m. . . . . Mel T. Cook
22. Notes on Deformed Embryos, 5 m. . . . . Mel T. Cook
23. The Lake Laboratory at Sandusky, Ohio, 12 m. . . . . Mel T. Cook
24. The Individuality of the Maternal and Paternal Chromosomes in the Hybrid between *Fundulus heteroclitus* and *Menidia notata*, 8 m. . . . . W. J. Moenkhaus
25. An Extra Pair of Appendages Modified for Copulatory Purpose in *Cambarus viridis*, 8 m. . . . . W. J. Moenkhaus
26. Description of a New Species of Darter from Tippecanoe Lake, 5 m. . . . . W. J. Moenkhaus
27. The Myxomycetes of Winona Lake, 10 m. . . . . Fred Mutchler
28. The Plankton of Winona Lake, 10 m. . . . . Chancy Juday
29. The Birds of Winona Lake, 15 m. . . . . Clarence G. Littell
30. A List of the Dragonflies of Winona Lake, 5 m. . Clarence H. Kennedy
31. A New Diagnostic Character for the Species of the Genus *Argia*, 10 m. . . . . Clarence H. Kennedy

CHEMISTRY AND GEOLOGY.

32. Investigation of the Action between Manganese Dioxide and Potassium Chlorate in the Production of Oxygen, 10 m. . . . . Edward G. Mahin
33. The Action of Heat on Mixtures of Manganese Dioxide with Potassium Nitrate and with Potassium Bichromate, 5 m. . . . . J. H. Ransom
34. Criticism of an Experiment Used to Determine the Combining Ratio of Magnesium and Oxygen, 5 m. . . . . J. H. Ransom
35. An Apparatus for Illustrating Charles's and Boyle's Laws. J. H. Ransom
36. Some $\triangle_2$ Keto-R-Hexene Derivatives, 5 m. . . . . J. B. Garner
37. Action of Hydrogen Peroxide on Cuprous Chloride, 10 m. W. M. Blanchard

THE EIGHTEENTH ANNUAL MEETING OF THE INDIANA ACADEMY OF SCIENCE.

The eighteenth annual meeting of the Indiana Academy of Science was held in Indianapolis, Friday and Saturday, December 26 and 27, 1902.

Friday, 11 a. m., the Executive Committee met in session at hotel headquarters. At 2 o'clock p. m. President Harvey W. Wiley called the Academy to order in general session in the room of the State Board of Agriculture, State House. The transaction of routine and miscellaneous business, occupied the first part of the session. Following this, papers of general interest were read and discussed. On the disposition of these, special technical subjects occupied the time until adjournment at 5 p. m.

The address of the retiring President, Harvey W. Wiley, was delivered in the auditorium of the Shortridge High School at 8 p. m. before the members of the Academy and a number of invited guests; subject, "Ye Shall Know Them by Their Fruits."

Saturday 27, 9 a. m., the Academy met in general session, before which the remaining papers of the program were read and discussed. Following the disposition of the papers unfinished business was considered.

Adjournment, 12 m.

THE FIELD MEETING OF 1902.

The field meeting was appointed for Madison and Hanover, May 22, 23 and 24. The President and some of the members assembled, but owing to the heavy rains and the inclemency of the weather all attempts to do field work were necessarily abandoned.

PRESIDENT'S ADDRESS.

H. W. Wiley.

Ye Shall Know Them by Their Fruits.

Members of the Indiana Academy of Science, Ladies and Gentlemen—It perhaps marks a sad epoch in the history of a man when he deliberately chooses a period of reminiscence for a public address. It is one of the privileges of the old to review the preceding years and draw from them such lessons of wisdom or of folly as may happen to be the case. I have therefore, chosen on this occasion to look back over the scientific history of Indiana during a period of a third of a century. Strange as it may seem, that short period covers practically all the progress which has been made in applied science in this great State. I do not forget the early days of the Owens and their associates, and the great contributions which came to the intellectual and scientific development of our people from the center first established at New Harmony, but I speak of the actual accomplishments for the good of the community from the application of the principles of science to mining, manufacture, commerce, agriculture and public health.

It was my fortune to enter upon the period of my education immediately following the great Civil War. This fratricidal struggle for four years had engaged every energy and consumed every resource of our country. The end of the war left our people in a remarkably susceptible condition—ready for the purpose of re-establishing their industries and of utilizing every available means thereto. In the very midst of the period of the Civil War were laid deep and sure, by wise congressional action, the foundations of the system of agricultural and technical education, which has since grown to be the admiration of the world. I refer to the Morrill Act of 1862, setting apart portions of the public domain for the purpose of promoting instruction in agricultural and mechanical arts and military tactics. Every State in our Union received grants of public lands in proportion to size, population and representation in Congress. It is true that some of the States invested this munificent endowment more wisely than others, but all have received from it substantial aid. This munificent gift to technical education was supplemented twenty years later by the Hatch Act, whereby there was established in each State and

Territory of the Union at least one Agricultural Experiment Station with an annual grant of $15,000. Still later Congress added to the income of each of the agricultural and technical colleges by a money grant which now amounts to $25,000 annually. I recall briefly the condition of scientific instruction in the State of Indiana in the five years immediately following the Civil War. I can illustrate these years by brief allusions to the system of instruction in use in our higher institutions of learning. By these I mean especially the colleges and universities then existing rather than the high schools. Beginning with the oldest institutions of learning, I will say that in the State University during the period noted, instruction in the sciences was given by Professors Owen, Kirkwood and Wylie. These three names are intimately associated with the beginnings of scientific instruction in our State. They were all men of remarkable intellectual power. Professor Owen devoted himself chiefly to the so-called natural sciences (I wonder what are unnatural?), Professor Kirkwood to astronomy and Professor Wylie to physics. It should not be forgotten that Professor Richard Owen was chosen as the first president of Purdue, but never actively entered on the duties of the office. His tastes and training were not in the line of executive work, and in addition, his advancing years precluded the possibility of that strenuous service which even in those early days was looked for, perhaps under another name, in the executive office. As there were beautiful women before the days of Helen, so the lives of these pioneers in scientific work remind us that there were great men in Indiana before the days of Jordan and Coulter.

The next oldest institution is the one I am most familiar with in the State, namely, Hanover College. In that institution instruction in the sciences at the time mentioned was given, with the exception of the mathematics, exclusively by Dr. John W. Scott. Having studied for four years with this illustrious man I can speak with knowledge of the great work which he accomplished; work, I am sure, which was only a type of that done by other teachers of science in colleges at that time. Dr. Scott had never received any special training in science more than was given in the old colleges existing in our country between the years 1820 to 1825. He was born with the beginning of the last century and happily lived almost to its close. He was educated for the ministry and devoted practically his whole life to the church. During the period of his professorship he was pastor of the village church, associating these onerous duties with those of the classroom. Doctor Scott taught many sciences, viz., botany, geology, biology, entomology, chemistry and physics. In addition to these he often had a class in Latin and occasionally other branches. Doctor Scott was a man of wonderful strength of body and mind, and had a capacity for continued work which was nothing less than astonishing. During the day, after the end of the recitation, he would spend the hours in his laboratory preparing for the experiments and recitations for the following day. The lamp in his study window would often be found burning at night up to 12 and even 1 o'clock, preparing for his sermons on Sunday. He was accustomed to have in his preparatory work in his laboratory the assistance of one of his students, and during my time at Hanover I especially remember the enthusiasm with which Mr. M. L. Amick, now a prominent physician in Cincinnati, displayed in the preparation of the lectures. With a laboratory outfit of the most meager description Dr. Scott was able to give in chemistry a series of experimental lectures which would have done credit to many of the elaborate lecture rooms of to-day. There was absolutely no provision for the students' work in the laboratory whereby the fundamental principles of chemistry could be illustrated by appropriate experimental work. Some of these experiments were very difficult, and at least one of them I have never seen performed in an experimental lecture anywhere else in the world, namely, the preparation of the highly explosive chloride of nitrogen. The preparation of this compound is one of such danger that it should only be attempted with those most skilled, yet every year for three years I saw Dr. Scott perform this experiment in a most successful manner. The small quantity of the explosive made was placed in a safe place out of doors and exploded by means of a long stick, the tip of which had been dipped in turpentine oil. By reason of this devotion to his profession and the success attending his efforts, he made chemistry, which was at that time one of the dry book studies, a most attractive science. In like manner he would conduct his classes in botany to the neighboring woods and fields and teach them not only the principles of botanical classifications, but the means of identifying the various species of plants growing in the vicinity. The hills of the Ohio River, rich in magnificent trilobites and other reminiscences of early geological life afforded a magnificent opportunity for teaching the practical principles of geology as illustrated in those lofty hills and deep ravines. Since those days, when I have seen practically all the magnificently equipped laboratories of the world, the wonder grows more and more in my mind at the great work which this great man could accomplish with so few material appliances to help him. I shall never forget the last time he visited my laboratory in Washington. After leaving Hanover he had come to Washington and taken a position as a clerk in the Pension Office. At the time I speak of he was 90 years of age, but still clear of mind and firm of step. It was soon after the inauguration of Benjamin Harrison as President of the United States. One morning Doctor Scott stepped into my office. He seemed uneasy and wore a worried look. When I inquired in regard to his health, he said it was most excellent, but he added, "Strange to say, I have become a victim of the Republican administration. General Harrison has insisted on me coming to the White House to live with him and has dismissed me from my position in the Pension Office." He continued, "I am a gentleman of leisure now, and I think I would like to come and study chemistry with you." It is only when we can look back on a life-work such as that done by Doctor Scott that we can realize the inestimable blessing of his career to humanity. Two years after that the end came peacefully to his existence. I can not help thinking that the feeling of love and interest taken in him by the President, expressing itself in the desire that he should pass his last days in the comfort and honor of the White House, may have shortened his life. If he could have kept at work, which was his normal condition, he might have rounded out the century.

Scientific instruction given during the period I speak of at Wabash College was in charge of Professors Campbell and Hovey. Professor Campbell is still in the harness—possibly almost the only one of the old guard that still wears his armor.

At the present time chemistry, biology, botany, mathematics, physics and astronomy are all separate departments. The change at Wabash has taken place gradually and progressively, so that it is not possible to designate these segregations by any particular period. It will be sufficient to say that it has been the constant effort at Wabash to keep up with the new without disparaging the old. Wabash is another of the so-called small colleges which has established for itself a place and a reputation of the highest character. We have so many illustrations of institutions of this kind in Indiana that the sneering remarks which are often made about the small colleges of Indiana meet with a merited rebuke when one takes the trouble to investigate the great work which has been accomplished by them.

At Earlham College instruction in science was given by Professors

Erastus Test, William B. Morgan and Joseph Moore. In the period from 1865 to 1870 the text-books used at Earlham in chemistry was Stockhardt's; in botany, Gray's Structural. Herschel's work on astronomy was the one used in the classroom, and Dana's was, of course, the one used in geology. Two of these veteran instructors I have had the pleasure of knowing personally, namely, Professor Test and Professor Morgan.

Earlham College enjoys the distinction of having been one of the foremost among the educational institutions of the West in the promotion of advanced practical instruction in science. In the year 1853 it made the first beginning in Indiana toward a permanent collection of material in geology and natural history for purposes of college instruction. The present Earlham College museum, with its more than 14,000 specimens, is the outgrowth of that beginning.

About the same time the first astronomical observatory in the State was established at Earlham. A room in Earlham Hall, adjoining the present quarters of the Christian Associations, was the location of the first chemical laboratory for the use of college students in Indiana.

At present Earlham offers courses in science as follows, a year's high school laboratory work in some one science being required for matriculation: Chemistry, six terms' work; physics, six terms' work; biology, ten terms' work; geology, four terms' work; astronomy, three terms' work; psychology, two terms' work.

Earlham now has a complete set of laboratories devoted to chemistry, biology, physics and psychology. These laboratories are equipped with all modern appliances, and although not as large as those in many institutions, they are complete in every respect for the prosecution of research and for purposes of instruction.

At Butler College, at that time known as Northwestern Christian University, instruction in science was given by that distinguished geologist and chemist, Dr. R. T. Brown, assisted part of the time by Professor Fairchild. During the years of 1869 and 1870 I learned to know Doctor Brown intimately, for during that period I served as instructor in Latin and Greek in the Northwestern Christian University. Interested, as I was, at that time, in scientific studies, I accompanied Doctor Brown on some of his geological excursions. I remember particularly the trip which was taken in the spring of 1869 down as far as Spencer. It was at the time that the railroad from Indianapolis to Vincennes was building and it was finished practically all the way to Spencer, and part of this trip was made on the railroad, and then the rest on foot, several days being spent in studying the geological formations. Doctor Brown was a man of practically the same type as Doctor Scott, full of enthusiasm, a wonderful capacity for work, a magnificent physique, and a faculty of interesting his students in the subjects under consideration. These two men, whom I knew so well, were typical teachers. They had the genius docentis. Mr. Brown's services to the State are written in its Geological Reports of the coal fields and in the promotion of its industries. Like Doctor Scott, he was also a preacher, and there was rarely a Sunday that he did not deliver at least two sermons. He was particularly fond of walking, and thought nothing, even at the age of seventy, of a tramp of ten or fifteen miles to fill an appointment. I remember a story which he told in regard to one of his trips when he was a young man and soon after he entered the ministry. He was too poor to have a horse and was in the habit of going from one appointment to another on foot, inasmuch as the railroads were then not in vogue. One morning after a long tramp he stopped at a farmhouse with the expectation of being entertained at dinner. The farmer happened to be a quaker, and, of course, devoid of any ceremony. Doctor Brown was a modest young man and was not quite accustomed to the directness of the quakers' hospitality, and when the hour for the meal arrived the host said, "Thy dinner is ready; will thee come in to dine?" He very politely said, expecting to be invited a second time, "I thank you, but I am not very hungry;" to which came the reply, "Very well, thee can sit there until we have finished." Whereupon the dinner was served with all the good things which a quaker farmer can put upon a table, while the young preacher was left to regale himself with all the delicious odors from the table and the thought of what he could do with all the excess of peptic ferments which the odor of the dinner were producing. After that experience he learned never to decline the first invitation from a quaker.

Instruction in Franklin College in science at the time I mention, was given by Professor Hougham. Professor Hougham was also a remarkable man in industry and in ability. I afterward had the good fortune to know him quite intimately when he was one of the professors in the early days of Purdue. In his laboratory work he was the perfection of neatness and order. In fact this was one of the predominating characteristics of his character, and his great success in life was, in a large measure, due to it. Professor Hougham was particularly interested in physics and had charge of that branch of science in the early days of Purdue. He had a happy constructive faculty and could make a very modest collection of appliances serve for extended illustrations. Professor Hougham was a manufacturer of philosophical apparatus, and Franklin College had the benefit of many of the pieces of apparatus which he built. He took post-graduate work at Brown University, and the first chemical laboratory built at Purdue was constructed on the exact plans of the laboratory at Brown. The Civil War had a depressing effect upon Franklin College, and I believe it was the only institution of higher learning which was closed for a period as a result directly or indirectly of that conflict. There was an interregnum at Franklin from 1865 to 1869. When the institution opened again in 1869, President Stott took temporary charge of chemistry, physics, physiology, botany and geology. The text-books used then were Youman's in chemistry; Ganot and Olmsted's in physics; Dana's in geology; Gray's in botany; and Hitchcock's in physiology. At the present time there are four large rooms devoted to chemistry, one to physics, and three to biology. There are two full professors giving instruction in these sciences and the laboratories are well supplied with apparatus and with working libraries. Franklin has also an excellent biological collection, mostly the gift of Mr. Gorby, at one time State Geologist.

DePauw University, in those days, was known as Asbury, and perhaps the only science teacher in the institution was Joseph Tingley. I never had the good fortune to know Professor Tingley very well, but met him on one or two occasions. One of these I should like to recall. It was, I think, in the winter of 1870, when he gave an illustrated lecture on electricity in Indianapolis. This was the first occasion on which I ever saw an electric light produced by the current passing between two carbon points. This current was generated by a battery of a great many cells (I have forgotten just now how many) composed of the elements of carbon and zinc. It was not a very big light, but very intense, and I imagine that none of the audience present, and it was a large one, had ever seen an electric light before. I have no doubt I address some here who were students of Professor Tingley, and they, without question, can say the good things of him which I, from my personal acquaintance, have said of Doctors Scott and Brown. In connection with the exhibition of the electric light which is now so universal in all our cities and towns, I might call attention to the fact that the first electric light generated by a dynamo seen in Indiana was at Purdue University. During the Centennial Exposition of

1876 there were exhibited three or four dynamos manufactured by Gramme, of Paris. One of these was purchased for the physical laboratory of Purdue University and one by Professor Barker for the physical laboratory of the University of Pennsylvania. Professor Barker, doubtless, got his apparatus before Purdue, since it was nearby. As soon as the exposition was over the machine belonging to Purdue was sent to Lafayette and early in November, 1876, the first modern electric light ever seen in Indiana blazed forth from the tower of the Purdue chemical laboratory. It was one of the wonders of the age and was the talk of the newspapers and the town for many weeks. It seems almost incredible to think that twenty-seven years ago one electric light would cause such a commotion in a community. But this fact should fully illustrate to the young people how much more keenly we of advanced age can understand the progress of science in our State. Prof. Joseph Tingley, at Asbury University, had a room 20x30 feet as a lecture room and one 9x12 feet for his store room. At the present time there are four departments of science teaching at DePauw, namely, chemistry, physics, botany and zoölogy. These departments are in charge of Dr. W. M. Blanchard, chemistry; Prof. J. P. Naylor, physics, and Prof. Mel. T. Cook, biology. Each professor has an assistant and their rooms, taken in the aggregate, amount to more floor space than the entire old college building of Asbury University. One of the latest acquisitions at DePauw is the Minshall laboratory, 80x130 feet, three stories, constructed of stone, brick and iron, fireproof, and with the most modern appliances for teaching chemistry and physics. Plans are now practically completed for the departments of botany and zoölogy.

One of the earliest contributions to the material prosperity of Indiana from the sciences was made by geology. I have no time here to review the voluminous geological reports which have been made from time to time in the history of our State. There are a few salient points, however, in the history of economic geology which may prove of interest.

I have already made allusions to the services of Dr. R. T. Brown to the geological development of our State. I have now to speak of a period in our geological development of most remarkable significance. I refer to the services of that distinguished scientist, Prof. E. T. Cox. Trained under the Owens, he had imitated their zeal and their industry, and was active in all his habits, both bodily and mental. He pushed with utmost vigor the investigations of a geological nature into the extent and character of the coal deposits of the State. He early saw the importance of utilizing the assistance of chemistry in this work, and established the first chemical laboratory for research, I suppose, ever built in the State of Indiana. I remember well this laboratory in one of the dingy rooms of the old State House as I first saw it in 1869 or 1870. Professor Cox had associated with him a chemist of skill and great industry, Dr. G. M. Levette. Doctor Levette was not only a skilled chemist, but had also a working knowledge of other sciences, and, therefore, his aid in developing some of the phases of the Geological Survey was of the greatest helpfulness. It was in this laboratory that I first saw a quantitative determination, and I remember the feelings with which I used to watch Doctor Levette, who patiently permitted me to hang around his laboratory and probably greatly interfere with his work without exhibiting any signs of petulance or resentment. All the different varieties of coal which were then known in the State were submitted to the most careful chemical examinations. He also erected and operated a small apparatus by means of which bituminous coal could be heated under pressure, making, as he termed it, an artificial coke or anthracite, illustrating probably some of the methods by which nature has secured the deposits of hard coal from those of a soft or bituminous nature. I shall never cease to be grateful for the interest which these two distinguished men took in my visits to their laboratories, which, I fear, were all too frequent for the even march of official business. The personal friendship which I formed for Professor Cox at that time, I am glad to say, has continued until the present. He is now an old man retired from work and spending the evening of his life in the grateful climate of Florida. The services, however, which he rendered to the economic development of Indiana will be more and more appreciated as the years roll by. It was also my good fortune to know one of the successors of Professor Cox personally and intimately, namely, Mr. John Collett, who was first an assistant to Professor Cox and became State Geologist in 1880. Mr. Collett had a wonderfully keen insight into the nature of scientific problems and great ability in developing them. His chief work toward the economical development of the State was directed to the building-stone industry. He called attention to the remarkable character of the deposits in Lawrence County, and it was during his incumbency of the office that the present State House was constructed of the stone of that locality and the Soldiers' and Sailors' Monument begun. Mr. Collett was chiefly active as a geologist, though contributing in many other ways to the development of applied science in the State. He was the author of the first fertilizer control law which was enacted in this State, a law which did so much to protect the farmers from fraud, and in its application to point out to them the fundamental principle of applying artificial fertilizer. This is another remarkable instance in which the geological development of the State was associated with the chemical. Mr. Collett had a strong personality. His snow-white beard and hair, his bright blue eyes, and his ruddy complexion made him a striking figure everywhere. The end of Mr. Collett's administration of office was followed by a remarkable innovation of a scientific nature. A distinguished poet and novelist, James Maurice Thompson, was elected to succeed Mr. Collett as State Geologist. Mr. Thompson has shown in his writings an intimate acquaintance with nature, but it was a poetic rather than a scientific knowledge which he possessed. Evidently the courses of scientific research were not found compatible with his efforts so signal and successful in the fields of poetry and fiction. After two years he resigned his office. There was perhaps little loss to geology in his resignation, but evidently a marked gain to literature, for had he remained as State Geologist that delightful romance, "Alice of Old Vincennes," would probably not have been written. Mr. Thompson was succeeded by Mr. S. S. Gorby, who held the position until the present incumbent assumed control of the office. We are so familiar with the valuable work which Mr. Blatchley has accomplished that it will not be necessary for me to dwell long upon it. One of the innovations which has been of distinct value in the prosecution of the geological survey of the State by Mr. Blatchley was the abolition of the method of county surveys formerly in vogue. In their stead he adopted the plan of taking up each of the natural resources in detail, and preparing a monograph or special report thereon, accompanied by maps, cuts, engravings and tables of chemical and physical tests. Another successful application of economic science to industry has resulted from a study of the clay deposits in the State. The description of the character of these clays, with their chemical and physical composition, has become valuable to intending investors and more than twenty large factories have been established in Clay, Vigo, Fountain, Vermillion, Parke, Morgan and other counties for the manufacture of clay products. The total value of the output of these factories in 1900 was $3,358,350. Another result of the geological studies of Indiana was the discovery of petroleum oil deposits. The output of oil in the State of Indiana in 1901 was 5,749,-975 barrels, of which the market value was only a little less than $1.00

per barrel. The magnitude of the building-stone industry which has grown as a result of geological investigations, has raised Indiana to the first rank in the States of the Union in the output of limestone for building purposes, as shown by the following statistics: The quantity mined in 1901 was 7,781,320 cubic feet. Five State capitol buildings, namely, those of Indiana, Illinois, Georgia, New Jersey and Kansas, have been constructed wholly or partly from it. Numerous custom houses and public buildings of the United States have also been made of this stone, and twenty-seven court houses in the State of Indiana are built of it. Mr. Blatchley has also taken up again the study of the coal fields of the State, as little has been done in that line since the time of Professor Cox, and the output of coal in Indiana has almost doubled in the last few years, amounting in 1901 to 7,019,203 tons. In conjunction with chemistry the Geological Survey of the State has also developed the resources for the manufacture of marl and cement. As a result of these investigations a large output of cement similar to that known as Portland is now credited to Indiana. It is estimated that the output of this cement for 1902 will be fully equal to 600,000 barrels. The adaptability of the oölitic and other limestones of Indiana as suitable material to be used in the manufacture of cement has been described, and, as a result of this, factories have already been able to make use of these materials. It has been shown that Indiana has the raw materials to supply not only the United States, but the whole world with a first-class article of cement for hundreds of years to come. The mineral waters of our State are justly celebrated for their medicinal and curative properties, and their development is the joint work of geology and chemistry. There are now known in the different parts of the State eighty-six wells and springs whose waters are valued for therapeutic purposes. The natural gas industry has also added hundreds of millions of dollars to the development of the State, and this development is largely associated with the work of the Geological Survey. It is hard in so brief a time to do anything like justice to what geology as a science has done for the industries, and also to recognize the services of the distinguished men who have been connected with this work. It is enough for our purpose here to call attention to the leading characters of the work done by geologists in the development of our industries.

The contributions made by botany, entomology and zoölogy, and animal and vegetable pathology, to the material welfare of the State are no less striking in character, though perhaps less in magnitude, than those which have been rendered by the science of geology. Botanical studies, which have ever been far advanced in Indiana, have disclosed the nature and character of our various forests and have especially been concerned with the improvements of economic plants for agricultural and horitcultural purposes. The study of economic botany is one which lies near to the welfare of many of the fundamental industries, chief among them being agriculture and pharmacy. Especially the study of the development of special characteristics of plants useful in the arts is one of the phases to which botany in this State has made large contributions. Without discriminating against the other botanical laboratories in the State, I can best illustrate the useful character of this work by what has been done at Purdue University, the work of that institution being more familiar to me in applied botanical science than of the other institutions of the State. From the botanical laboratories of Purdue University there have been, from 1884 to 1898, fifty bulletins published on botanical subjects of practical importance to the industries of our State. These were chiefly from the fertile pens of Arthur and Coulter. It will, of course, be impossible to even give a brief review of this magnificent work. I must confine myself merely to quoting the titles of some of these important contributions in order to show how closely allied they are to the industries of the State. Among these titles I might mention the following: "What Is Common Wheat Rust?" "A New Factor in the Improvements of Crops," "Black Knot and Other Excrescences," "Living Plants and Their Properties," "The Forest Trees of Indiana," "Science and the State," "Forest Fruits," "The Flora of Indiana," etc.

If you add to the contributions which have been made from Purdue University those which have been made from other centers of botanical studies and investigations you have a sum total of most important practical results. In general, it may be said, that by reason of the activity of the botanical science in this State and the application thereof to our industries we have a far more accurate knowledge of those plants which are most intimately related to our industries. In the second place, we have a systematic and scientific conception of the methods of treating these plants in order to produce the greatest economic results. Third, we have a more advanced knowledge of the proper distribution of these plants in such a manner as to take advantage of the natural qualities of the soil or topographical features of the State and the meteorological environments. In the fourth place, we have an advanced knowledge of the nature of the diseases which affect the value of plants and the methods of successfully combatting them. What has been said of botany is true, also, to a large extent, of the science of entomology, although perhaps Indiana has not been so prominent in entomological as it has been in botanical studies. Nevertheless, most valuable contributions have been made by the entomologists of our institutions of learning to the general store of knowledge. In regard to animal diseases, we find also that science has been of immense use to our industries. The State has been well mapped in regard to the plague of hog cholera and other animal diseases. Careful studies have been made of the causes of these diseases and their distribution coupled with the regulations for the restriction of these diseases and their suppression. These studies have come largely from Purdue University and the reports issued by Doctor Bitting of that institution upon animal diseases have been of the highest utility. The health of the human animal has also not been neglected in the application of science to the public welfare. The Indiana State Board of Health, which is charged with the general oversight of the hygiene of this commonwealth, has been established on a truly scientific basis. The State Board of Health is composed of eminent physicians in active practice and its executive officer is a chemist and pharmacist of national reputation. You are so familiar with the contributions which this distinguished body has made to the welfare of your people that I can not enlighten you to any extent upon the subject. There is one thing that I ought to say in reference to this work, and that is, it should be supported more generously by the people. What the State Board of Health needs from Indiana is a fund for the enlargement of the activities, and to make its work more useful, a laboratory of hygiene is necessary for the study of the foods and waters and a control of the pathogenic germs therein.

The execution of the pure food law which was enacted, I believe, by the last Legislature or the one before, is of prime importance. No one will doubt the benefit which the pure food law gives to the people and its helpfulness to the prosperity of agriculture and the honesty of commerce in foods. There is perhaps little lacking in the letter of the law which has been carefully prepared and worded. I must say, however, that from a careful study of the facilities at the disposal of the health office I fear the law can not be administered to the full measure of its letter and spirit. The population of Indiana in round numbers is 2,750,000 at the present time. There must be at least 500,000 wage earners in the State, and statistics show that the average amount earned by each wage earner is about eighty cents per day. This enormous sum of from $400,-000 to $500,000 is paid daily in wages to the workers. It is safe to say that fully three-fourths of the wages earned per day are spent for agricultural products, that is, foods and clothing, so that the average amount spent each day for these necessities of which food is the chief, is not far from $350,000. Researches of chemists in all parts of the country show the enormous extent of food adulteration resulting in selling at the high price of the genuine cheaper and inferior articles. The wage earners are the principal victims of these frauds, not perhaps in actual magnitude of expended money, but in proportion to their income. A very conservative estimate would place the magnitude of the financial fraud practiced upon the wage earners of the State in the matter of adulterated foods alone at from $15,000 to $20,000 daily. Not only is this condition of affairs reprehensible by reason of this enormous tax upon the daily wages of hard working men, women and children, but it is a moral crime of a still more heinous nature. Twenty thousand dollars a day for fraudulent foods, mean a tax of 5 per cent. on all wages of all workers. When a fraud of this magnitude is considered it does not seem unreasonable to ask the Legislature for an endowment which will support the hygienic laboratory in its investigations of the nature and character of these fraudulent foods and in order that the evil effects of these can be properly ascertained. Great as have been the contributions of the Board of Health to the welfare of the State in securing immunity from disease, freedom from plagues and from contagious and epidemic diseases, we look forward to a still more useful career of this institution when it is fully equipped for the hygienic work outlined above. An admirable historical sketch of the Indiana State Board of Health and a statement of the benefits it has conferred upon our people is found in a paper contributed to the Indiana State Medical Society by J. N. Hurty, read at the Lafayette meeting, May 6, 1898, and published in the proceedings for that year. In that paper Dr. Hurty gives an admirable summary of the progress of sanitary science in Indiana.

The development of medical education of the State must not be forgotten when speaking of the public health. I attended the first lecture of the Indiana Medical College, given in the Senate Chamber of the old State House. Later I was one of the first students in the laboratory established by Dr. Thaddeus Stevens, where students really worked at the desk.

Doctor Stevens had a real enthusiasm for chemical studies connected with medicine, and I believe supported his laboratory chiefly from his own funds.

You now have in the city at least two, probably more, thoroughly equipped schools of medicine, with commodious and well-appointed laboratories of chemistry, physiology and pathology, and these institutions are doing a great work for the public welfare.

Intimately related with the benefits which could be conferred upon the State of Indiana by its Board of Health are those of a somewhat similar nature which have come from the State Board of Charities. This academy is also honored in having among its leading and most industrious members the Secretary of the State Board of Charities. It is hard to speak in an unbiased manner of any of these contributions to the State because of my intimate personal acquaintance with the men who are most active in the work. It is hard even for scientific men, and one who has lived so long away from the home of his youth, to banish from his heart a very affectionate and praiseworthy prejudice in favor of his friends. For that reason it is pretty difficult for me to find fault with what such men as H. A. Huston, Stanley Coulter, J. N. Hurty, W. F. M. Goss, A. W. Butler *et id omne genus* do. When I know that they have done something I am convinced without further investigation that that something is good for the State. There are some features of the work of the Board of Charities which perhaps are not fully comprehended even by those who have read its reports. They have introduced into the study of the public charities of the State a truly systematic method of investigation. In their studies of causes and effects they have endeavored to use every means of securing accuracy. They have striven to get at the individual and family history of every person who is an inmate of these institutions. The results of these endeavors have been the collection and tabulation of the most accurate and complete set of sociological statistics in this country. Mr. Butler developed one phase of this work in his vice-presidential address before the section of Anthropology of the American Association for the Advancement of Science at its Denver meeting. In this address he took up the study of the heredity effects of feeble-mindedness. This study of feeble-mindedness had been pronounced by competent experts to be one of the most exhaustive and thoroughly scientific of any that has ever appeared. Its excellence has been recognized across the water and it has been reprinted in Great Britain for public distribution.

Another phase of this work is the study of the problems in these records which have been secured in order to determine those conditions which are preventive of dependency, delinquency and degeneracy. The charitable institutions of our State have long been the admiration of the whole country. The great work of the State Board of Charities looking to the prevention of crime will perhaps bring more lasting benefit to our people than the institutions themselves over which this board has control. The successful efforts of this board in bettering the condition of our people has been seen especially in the enactment of the Child Labor Law, the Child Saving Law, the Poor Relief Law, the Indeterminate Sentence and Parole Law, the Compulsory Education Law and the law for the custodial care of feeble-minded women. It is evident, therefore, that in enacting the laws providing for the State Board of Charities by the Legislature, in 1889, Indiana took a great step forward, both in a scientific direction and also from an economic standpoint. There is no institution of our State more worthy of support and encouragement than the State Board of Charities, and no one, if properly supported, will do more for the honor and welfare of our people.

As a direct effect of the establishment of this Academy we may point to the law regarding the protection of birds and game. Birds may be taken for scientific purposes only by persons having permits through the Indiana Academy of Science. The bird law is well supplemented by the game law enacted by the last Legislature. There still remain, however, to be enacted some desirable features of one of these laws, and that is, the enactment of a provision for the taking of fish. The Commissioner of Fish and Game has the oversight of fish and game protection, but it might be well to have the law changed so as to have this official in organic connection with the Academy.

I have already alluded to some of the services of chemistry to the State of Indiana in connection with the development of its geological resources and also in its services to the State Board of Health. The chief value, however, of the science of chemistry to the State of Indiana has been in its application to our agricultural industries. The enactment of the Morrill Law, already referred to, in 1862, resulted in the establishment of Purdue University, an institution devoted to the study of agricultural and mechanical arts and military science. The foundation thus provided was generously increased by a gift of Mr. Purdue, and with the assistance of citizens of Lafayette, a commodious home was secured for the institution, and the work based upon the foundations thus given has been generously sustained by the State by annual appropriations. The enactment of the Hatch Law, already mentioned, about twenty years after the Morrill Act, gave a magnificent impulse to agricultural research. By the terms of the Hatch Law there were established in each State at least one Agricultural Experiment Station charged with the investigation of the problems relating to agriculture, horticulture and forestry. As a result of these generous endowments no other country in the world has a system of agricultural research which can compare in magnificence of endowments, number of workers and practical results obtained, with the agricultural institutions of this country. The services which have been conferred upon the State by these endowments have already been pretty fully exploited in this address.

But I must be permitted still to call attention to the fundamental place which one of the sciences, viz., Chemistry, holds in these investigations relating to the progress of agriculture. Before the establishment of the Agricultural Experiment Station of Indiana Mr. John Collett, State Geologist, as previously mentioned, secured the enactment of a law by the Legislature establishing the office of State Chemist. I, as most of you know, had the honor of being the first incumbent of that office. A peculiar feature in the history of the enactment of this law is the way in which Mr. Collett secured it. He did not consult, in so far as I know, any of the officials connected with Purdue University. The first intimation that I had of the enactment of the law was a commission signed by the Governor sent by the Secretary of State appointing me to the place. On looking into the law I found that the duties of the State Chemist were particularly confined to the fertilizer control, and thus there was established in 1882 at Purdue the first laboratory for the control of fertilizing products sold in the State. The laws before this were crude and powerless to protect the farmers of our State against barefaced frauds. At that time any kind of mixture could be sold as a fertilizer for a fancy price and there was no official method of detecting a fraud and no provision for its punishment. Under the provisions of the law the farmer is now completely protected in the character of the goods which he buys. This has been a saving in hard cash to our farmers in sums difficult to estimate, but this is not the most valuable result which has been obtained by the establishment of this office. In addition to analyzing the fertilizers offered for sale the State Chemist commenced a study of their effects upon the crops to which they were applied. This led naturally to an examination also of the soils for the purpose of determining their needs in fertilizing materials. The result of all this is that the farmer at the present day is enabled not only to purchase his fertilizers in a fair and honest market, but also to have them so balanced in respect of the plant food they contain as to give the most economic results in the crops. If the farmer of Indiana at the present day adds phosphoric acid, nitrogen or potash to the soil when it is not needed, he simply does so because he does not take advantage of the facilities which the State affords him of learning the true method of fertilizing his farm. Thus the contributions which chemistry has made with the assistance of the sister science of geology, and through the medium of the Board of Health to the welfare of our people have been vastly increased by its solution of some of the agricultural problems which confront us. With this aid and the efforts of agricultural chemistry the exhaustion of the virgin soils of our State, which are among the most fertile of our country, has been checked, and a start has been made on the up-grade toward the restoration of that fertility which our early settlers found. It would have been glory enough to have checked the deterioration of our soils, but it is an additional glory to our science when it has commenced to build them up again. We can consistently look forward to the near future when fields and farms which have been practically abandoned by reason of exhausted fertility will be again brought into cultivation and made to produce abundant and profitable crops. The investigations which chemistry has made have also shown to a large extent, how our agricultural crops could be distributed with the greatest advantage. In this respect chemistry collaborates with her sister science, botany, which study I have already referred to. As a marked illustration are seen the investigations which have pointed out the fact that the beet sugar industry in Indiana could only prove profitable in its northern part and that it would be economic waste to try to establish it, for instance, in the southern third of our State. Similar studies in connection with botanical science will aid in marking the areas most suitable for other agricultural crops, such as Indian corn, tobacco, etc.

As a final result of all these scientific investigations, the farmers of our State will eventually grow only those agricultural crops which are best suited to the environment and therefore most profitable. Thus agriculture will be made more productive and profitable by such specializations as render great manufacturing industries most useful. As the skilled worker in a great manufacturing establishment is placed at that task which he can do best, so the farmer will utilize the field for that which it can best produce.

These brief surveys of the contributions which science has made to the industries of our State would be incomplete without some tribute to the wonderful work which technical education has accomplished. I mean by technical education, that instruction in the mechanic arts which was practically unknown a third of a century ago, and which has now advanced to such a degree as to place Indiana in the front rank of states in developing this branch of applied science. We have in this State two great centers of technical education, namely, the Mechanical and Engineering Laboratories of Purdue University and the Rose Polytechnic Institute. In addition to these, attention should be called to the splendid courses given in manual training in many of our high schools and other institutions of learning. The Hoosier of fifty years ago was the butt of every jibe. His agricultural skill was supposed to be confined to the growth of pumpkins, and his mechanical genius was occupied with the manufacture of the svelt hoop pole, but his State is now the home of the most famous poets, novelists, statesmen, engineers and scientists.

My friends from other institutions will, of course, pardon me if I speak particularly of the wonderful work at Purdue developed first of all by Professor Goss, who is now assisted by a large corps of mechanical and electrical engineers. It is evident from the activities of Purdue and other institutions that we are in the progress of educating as engineers at least 1,000 of the sons of the State. During the past five years from 50 to 100 have been graduated each year from the engineering classes of Purdue University, and this great influx of men has been absorbed by the industries of this and other states. Purdue has already a thousand graduates in engineering. Without stating in detail the influence of this great institution upon the material prosperity of Indiana, the fact that so many of its young men have been prepared for this useful life work is in itself significant.

The whole industrial activities of the State of Indiana have derived their life and vitality from the instruction which I have outlined. It would increase to an undue size an address of this kind to go into a minute detail. This technical instruction of our State is touching every branch of our industries. Without speaking specifically of what it may be doing for each of the industrial interests of the State, we may say that wherever there are waterworks recently designed, or street railway lines, or electric lighting stations, or a manufacturing plant of any kind, and in general, wherever the people are enjoying the benefits of modern engineering, mechanics and electrical development, there you will find the representatives of the technical education of which I have spoken. The graduates of these technical schools are everywhere. Whatever progress the State is making in industrial lines they are instigating and conducting it. They are in charge, or assisting in the management, of the great manufacturing plants of the State. They are superintendents of motive powers and machine shops. They are found in smaller corporations in charge of the machinery or of the technical processes. Wherever industry is progressing and where manufacturing is growing and where technical skill is adding to the prosperity and welfare of the people, the graduates of these technical schools are found.

It is a good old proverb that you should judge the tree by its fruits. In this free land of ours we judge a man for what he is and from what he does, and therefore, we are justified in applying this same rule in estimating the value of the sciences in the material development of our State by what they have accomplished. I have given in merest outlines some idea of the services of science to our industrial development. Industrial development is always intimately associated with intellectual advancement, moral welfare and spiritual well-being. The first stone in the foundation of a national edifice is material prosperity. No nation, no matter how perfect its ancestry may be and how lofty its purposes, could flourish in a desert, or on an iceberg. The insistent demands of humanity are for food and clothing and comfort. He who would elevate his State must begin by ministering to these primeval wants. It is useless to try to educate the boy who is starving and to preach religion to a man who is shivering. The inventions which increase the power of man to do things, along mechanical lines, the development of those forces of nature which give power such as heat and electricity, the discovery of laws which increase the fertility of soil such as are disclosed by chemistry and botany, the mastery of those sciences which reveal the wealth of the earth, such as geology, mineralogy, and mining, the utilization of those sciences which prevent disease, such as serum therapy and inoculations, the application of the principles of biology to the common affairs of life, as in economic entomology and zoölogy, all these underlie and sustain not only our industrial life but form the basis on which to build our magnificent systems of education, morality and politics. As human knowledge advances the realm of superstition and bigotry contracts because there can be no superstition where knowledge is and no bigotry where broad views of things exist. Science shows that all processes of nature are based on immutable laws. Many of these are known, others are foreshadowed by the brilliant conceptions of the scientific imagination, while some are still unknown and belong to the category which was once regarded as supernatural, but which is now relegated to the undiscovered. If science in its comparative infancy has thus been able to make such magnificent contributions to those elements which make life worth living, what may we not expect of the future years, when the knowledge which we have to-day will seem only as ignorance to our descendants? We judge science by what it has already accomplished. We know it by its results. When these wonderful contributions to human welfare shall have been made in the future, the words of our text will be no less true: "Ye Shall Know Them by Their Fruits."

Transmissible Diseases in College Towns.

Severance Burrage.

The college town of moderate size is unique in some respects, unique in the possession of certain opportunities for the contraction and dissemination of various diseases. College students, as a class, are looked upon as healthy to an unusual degree, and in many respects this view is a correct one; and yet when looked at from the standpoint of sanitary science, we find them exposed to many dangers that are oftentimes overlooked. Many of these dangers do not exist in other communities.

The herding together of a lot of men or boys into unhygienic quarters in unsanitary dormitories is one of the features of the student's life that must be looked upon as a danger. It is also an added responsibility to the college authorities. When the dormitory fulfills all the requirements of the rules of hygiene and sanitary science; and when there are good hospital facilities for students living in the dormitory who may become ill with a contagious or an infectious disease, then the above statements might be somewhat modified.

But when the dormitory system does not exist, and the students are distributed about the community in private and fraternity boarding houses, then dangers to the students as a mass are greatly reduced, while on the other hand there are dangers added to the community at large.

In many of the college towns as we find them in Indiana, there is no such thing as a detention hospital or a pest-house, and under these conditions the question arises as to the disposition of the sick student, and of the other occupants of the same house. If the whole house is quarantined, as the rules of the Board of Health require, and I believe rightly so, then the inmates are or seem to be needlessly exposed to the disease unless extraordinary precautions be taken by each one who finds himself at that time a member of the unfortunate household. And under such conditions, it is difficult not to be in sympathy with the student or students who break quarantine and go to their homes. I am not giving my sanction to any such actions, however, unless every preventive measure be taken before each one departs. I refer to such measures as vaccination, disinfection of body, clothing, and any articles taken away as baggage.

Another feature that is of vital interest to the student is the matter of procuring food. The usual method when there is no general dining hall for the students, is to form clubs, the main feature of which in most cases is to get the meals for very little money. The consequence is that by paying their $1.50 to $3.00 per week the students are fed three times a day on something. It is possible that we have here in our college towns some experiments on adulterated foods and improper dietaries on a larger scale than our President Wiley is conducting at Washington, but we have no one to keep record of them.

Now there are two features about this food that I desire to call attention to:

First. Are not the students who are subjected to such diet—I can not go into the details of the diet here,—are not the students who are subjected to this diet, more prone to come down with a transmissible disease than those who get a more wholesome diet?

And second. Is there not a greater chance of coming in contact with infected food at these low-priced boarding tables? Certainly these two factors working together, form a feature of student life that is worth consideration, as one of the dangers existing in a college community. To emphasize this last point, I take this opportunity to describe a recent epidemic of scarlet fever among the students at Purdue University, and it is this that I consider the feature of this paper.

About the first of December, 1902, it was reported to the authorities of Purdue University, that there were a few cases of suspicious sickness among the students. One instructor, also, was found to be quite ill, and during the illness had a well defined rash, and later had the characteristic "peeling" of scarlet fever. This case was not reported at first as being scarlet fever.

Six cases were confined in the hospital (St. Elizabeth's) and twenty-nine others, most of which were not well defined cases, were at large among the other students. Some few cases were purposely concealed by students and physicians, so that other students rooming in the same houses would not be quarantined, and thus lose time from their classes. At first, no common source of infection could be traced, the boys not eating at the same places, and in some cases not even knowing the other patients. The thirty-five cases, it was found, were fed at eleven different boarding houses or clubs, all of which were supplied with milk from the same dairyman.

Interesting, too, in this connection was the fact that the boy who assisted in delivering the milk, came down with a severe case of "tonsilitis" at the same time as the students, and had to give up his work temporarily. Five private families, supplied with milk from this same man, had one or more cases of genuine scarlet fever among their children at the same time. It is not likely that the boy who delivered the milk spread the disease, but that he contracted it by drinking the milk as did the students.

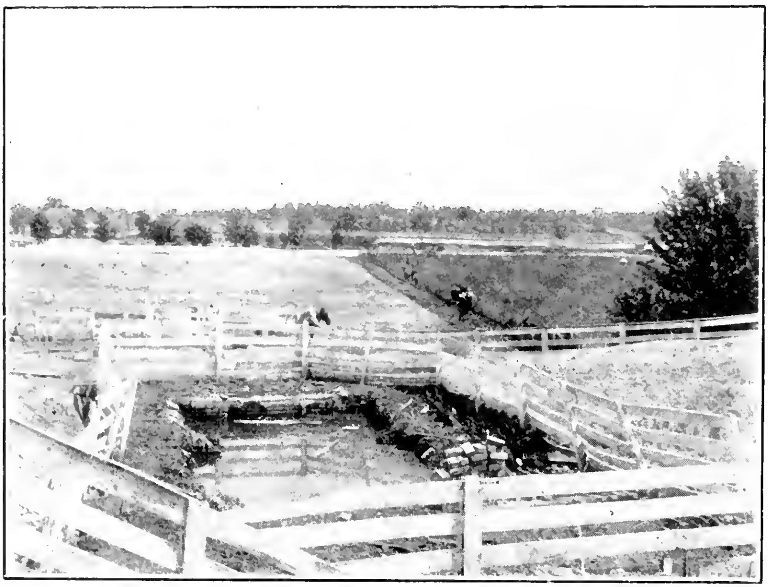
An investigation of the dairy, and the dairyman's family, did not reveal anything that could have caused the epidemic. There was no sickness in the family, nor in either of the other two families that supplied the dairyman with additional milk. The probable explanation of the source of infection lies in the fact that last March the dairyman's family ran through a course of scarlet fever, and this being about the time that the winter clothing was abandoned for the thin summer clothing, that winter clothing would again have to be put on but a short time prior to the outbreak among the students at Purdue. As it is known that the scarlet fever infection may remain virulent for a considerable time in clothing, it is not unlikely that it was through this means that the milk was infected. There is one other possibility, viz., that there might have been another family supplying the dairyman with milk in addition to the two families that he named, and he might have concealed this fact, knowing there was some sickness there. In this case the dairyman would be far more culpable.

This is one of the few scarlet fever epidemics traced to infected milk that have been reported in this country.

Sewage Disposal at the Indiana State Reformatory at Plainfield.

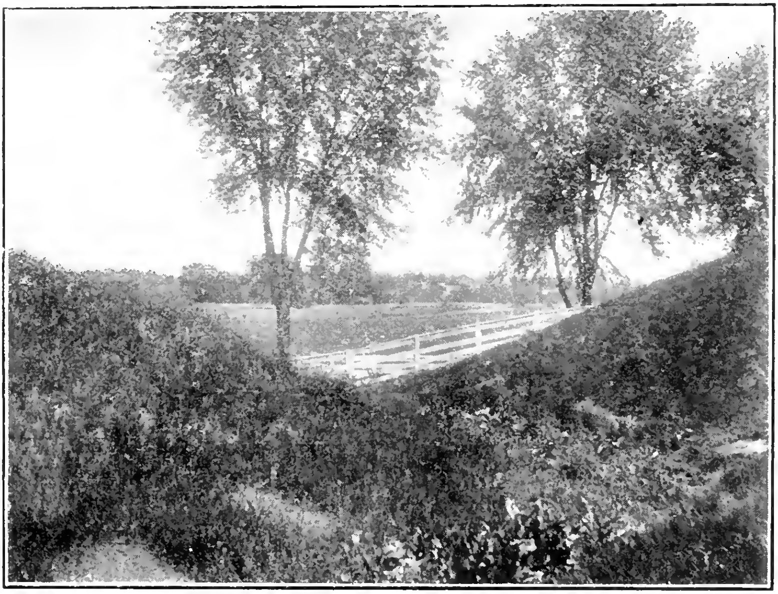
Severance Burrage.

The problem which recently presented itself to the authorities at the State Reformatory, at Plainfield, was a pretty one. An appropriation of $6,500 was available for the purpose of securing a certain amount of



Old Cesspool, showing method of disposal of sewage prior to new system.

plumbing in each of the so-called "family" buildings and to install a system of sewage disposal that first, would be sanitary, and second, would be of use in fertilizing and irrigating the fields on which crops are raised. Until the present year the sewage from the large out-building had been carried in a southeasterly direction to an open settling tank or cesspool, situated on the edge of the river bottoms. This cesspool in the summer time became a mass of fermenting filth, obnoxious and unhealthful. Moreover, it could not be utilized in any way. Now, with the introduction of plumbing into many of the buildings there would arise an appreciable



Site of Septic Tank north of the grounds, looking toward field to be irrigated and fertilized by the effluent from the tank.

increase in the amount of sewage and it would be out of the question to continue the old method of disposal. Up to this time practically all of the sewage came from one large out-building, which was nothing but a combination of closets and urinals, and while this made a considerable amount of sewage, both solid and liquid, there would be a considerable increase with the introduction of plumbing into all of the "family" buildings. This plumbing, including water-closets, wash-basins, and perhaps an occasional bath-tub.

There were two possible methods of sewage disposal that could be considered as practical in this instance, one being the system called "irrigation," which simply depends upon the distribution of the sewage directly on the fields (in this case on the river bottoms) that are being cultivated, and the other method was the septic tank system. After a very careful consideration of all the conditions, it was finally concluded to adopt a system which was a combination of both the septic tank and irrigation. This conclusion was arrived at because, should the raw sewage

Site of the Septic Tank north of grounds, as seen from main drive.

be thrown directly upon the fields in question it was feared by some that the odor from this raw sewage would be offensive, if not unhealthful, at certain times, and in view of the fact that these fields were adjacent to the main drive to the Reformatory, should any obnoxious odors arise, they would be noticed by everybody, and might be the cause for critical comment. In all probability there would not have been sufficient sewage at any one time to cause anything that would be called a nuisance in the manner just described, but it was thought better to err on the side of safety, and consequently the present plan includes a septic tank in which the sewage receives preliminary treatment before being distributed on the fields.

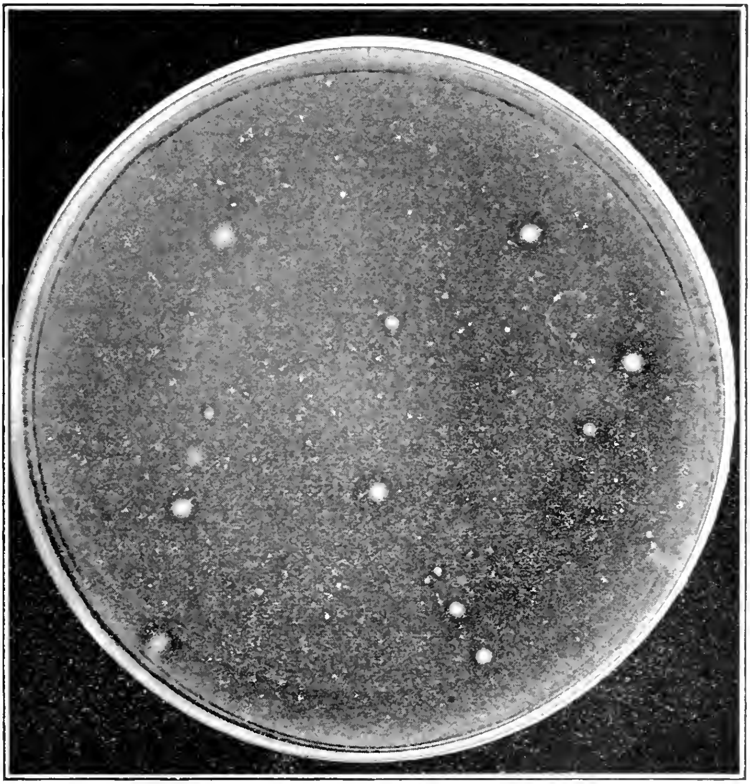
A casual survey of the Reformatory grounds showed at once that the lay of the land was so favorably arranged that the sewage could be collected and distributed by gravity. At no point would there need be any pumping; and yet when it came to make an accurate survey, including the levels, it was found that there were a number of quite difficult points to settle as to the best lines for the sewers to take in order to collect the

Field to be irrigated and fertilized by effluent from Septic Tank, as seen from main drive.

material from all the family buildings, and it was finally thought advisable to make two main lines of sewers, one leading to the fields northeast of the Reformatory, and the other following in general the line of the old sewer from the out-building in a southeasterly direction. Each one of these sewers ends in a septic tank in which the sewage undergoes a certain fermentation, and only the clear, or comparatively clear effluent passes out of the septic tank as an inoffensive liquid, very useful in irrigating the fields. Of course, this effluent from the septic tank is not as rich in fertilizing properties as the raw sewage would be, but it is free from any of the objections which might arise should the raw sewage be distributed upon the fields. The main problem in connection with the designing of the sewage disposal plant, furnished the material for the graduation thesis of two students of Purdue University, Messrs. Beuhler and Armstrong, who graduated in 1902. Their thesis work was done

Agar Plate, showing colonies of bacteria in 1/500 cu. centimeter of sewage as entering Septic Tank.

under the direction of Mr. C. V. Seastone of the Civil Engineering Department of the University, and the writer. The lines for the sewers were laid by another student of the University, Mr. Alva Baynes, who spent a large part of his summer vacation on the grounds. When it came to actually do the work it was found advisable, for one reason and another, to depart somewhat from the lines as designed by the gentlemen mentioned above in their thesis work, and it was also found advisable to depart somewhat from certain points in the specifications as set down by these same gentlemen. For example, the original thesis design called for but one main sewer collecting the material from all the family buildings



Agar Plate, showing colonies of bacteria in 1-500 cu. centimeter of effluent from Septic Tank.

and the hospital, etc., leading in a northeasterly direction toward the so-called garden, but the system as now existing includes the two main sewer lines as described above, one leading in a northeasterly direction, and the other in a southeasterly direction, and each ending in a septic tank.

All of the work of laying the pipes and building the septic tanks, etc., was done by the boys of the Reformatory, and thus the expense of the whole system was very much smaller than it would ordinarily be. The trenches for the pipes vary in depth from two to seventeen feet, and at many points considerable difficulty was encountered by running across springs or currents of underground water, which interfered very materially with the progress of the work. At the time of writing the paper, the sewer and septic tanks were all ready for reception of the material. The plumbing, however, has not yet been completed, but as soon as this is done the sewage can be turned into the pipes and the result of the method of disposal installed will be watched with much interest. It is practically the first experiment of this kind attempted by any institution in this State; and if successful, and there is no reason why it should not be, it should serve as a type or an example for many of the State institutions, and even for many of the smaller towns of the State.

Some Recent Mound Investigations in Jefferson County, Indiana.

Glenn Culbertson.

During the summer of 1902, through the interest, and under the direction, of Miss D. L. Cravens, of Madison, Indiana, several mounds located in Jefferson County were examined, and two were explored. The writer was asked to assist in the investigation.

The purpose of this paper is, in part, to give a record of the contents of the mounds opened, and in part to call attention to the fact that, in many parts of our State, and especially along the Ohio River and its larger tributaries, there are mounds and other evidences of the existence of a prehistoric people of which no record has been made, and which should be of great interest to science. Many of the mounds have been opened by curiosity or treasure seekers, or destroyed by cultivation, and the contents scattered or lost, and no record has been, or can be made.

As an example of the ruthless destruction of valuable anthropological material, a case may be cited of a Jefferson County farmer, who, in grading a plot of ground for building purposes, ploughed up at least twenty skeletons, many of which were said to be in a fair state of preservation, Some of the bones were carried off by neighbors, others were scattered about, and no record whatever preserved. This occurred some six or seven years ago, and similar cases probably occur every year in different parts of the State.

The first mound opened in Jefferson County, in 1902, is known locally as the "Lawson Mound." It is situated in Milton Township, T. 4, R. 11, Section 14, one mile east of Manville, on the narrow ridge between Brushy Fork and Indian Kentucky creeks, and approximately 300 feet above the level of the latter stream. The mound has been, until recently, covered with forest or underbrush growth, and is well preserved. It is essentially circular, sixty-five feet in diameter, and approximately nine feet high. The materials of which the mound was made are of local origin, and are made up of the ordinary surface soil of the vicinity. They include a few limestones, burnt and unburnt, and a few pebbles and pieces of chert. A thorough investigation of the contents of the mound could not be made, since the central portion was preoccupied by graves of the former owners of the property. When these graves were dug a skeleton was found some three feet below the surface of the mound. Along with the human bones nine arrow heads, placed in a circle, and a stone ax were found so situated as to lead to the opinion that they had been placed on the breast of the buried body. These articles were not preserved, according to Mr. Frank Wolf, who was present when the graves were dug and whose statements I have recorded above.

The excavation of this mound consisted in opening a ditch four feet wide and to the depth of the original soil, from the east side toward the center, and surface excavations to the depth of three feet on the north, west and south of the graves mentioned. At a point some five feet east of the center of the mound, and three feet below the surface, an unglazed earthenware vessel of approximately one and one-half gallons capacity was found. In shape, this vessel was similar to the ordinary Chinese rice pot, and was without markings of any kind. It contained two mussel shells, such as could be obtained from the surrounding streams. The vessel was cracked and had probably seen considerable service before being placed in the mound, as the lower portion showed the reddening influence of the fire.

Within a foot or fifteen inches of the earthenware vessel, and to the east, there were obtained the fragments of a skull and the larger bones of the arms and lower extremities, and one rib. All were greatly decayed. The position of the bones might indicate burial of the body on its side with arms and legs folded together, but this could not be decided definitely. The skull was so badly decayed that no definite idea of its shape could be obtained. The bones were those of a medium-sized person.

On the west side of the mound, in line with the two skeletons already mentioned, and at about the same depth as the others, another deposit of human bones was obtained. This deposit consisted of a skull and the larger bones of the upper and lower extremities. These were also greatly decayed. The position of these bones precludes the idea of their being the result of an ordinary burial. The long bones had the appearance of having been piled in, very much as a bundle of sticks or stove wood would be placed. The skull was placed directly on top of the other bones. These bones were those of one body of large but not unusual stature. The relics obtained from this mound are at present in the Hanover College Museum.

The reputed "Indian Mound" in the village of Lancaster, in Lancester Township, T. 5, R. 9, Section 33, was next examined. It was found to give every evidence of being a natural formation. The so-called "Indian Mound" on the Wainscott Place, near Middle Fork Station on the P. C. C. & St. L. R. R., was also closely examined. Evidence of its human origin, however, was entirely wanting. This peculiar mound is, in all probability, the result of stream erosion.

A mound situated on the second bottom of the Ohio River, a short distance below Hanover Landing, in Hanover Township, T. 3, R. 10, Section 18, was next excavated. This mound had been explored in part by Messrs. G. S. Tayler and W. W. Walker, some fifteen years ago. As reported by Mr. G. S. Taylor, now Superintendent of Schools of Jefferson County, this moand was then some twelve or fourteen feet high and of conical shape. At a depth of about three feet from the original top of the mound these gentlemen found five copper beads from one-half inch to three-quarter inch in diameter and of rough finish, arranged in a circle, as though originally forming a necklace. A considerable quantity of charcoal and ashes was also found, but no human bones.

Last July a trench eight feet wide was opened through the mound from east to west, and extending to the depth of the mound. All the excavated material was closely searched. At a point approximately three feet above the bottom of the mound two stones, each about 15x7x1½ inches, were found in an erect position and about four feet apart. Two and a half feet to one side of these stones a copper bead one-half inch in diameter and thickly encrusted with the green carbonate of copper was found. No bones were found at this level. On the original soil, at the bottom of the mound, a large quantity of charcoal and ashes, and one or two bone fragments, probably non-human, were obtained. With these there were fragments of burnt limestone. The failure to find human bones in this mound may be due to its great age, or it may be accounted for by the partial destruction of the mound by cultivation, since such material may have been ploughed out and no record made of the fact.

The Water Supply of Havana, Cuba.

C. H. Eigenmann.

Until recent years the water supply of Havana came from the Almendares River. During the nineties the present waterworks, deriving the entire supply from a large spring at Vento, on the south bank of the Almendares River, was completed. The Vento Springs and the covered aqueduct leading its waters under the Almendares River and into Havana are the pride of the city of Havana, which has erected an imposing monument to the engineer by whom the work was conceived. The Vento Springs are surrounded by masonry with walls sloping outward from the springs, except on the side nearest the Almendares River, where they are vertical. The surface water running down the slopes of the masonry are caught in a gutter which discharges it into the Almendares. At the top of the masonry, and some distance removed from its margin, another gutter catches the surface water of the region sloping toward the springs, and discharges this also into the Almendares. The spring water flows direct from the basin into the covered aqueduct. The provisions for maintaining the water in its original purity from the time it issues from the ground till it is discharged either into the reservoirs near the city, or direct from the faucets in the city, seem ideal.

There has been some speculation as to the origin of the water issuing from the spring at Vento. The water is beautifully clear and rather warm, having a temperature of 26°C. at the time of our visit. The Almendares River, flowing but a few feet away, also has clear water except after heavy rains, and its water at the time of our visit was slightly colder than that of the springs. It is possible that the Vento Springs derive their water from the upper courses of the Almendares, though this is so highly improbable that the suggestion may be left out of consideration. The springs being situated on the south side of the lower course of the Almendares the region across the river—that is the region north of the river—may be excluded as a possible contributing source of the supply of the Vento Springs. The region about the springs is composed of corralline rock. In such porous material conditions under which territory on one side of a river may contribute to springs located on the opposite side of a river are impossible.

The most probable origin of the Vento water supply can best be understood after a general statement of the conditions of the surrounding region.

The southern slope of the provinces Guanajai, Havana and Matanzas is largely drained by underground streams. The streams arising in the hills and mountains, forming the watershed between north and south drainage, run above ground for a distance and then disappear underground. The Ariguanabo River thus runs into a bank at San Antonio de los Baños and disappears among fallen rocks. A few yards away from its "sumidero" the water can be seen running in its underground channel through an opening in the thin roof of the channel. A few yards further on a dry cave leads down to the water, which, at the end of the dry cave disappears among fallen rocks. Other rivers disappear in a similar manner. They can not be followed in their underground courses because they completely fill them. The underground waters and the channels in which they run can, however, be reached in places through sink-holes. The streams reappear, in part, at least, in a number of "ojos de agua," some near the coast south of San Antonio. The region drained by underground streams is comparatively flat with frequently no indications of surface streams and their erosion, and extends westward to near San Cristobal, where the first permanent surface stream is observed. At Artimisa and Candalaria stream beds contained pools of water at the time of my visit.

From San Cristobal to Pinar del Rio there are many small perennial streams. Eastward from San Cristobal the cave region has an unknown extent. Poey limited it to the jurisdiction of Guanajay, but it certainly extends as far east as the meridian of Matanzas, and from reports probably beyond Cienfuegos. East of Rincon there are, however, frequent river beds, all but one of which were dry during the time of our visit. This main cave region belonging to the southern slope sends a tongue northward from Rincon to Vento on the Almendares River in the northern watershed. Aside from the "ojos de agua" along the edge of the cienegas skirting the southern coast there are two notable places where underground rivers find an exit. The one at Vento, as already mentioned, supplies the entire city of Havana with its water, the other serves to make the region about Guines a garden, its waters being used for irrigation. Other subterranean rivers in all probability have a sub-aqueous exit to the south.

The large spring at Vento is the only one on the northern slope as far as I know. The origin of the supply issuing from the Vento Spring has not been traced. But the region north of the Almendares River, being shut out from a possible contributing source, it undoubtedly derives its water from the tongue of the system of underground streams thrust into the northern slope. An examination of the best available map and the levels of the Western and United Havana Railroads make it seem quite certain that the Vento Springs derive their water from the region immediately south of Vento and north of Rincon and Bejucal. This region contains various sinks, without surface outlets, as well as dry sink-holes. A notable sink-hole in this region is that at Aquada on the United Havana Railroad. This is very broad, shallow and dry during the dry season, but the water rises to stand over ten feet deep on the railroad track during some of the wet seasons. All of these probably drain into the Vento Spring.

It behooves the health authorities of the city of Havana to exercise the strictest guard over the region between Vento on the north and Rincon and Bejucal on the south. Any contamination of sink-holes in these regions is sure, during the wet season at least, to contaminate the underground streams leading to Vento. An examination of the underground channels in the Lost River region of Indiana has shown the main underground channels to be provided with numerous smaller tributary channels which in ordinary weather do not carry water but which do carry water into the main stream after a long rain. At such a time any filth that may have accumulated in any of the sink-holes over one of the tributary streams is sure to find its way into the main stream. The same is very probably true of the Vento supply, although on account of the nature of the region it is not possible to follow the underground channels. At present some of the sink-holes between Rincon and Vento are used as cesspools and receivers of sewage.

Naezhosh; or, The Apache Pole Game.

Albert B. Reagan.

[Abstract. Original in possession of Bureau of American Ethnology. Illustrations used by permission of Bureau.]

Naëzhosh is the Apache tribal game. It is played most every day from early morning till late in the afternoon by the men; in fact they do but little else, except hunt horses in the hills and drink Indian whiskey. This game is sometimes played to pass time; but most always for gain. The Indians often bet all they have on its outcome, and then having suffered reverses, they brood over their losses in sullen silence. Below is a description of the game; and the requisites—the pole-stick, the pole-hoop, and the pole-ground:

Fig. 1.

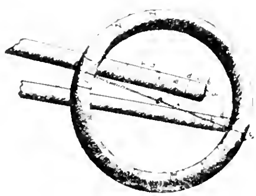


Fig. 2.

Diagram of Pole Sticks and Pole Hoop.

Fig. 1. Pole Stick. The grooves b, c, d, g, h; the spaces e, f, i, and the point a are points used in the game.

Fig. 2. The Pole Hoop, etc. The spaces 1-4 and 6-11 and the gr ove 5 are the points on the hoop used in the game.

The Pole-Stick.—The pole-stick is a willow pole one and one-half inches in diameter at the larger end. It tapers to a point at its smaller end. Its length is about fifteen feet. It is made in three sections, the sections being spliced together with sinew. The larger end of this pole is called the counting end. On it are several transverse grooves. These grooves together with some of the intervening spaces are the points on the pole used in the game.

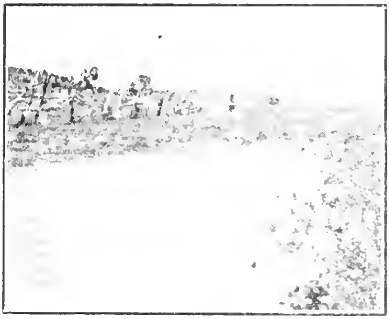
The Pole-hoop.—The pole-hoop is about a foot in diameter. It is made of a willow withe, the ends of which are tied together with sinew. A buckskin cord forms a diameter to it. On this cord are strung one hundred and one beads, one large center bead and fifty smaller ones on each side of it. These beads are counts used in the game. In addition to the bead counts, the hoop rim has several counts on it. They are its transverse grooves, together with certain intervening spaces.

The Pole-ground.—The pole-ground is a leveled spot thirty-six yards in length, by six yards in width, laid off in a north and south direction. At its center is the base, usually a rock, from which the pole-hoop is rolled and the poles, two in number, are hurled. Nine yards both to the north and also to the south of this base, are three hay ridges, the center ridge being on the north and south center line of the pole-ground. These ridges are three yards long and the distance from the outer edge of the east ridge to the outer edge of the west ridge is five feet. The furrows between the ridges are narrow. It is into one of these furrows that the hoop rolls, under which the poles are slid before the points are counted.

Rolling the Pool-hoop.—In rolling the pole-hoop it is held with rim vertical between thumb and second finger of the right hand, it resting on the extended front finger over which it rolls when sent on its mission of chance. If the hoop, when rolled, fails to enter either of the furrows, a break in the game is declared, and it is brought back and rolled again. On entering one of the furrows, the loose hay retards its speed, and it soon falls, to be slid under by the well guided poles. The hoop is always rolled twice to the south and once to the north, and so on for hours, till the game is finished.

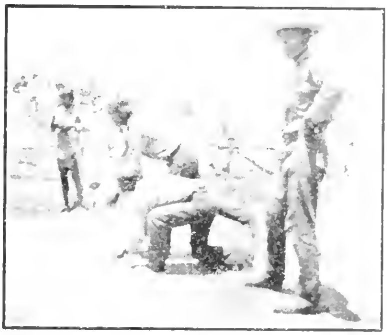
Hurling the Pole-stick.—The pole-stick, when being hurled, is held so as to slide through the left hand. The propelling power is the right hand, the index finger being placed against the rear end. The pole being dexteriously hurled, slides into the furrow, and stops with the larger end beneath the hoop. The counting then begins.

Counting the Points.—All points on each pole that fall on or within the rim of the hoop are counted as are also all points on the hoop-rim, and all the beads on the transverse cord which fall within the edges of either pole. The points being counted, the players again proceed to the base and play again as before. This playing is continued for hours till one of the contestants gets the number of points agreed upon by the players to constitute a game. A transfer of the staked property follows. Then the betting begins for a new game.



The pole field.

Starting the pole hoop. The beginning of the game.

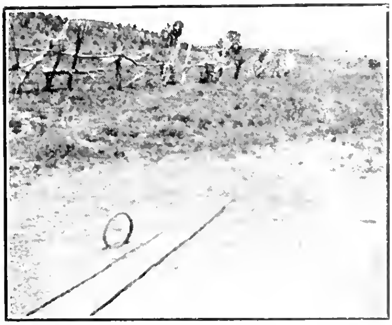


Hurling the poles.

Hurling the poles.

The poles speeding on their way.

The hoop rolls wide of the counting field. A break in the game.



Hoop and poles entering the counting field.

Hoop and poles after motion has ceased. The hoop overlies the counting ends of the poles. The counting now begins.

Counting the points in the pole game.

Picking up the poles in the counting field.

Returning to the base.

The game begins anew.

Geodesic Lines on the Syntractrix of Revolution.

E. L. Hancock.

The syntractrix is defined as a curve formed by taking a constant length, d upon the tangent c to the tractrix*. The surface formed by revolving this curve about its asymptote is the one under consideration. We shall call it S.

Being a surface of revolution it is represented by the equations

$$x = u \cos v$$
$$y = u \sin v$$
$$z = -\sqrt{d^2 - u^2} + \frac{c}{2} \log \frac{d + \sqrt{d^2 - u^2}}{d - \sqrt{d^2 - u^2}}$$

Using the Gaussian notation† we find:

$$E = \frac{u^2(d^2 - 2cd) + c^2d^2}{u^2(d^2 - u^2)},\ F = o,\ G = u^2,\ A = -\frac{u^2 - cd}{u\sqrt{d^2 - u^2}}\, u \cos v,\ B = -\frac{u^2 - cd}{u\sqrt{d^2 - u^2}}\, u \sin v\ C = u,\ D = \frac{u^2(d^2 - 2cd) + cd^3}{u(d^2 - u^2)^{\frac{3}{2}}},\ D' = o,\ D'' = \frac{u(u^2 - cd)}{\sqrt{d^2 - u^2}}$$

$$K = \frac{1}{R_1R_2} = \frac{DD'' - D'^2}{EG - F^2} = \frac{(u^2 - cd)[u^2(d - 2c) + cd^2]}{(d^2 - u^2)[u^2(d - 2c) + c^2d]}$$

In the particular surface given by $d = 2c$ the Gaussian curvature becomes

$$\frac{2\left(u^2 - \frac{d^2}{2}\right)}{d^2 - u^2}$$

Here d is positive, and since $d > u$, the denominator is always positive. We get the character of the curvature of different parts of the surface by considering the numerator. When $u^2 = d^2/2$, $K = O$, i. e., the circle $u = d/2$ $\frac{d}{\sqrt{2}}$ is made up of points having zero-curvature. When $u^2 > d^2/2$, $K > O$, and when $u^2 < d^2/2$, $K < O$.

For this particular surface

$$E = \frac{d^4}{4u^2(d^2 - u^2)},\ F = o,\ G = u^2,\ A = -\frac{2u^2 - d^2}{2u\sqrt{d^2 - u^2}}\, u \cos v,\ B = -\frac{2u^2 - d^2}{2u\sqrt{d^2 - u^2}}\, u \sin v\ C = o,\ D = \frac{d^4}{2u(d^2 - u^2)^{\frac{3}{2}}},\ D' = o,\ D'' = \frac{u(2u^2 - d^2)}{2\sqrt{d^2 - u^2}}$$

To get the geodesic lines of the surface we make use of the method of the calculus of variations according Weierstrass§. This requires that we minimize the integral:

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* Peacock, p. 175.

† Bianchi, Differential Geometrie, pp. 61, 87, 105.

§ Osgood, Annals of Mathematics, Vol. 11 (1901), p. 105.

$$I = \int_{t^2}^{t^1} \sqrt{E\,du^2 + 2F\,du\,dv + G\,dv^2}.dt$$

Denote $\sqrt{E\,u'^2 + 2\,F\,u'\,v' + G\,v'^2}$ by F. Then the first condition for a minimum of I is $Fv - \frac{d}{dt}Fv' = o$||

Now, in this case $Fv = o$, so that $\frac{d}{dt}Fv' = o$

Hence $Fv' = \delta$, or substituting the values E, F and G this becomes

$$\frac{u^2\,v^1}{\sqrt{\frac{d^4\,u'^2}{4\,u^2(d^2 - u_2)} + u^2\,v'^2}} = \delta$$

When $\delta = o$, $v' = o$, hence $v =$ constant, i. e., the meridians are geodesic lines.

When $\delta = o$

(1) $$v = \int \frac{\delta\,d^2\,u^1}{2\,u^2\sqrt{(d^2 - u^2)(u^2 - \delta^2)}} + \delta'$$

Making the substitution $u = 1\,t$, (1) becomes

(2) $$v = \int \frac{-\delta\,d^2\,t^2\,dt}{2\sqrt{(t^2\,d^2 - 1)(1 - \delta^2\,t^2)}} + \delta'$$

We have for the reduction of the general elliptic integral

$$*R(x) = A\,x^4 + 4\,B\,x^3 + 6\,C\,x^2 + 4\,B'\,x + A'$$

$$g_2 = AA' - 4\,BB' + 3\,C^2$$

$$g_3 = AcA' + 2\,BcB' - A'B^2 - AB'^2 - c^3.$$

These become in the present case

$$R(t) = (t^2d^2 - 1)(1 - \delta^2t^2) = \quad \delta^2d^2t^4 + (d^2 + \delta^2)t^2 - 1$$

$$g_2 = \delta^2d^2 + \frac{(d^2 + \delta^2)}{12}$$

$$g_3 = \frac{\delta^2\,d^2(d^2 + \delta^2)}{6} - \left(\frac{d^2 + \delta^2}{6}\right)^3$$

We get also

$$R'(t) = -4\,\delta^2d^2t^3 + 2\,(d^2 + \delta^2)\,t$$

$$R'(t) = -12\,\delta^2d^2t^2 + 2\,(d^2 + \delta^2)$$

Making the substitution

(3) $$t = a + \frac{\frac{1}{4}\,R'(a)}{p\,u - \frac{1}{24}\,R''(a)}\dagger$$

Where a is one of the roots of R(t), say 1 d, we get

$$t = \frac{1}{d} + \frac{\frac{\frac{1}{2}(d^2 - \delta^2)}{d}}{p\,u - p\,v} \quad \text{where } p\,v = \tfrac{1}{12}(d^2 - 5\delta^2)$$

|| Kneser, Variationsrechnung. Fv denotes function v.

* Klein, Ellip. Mod. Functionen, Vol. I, p. 15.

† Enneper, Ellip. Functionen, 1890, p. 30.

Now, since $\frac{dt}{du} = \sqrt{R(t)}$ we get from (2)

$$(4) \quad v = -\frac{\delta d}{2}\int t^2 du + \delta' = \frac{1}{2\delta}\int\left[-\delta^2 - \frac{\delta^2(d^2-\delta^2)}{pu - pv} - \frac{\frac{\delta^2}{4}(d^2-\delta^2)^2}{(pu-pv)^2}\right]du + \delta'$$

Noting that in the present case

$$(p'v)^2 = -\frac{\delta^2(d^2-\delta^2)^2}{4}$$

$$p''v = -\delta^2(d^2-\delta^2)$$

and remembering that

$$\frac{(p'v)^2}{(pu-pv)^2} = p(u+v) - p(u-v) - 2pv - \frac{p''v}{pu-pv}$$

(4) becomes

$$v = \frac{1}{2\delta}\int\left[-\delta^2 + p(u+v) - p(u-v) - 2pv\right]du + \delta'$$

$$= \frac{1}{2\delta}\left[-\frac{1}{6}(d^2+\delta^2)u + \zeta'(u-v) - \zeta'(u+v)\right] + \delta'$$

The functions ζ' may be expressed in power series. We have then the geodesic lines given by the equations

$$v = f(t) + \delta'$$

$$u = \frac{1}{t}$$

The constant δ' being additive has no effect upon the nature of the geodesics. It determines their position. All lines given by δ' may be made to coincide by a revolution about the z-axis. The curves may be completely discussed when $\delta' = o$.

Since the parameter lines of the surface consist of geodesic lines through a point and their orthogonal trajectories E may be taken equal to unity.* $E\,du^2 = du'^2$

Hence $-\frac{d}{2}\log\left[\frac{d+\sqrt{d^2-u^2}}{u}\right] = u'$, or $u = d\,\mathrm{sech}\,\frac{2u'}{d}$

Because of the relations of the surface to the pseudo-sphere it may be represented upon the upper part of the Cartesian plane†. The relation between the surfaces is given by the equations

$$v = v'$$

$$u = \frac{c}{d}u'$$

* Knoblauch, Krummen Flächen, p. 49.
† Bianchi, Differential Geometrie, p. 419.

where u and v are co-ordinates of points on the pseudo-sphere and u′ and v′ co-ordinates of points on S. The equations of transformation from S to the plane are

$$v = x$$

$$c\,e^{-\frac{u}{d}} = y$$

The real part of the surface being represented on the strip included between $y = c$ and $y = c\,e$.

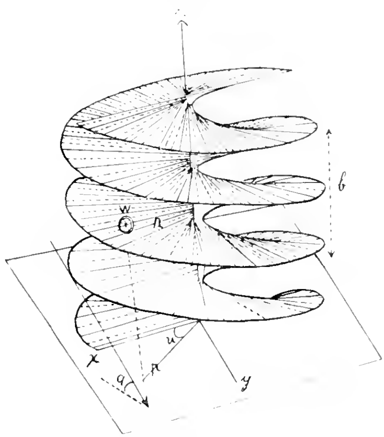
Comparison of Gauss' and Cayley's Proofs of the Existence Theorem.

O. E. Glenn.

[By title.]

Motion of a Bicycle on a Helix Track.

O. E. Glenn.



The equation of the helix surface may be conveniently expressed in surface co-ordinates, thus:

$$x = r \cos u = f_1(ru)$$

$$y = r \sin u = f_2(ru)$$

$$z = \frac{bu}{2\pi} = f_3(ru)$$

in which r represents the distance of a point from the z axis, and u the angle between the x axis and the projection of r upon the (xy) plane; b being a constant.

It will be assumed here that there is a force of friction equal and opposite to the centrifugal force, of a particle (or wheel) moving down the surface, under the action of gravity (g). If these equal and opposite vectors be introduced, the problem reduces to that of determining the motion of a particle (or wheel) on a fixed smooth surface.

The general equation of kinetic energy* is,

$$(1)\quad d\left(\tfrac{1}{2}mv^2\right) = \left\{X\frac{\dagger df_1}{dr} + Y\frac{df_2}{dr} + Z\frac{df_3}{dr}\right\}dr + \left\{X\frac{df_1}{du} + Y\frac{df_2}{du} + Z\frac{df_3}{du}\right\}du,$$

where m represents the mass, v the velocity and X, Y and Z the axial components of the impressed forces.

Denoting the angle between the [xy] plane and the tangent plane of the surface by a there results:

$$(2)\quad X = mg\sin a\cos a\cos u = mg\frac{\sin 2a}{2}\cos u.$$

$$Y = mg\sin a\cos a\sin u = mg\frac{\sin 2a}{2}\sin u.$$

$$Z = mg.$$

And equation (1) reduces to

$$d\left(\tfrac{1}{2}mv^2\right) = \left\{g\frac{\sin 2a}{2}\cos^2 u + g\frac{\sin 2a}{2}\sin^2 u\right\}m\,dr$$

$$+\left\{-g\frac{\sin 2a}{2}r\sin u\cos u + g\frac{\sin 2a}{2}r\sin u\cos u + \frac{gb}{2\pi}\right\}m\,du;\ \text{or,}$$

$$(3)\quad d\left(\tfrac{1}{2}mv^2\right) = m\left\{g\frac{\sin 2a}{2}\right\}dr + \frac{mgb}{2\pi}du.$$

But the angle a equals,

$$a = \cos^{-1}\frac{2\pi r}{\sqrt{4\pi^2r^2+b^2}}$$

Whence $\dfrac{\sin 2a}{2} = \sin a\cos a = \dfrac{2\pi rb}{4\pi^2r^2+b^2}$ and from (3).

$$(4)\quad d\left(\tfrac{1}{2}mv^2\right) = \left\{\frac{2\pi b\,mgr}{4\pi^2r^2+b^2}\right\}dr + \left\{\frac{mgb}{2\pi}\right\}du.$$

This, upon integration, gives,

$$(5)\quad v^2 = \frac{gb}{2\pi}\log\left[\frac{r^2+\dfrac{b^2}{4\pi^2}}{r_0^2+\dfrac{b^2}{4\pi^2}}\right] + \frac{gb}{\pi}u,$$ the initial conditions being $v=0$

and $r = r_0$ when $u = 0$.

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* Ziwet Mechanics, p. 103, Vol. III.

† These are partial derivatives.

$$\text{Now } v^2 = \left\{ \frac{^*df_1}{dr}\frac{dr}{dt} + \frac{df_1}{du}\frac{du}{dt} \right\}^2 + \left\{ \frac{df_2}{dr}\frac{dr}{dt} + \frac{df_2}{du}\frac{du}{dt} \right\}^2 + \left\{ \frac{df_3}{dr}\frac{dr}{dt} + \frac{df_3}{du}\frac{du}{dt} \right\}^2$$

in which t represents the time and v the velocity. Therefore,

$$(6)\quad v^2 = \left\{ \cos u \frac{dr}{dt} - r \sin u \frac{du}{dt} \right\}^2 + \left\{ \sin u \frac{dr}{dt} + r \cos u \frac{du}{dt} \right\}^2 + \left\{ \frac{b}{2\pi}\frac{du}{dt} \right\}^2$$

$$= \left\{ \frac{dr}{dt} \right\}^2 + \left\{ r^2 + \frac{b^2}{4\pi^2} \right\} \left\{ \frac{du}{dt} \right\}^2.$$

From (5) and (6).

$$(7)\quad \frac{gb}{2\pi} \log \left| \frac{r^2 + \frac{b^2}{4\pi^2}}{r_0^2 + \frac{b^2}{4\pi^2}} \right| + \frac{gb}{\pi} u = \left\{ \frac{dr}{dt} \right\}^2 + \left\{ r^2 + \frac{b^2}{4\pi^2} \right\} \left\{ \frac{du}{dt} \right\}^2$$

This is the differential equation of the motion.

Its integral furnishes solutions of the following:

1. What is the time of descent?
2. What is the equation of the curve of quickest descent?
3. What is the space passed over in a given time?
4. What is the velocity at any instant?
5. What is the normal pressure on the surface?

Problem: A wheelman rides down a helix surface along the line of pitch 30°, keeping his wheel at a constant radial distance of 30 feet. Find the time of descent and his velocity upon reaching the ground; the helix making one complete turn.

Since r is constant and equal to r_0, we have:

$$(8)\quad r = r_0 = 30.$$

$$b = 2\pi r \tan 30^0 = 3.1416 \times 60 + \tfrac{1}{3}\sqrt{3} = 108.824.$$

$$g = 32.$$

Equation (7) now becomes,

$$\left\{ r_0 + \frac{b^2}{4\pi^2} \right\} \left\{ \frac{du}{dt} \right\}^2 = \frac{gb}{\pi} u$$

Substituting from (8)

$$\frac{du}{dt} = \left\{ \frac{32 \times 108.82}{3.1416 \times 1199.982} \right\}^{\frac{1}{2}} \sqrt{u} = .96\sqrt{u}.$$

$$\therefore t = \frac{2}{.96}\sqrt{u}\,\Big]_0^{2\pi} = \frac{200}{96}\sqrt{2 \times 3.1416} = 5.2 \text{ seconds} = \text{time of descent.}$$

From equation (4).

$$v = \sqrt{\frac{32 \times 108.824.}{3.1416}}\sqrt{u} = \sqrt{64 \times 108.824} = 83.4 \text{ ft. per second} = \text{velocity}$$

at bottom.

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* Partials.

It may be observed that the velocity is the same as that acquired by a body falling through the height h, and is independent of the radial distance, r. The time of descent is directly proportional to r; and both are independent of the weights. That is, we have the theorem:

Motion on the helix surface is equivalent to that on the incline plane, when r is constant.

A Generalization of Fermat's Theorem.

Jacob Westlund.

Consider the function

$$(1)\quad F(\alpha,\ A) = \alpha^{n(A)} - \left(\alpha^{\frac{n(A)}{n(P_1)}} + \ldots + \alpha^{\frac{n(A)}{n(P_i)}}\right) + \left(\alpha^{\frac{n(A)}{n(P_1P_2)}} + \ldots\right) - \ldots + (-1)^i\,\alpha^{\frac{n(A)}{n(P_1P_2\ldots P_i)}},$$

where α is any algebraic integer and A any ideal in a given algebraic number field, $P_1, \ldots P_i$ are the distinct prime factors of A, and n(A) denotes the norm of A. The theorem which we shall prove is that $F(\alpha, A)$ is always divisible by A.

For the case when α and A are rational integers several proofs of the divisibility of $F(\alpha, A)$ by A have been given*.

When A is a prime ideal the function $F(\alpha, A)$ reduces to $\alpha^{n(A)} - \alpha$, which, as we know, is divisible by A.

Let us first consider the case when $A = P_1^{S_1}$, where P_1 is a prime ideal of degree f, and p_1 the rational prime divisible by P_1. Then

$$F(\alpha,\ P_1^{S_1}) = \alpha^{p_1^{fs_1}} - \alpha^{p_1^{f(s_1-1)}}.$$

But

$$\alpha^{p_1^{f(s_1-1)}(p_1^f-1)} \equiv 1, \bmod P_1^{S_1}$$

and

$$\alpha^{p_1^{fs_1}} \equiv \alpha^{p_1^{f(s_1-1)}}, \bmod P_1^{S_1}$$

hence

$$(2)\quad F(\alpha,\ P_1^{S_1}) \equiv 0, \bmod P_1^{S}.$$

Now, suppose $A = B \,.\, P_1^{S_1}$ where B is any ideal not divisible by P_1. Then we can easily derive the following relation:

$$F(\alpha^{p_1^{fs_1}},\ B) - F(\alpha,\ B \,.\, P_1^{S_1}) = F(\alpha^{p_1^{f(s_1-1)}},\ B),$$

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* Dickson, Annals of Mathematics, 2d Series, Vol. 1, 1899, p. 31.

or

(3) $F(\alpha, BP_1^{S_1}) = F(\alpha^{p_1^{fs_1}}, B) - F(\alpha^{p_1^{f(s_1-1)}}, B)$.

If we let $B = P_2^{S_2}$ we get from (3)

$$F(\alpha, P_2^{S_2}P_1^{S_1}) = F(\alpha^{p_1^{fs_1}}, P_2^{S_2}) - F(\alpha^{p_1^{f(s_1-1)}}, P_2^{S_2})$$

and hence by (2)

(4) $F(\alpha, P_2^{S_2}P_1^{S_1}) \equiv 0, \bmod P_2^{S}$

By a similar reasoning we also get,

(5) $F(\alpha, P_2^{S_2} P_1^{S}) \equiv 0 \bmod P_1^{S_1}$ and hence by (4) and (5).

(6) $F(\alpha, P_2^{S} P_1^{S_1}) \equiv 0 \bmod P_2^{S_2} P_1^{S_1}$.

We now assume that for an arbitrary α the function $F(\alpha, A)$ is divisible by A, then if P be any prime ideal not contained in A we have by (3)

$F(\alpha, AP^s) = F(\alpha^{p^{fs}}, A) - F(\alpha^{p^{f(s-1)}}, A)$ and hence,

(7) $F(\alpha, AP^s) \equiv 0 \bmod A$.

Now let $A = CQ^t$ where Q is a prime ideal and C prime to Q. Then,

$F(\alpha, AP^s) = F(\alpha^{q^{ts}}, CP^s) - F(\alpha^{q^{t(t-1)}}, CP^s)$ where q is the rational prime divisible by Q and t the degree of Q, and since by our assumption the two terms on the right side are divisible by CP^s it follows that,

(8) $F(\alpha, AP^s) \equiv 0 \bmod CP^s$, and hence,

(9) $F(\alpha, AP^s) \equiv 0 \bmod AP^s$.

Hence if $F(\alpha, A)$ is divisible by A when A contains n distinct prime factors it is also divisible by A when A contains n+1 distinct prime factors. Making use of (4) we then find that $F(\alpha, A)$ is divisible by A for any A.

ON THE CLASS NUMBER OF THE CYCLOTOMIC NUMBERFIELD $K\left(e^{\frac{2\pi i}{p^n}}\right)$

JACOB WESTLUND.

[By title.]

[Will appear in Transactions American Mathematical Society, Vol. IV: 2.]

Photographic Observations of Comet C, 1902.

John A. Miller.

Comet c (Perrine) 1902, was photographed here on every clear night from October 5 to October 22, clouds preventing either earlier or later ones. With few exceptions two photographs were made on each night. One photograph being made with a portrait lens built on the Petzval system, but afterward refigured by Brashear. This lens had an aperture of twelve centimeters and a focal length of fifty-five centimeters. The other photograph was made with an old "tintype" lens which Mr. W. A. Cogshall rescued from a photograph gallery here and which performs surprisingly well. This lens has an aperture of 5.5 centimeters and a focal length of twenty-two centimeters.

The tail of this comet was exceedingly faint, so faint that it was with difficulty that it could be photographed at all. Each of the photographs showed two streamers, a long one nearly straight and a shorter one more sharply curved. The greatest length of the short tail was shown on the photograph of October 6. It was then 1.°8 long, while on October 22 it did not exceed one-half degree in length. On October 5 the long streamer subtended 3.°2. Each succeeding photograph showed the streamer longer until on October 22 it subtended an angle of 8.°4. In the following table I have shown the results obtained by measuring five of the photographs, which represents fairly well the behavior of the comet.

In this table T is the central time of exposure; L, the length of the long tail in degrees; S, the length of the short tail in degrees; N, the number which when multiplied by the cosine of the angle between the direction of the comet's tail and the radius vector from the sun to the comet gives the length of the long streamer in terms of the mean distance of the earth from the sun:

T.	L.	S.	N.
h. m. h. m.			
October 5, 8:10 — 9:00	3.2	1.0	.0294
October 6, 8:00 — 11:45	3.2	1.8	.0383
October 7, 6:00 — 7:20	3.8	1.5	.0323
October 20, 6:00 — 7:20	6.1	1.2	.0686
October 22, 6:15 — 7:45	8.4	...	.0966

The Genus Puccinia.

J. C. Arthur.

The present paper is a continuation of two previous attempts to bring to the notice of this society something of the efforts that are being made to devise a workable method that will eventually lead to a stable nomenclature for plants. The necessity for having one authoritative name for each species and genus of plants is conceded by all botanists. The methods proposed for arriving at this desirable state are various. It is evident that nomenclature will never become stable if left to itself, that is, to the judgment of the individual. There must be rules of procedure which most botanists, if not all, will feel bound to respect.

The wise formulation of such rules and the impress of authority, which they must necessarily bear, are difficult to secure. Were there an international organization of recognized competency to take up the matter, the way would seem easy. In the absence of such a body, suggestions and attempts must be expected from various sources, which may finally crystallize into a form which the botanical world at large will accept.

American botanists, acting through the American Association for the Advancement of Science, promulgated the Rochester-Madison rules of nomenclature in 1892-93. These rules, after the test of a decade, have been somewhat modified and extended, and today represent the most carefully considered and most practical scheme for securing uniformity of procedure in naming plants that has yet been brought forward. Whatever may be thought of these rules, or of any other, it is certainly the part of wisdom to test their applicability, and lend a hand to their improvement.

In order to illustrate the American rules I propose to take the very interesting case of the genus *Puccinia*. As the name is generally used it embraces about one thousand species of plant rusts, which are characterized by having free, two-celled telentospores. In my paper* of four years ago I pointed out, that according to the Kuntzean rules of nomenclature this generic name should be transferred to the cedar apple rusts, to replace *Gymnosporangium*, a name that has been in use since 1805. In my second paper,† presented two years later, I showed that if we accept the

* Indiana plant rusts, listed in accordance with latest nomenclature. Proceedings Indiana Academy of Science for 1898:174-186.

† Generic nomenclature of cedar apples. Proceedings Indiana Academy of Science for 1900:131-136.

first species published under a new genus as the type species to which the genus is to be invariably anchored, and from which its essential characters are to be drawn, the cedar apples must be listed under the Linnaean genus *Tremella*, while the fate of the name *Puccinia* was left in doubt.

In the meantime the amended rules of nomenclature by the American Committee have been distributed, and although these recognize the great value of types, a specimen used by the author as type of the species, and a species as type of the genus, they provide other ways of determining the type of a genus than always taking the first species named under it. The new rules require that the intent of the author, or if that is not ascertainable, the usage of his followers, shall be respected.

If we examine the status of the three genera, *Tremella*, *Gymnosporangium* and *Puccinia*, under the present rules, we will find that the first becomes a genus of algae, no longer to be included among the fungi, the second is restored to the position it has long occupied, while the third is well nigh lost in the toils.

The name *Puccinia* was introduced into botanical literature by Micheli in 1729, and is consequently pre-Linnaean. It was employed by Haller in two different works prior to 1753, the initial date for the operation of the law of priority, and by the same author in his *Historia stirpium indigenarum Helvetiae inchoata* (Vol. III, p. 126) of 1768. The last work, however, does not employ binomial names, and is not to be used in establishing modern nomenclature. Another early author, who cites the name *Puccinia*, is Adanson in his *Familles des Plantes* (Vol. II, p. 8) of 1763. He adopts both the name and the description of the genus from Micheli, but does not mention any species. There is a failure, therefore, to establish the genus on account of the lack of a type species.

The next oldst auther to employ the name is Willdenow in his *Florae Berolinensis*, of 1787. Willdenow characterizes his genus *Puccinia* as follows: "*Corpus cylindraceum seminibus caudatis radiatim positis, elastice exsilientibus farctum.*" Under this genus he places a single species, *Puccinia simplex*, which is described as "*P. corpore cylindrico simplicissimo obtuso.*" It is said to occur on the trunks of plum trees (*Prunus armeniaca*) in autumn, and to be rare in the vicinity of Berlin. Although reference is made to Micheli, yet careful comparison shows conclusively that Willdenow's plant was different from that of the Italian author. Moreover, it could not have been one of the cedar apples

(Gymnosporangium), as pointed out by Magnus,* for they neither grow upon the plum nor produce their spores in autumn. Further confirmation of this is found in Roth's *Floræ Germanicæ*, the first volume of which was issued the year following the appearance of Willdenow's work. In this volume (p. 547) *Puccinia simplex* is given, and credited to Willdenow, with no reference to Micheli, while a few pages farther on in the volume the common cedar apple of Europe is listed as *Tremella juniperina*. The two were evidently considered by the author to be distinct fungi.

There seems to be no doubt, that according to our present form of procedure, we must consider that the genus *Puccinia* was established by Willdenow in 1787, with the single species, *P. simplex*, a species that does not belong to the *Uredineæ*. What fungus Willdenow had in hand, I am not prepared to say. The description fairly well applies to *Cornularia Persicæ* (Schw.) Sacc., but that is a North American fungus, common in America but not yet reported from Europe. So far as our present purpose is concerned, however, it is enough to know that the type of the genus *Puccinia* is not uredineous. Therefore, the largest and best known genus of plant rusts, the one that includes the chief economic species, drops entirely out of the extensive family of the *Uredineæ*. Probably Doctor Kuntze is to be followed in placing under Dicaeoma the species that have heretofore been listed under *Puccinia*, as I have already pointed out in my preceding paper before the Academy.

Whether this is the final word regarding the genus *Puccinia*, and the fungi which it has been used to cover, yet remains to be seen. It may appear foolish to some to relegate to obscurity a well known and long established name, upon what seem to be technical grounds. But the loss of a familiar name should not stand in the way of the introduction of definite rules which will lead to a reasonably permanent nomenclature. What is most desired is that the period of trial and transition shall be as short as possible, and to assist in bringing this about the study of the genus Puccinia is herewith presented.

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* Bot. Centr., Vol. LXXVII. p. 5.

Forestry Conditions in Montgomery County, Indiana.

Samuel J. Record.

The recent interest in forests and forestry problems in Indiana makes it very important that every one collecting accurate information regarding the forestry conditions in any part of our commonwealth, present in as complete a manner as possible everything that may be of general importance in arousing public interest and at the same time serve as a basis for intelligent work in that particular part of the State.

The writer has studied with some degree of thoroughness the conditions in Montgomery County, which conditions, as revealed by the following facts, demonstrate the very serious nature of the problems we are confronting and the lines for future work.

Montgomery County is located in the middle western part of the State and contains 504 square miles, or 322,560 acres. Owing to its large size, its prominent location and the diversity of its surface and soil it may well be considered as a typical section of the central part of Indiana. Hence, what may be said of the forestry conditions and the plans and possibilities of its reforestation may in a general way be considered true of the whole central portion of the State.

The surface of the county is pleasantly diversified. The western and central part near the principal streams is hilly and broken, in the north central it is gently undulating and at the east and southeast flat and level. The northern part of the county is notably a prairie region, level or gently rolling.

The drainage takes direction from the dip of the underlying rocks generally a little west of southwest. The main stream is Rock River or Sugar Creek, which enters south of the northeast corner and traversing the central area, passes out six miles north of the west corner of the county. Its tributaries from the north are Black and Lye creeks; from the south, Offield, Walnut and Indian creeks. The southern and southeastern parts are drained by Big and Little Raccoon creeks and at the southwest by Coal Creek, which flows directly into the Wabash.

The early settlers found the county one vast forest, broken only by the wind swept streak of the cyclones or the marshy land of the prairies. So dense was the wilderness that their way had to be cut with the axe. Trees and saplings were cut and their trunks made into corduroy roads.

Everywhere were the most valuable varieties of forest growth, such as the oak, walnut, ash, poplar, cherry, maple, elm, hickory, beech, mulberry, buckeye, locust, willow, sycamore, cedar, and some hemlock, each towering and climbing and ever contesting for the necessary light of the sun. The lower branches were of little use in the shade and soon died away, thus by the natural pruning leaving the stem of the tree smooth and unbranched.

To appreciate something of the size of these giants of the forest we need but note the following:

Common Name.	*Diameter.*	*Height to First Limbs.*	*Total.*
Burr Oak	7	72	160
White Oak	6	60	150
Black Oak	6.5	75	165
Red Oak	7	94	181
Black Walnut	7	74	155
Poplar	8	91	190
Sugar Maple	5	62	120

All the ground was covered with underbrush and litter which had been accumulating for ages, producing a deep, rich loam which is still evident in the richness of the cultivated fields. Here were myriads of birds making their homes in the kindly shelter of the trees, and in turn destroying the multitude of insects which threatened the life of the forest. Thus when we closely examine the natural conditions we find the forest is a unit, a natural community in which each factor plays its part. An equilibrium is established, the result of the adaptation of each element to its environment; and when this equilibrium is disturbed the result is an undue development of one factor and consequent suppression of others. In this instance thoughtless man has destroyed the equilibrium, and the drying up of the wells and streams, the decrease in fertility of the fields and loss to our crops are a few of the disastrous results.

Now but little remains to remind us of the luxuriant forests of this county sixty years ago. Here and there are scattered patches of woodland standing like islands in a wide sea of clearing, and most of these so thinned and mutilated that they can scarcely be called forests at all. To the student of such affairs the destruction of this once mighty forest has all the features of a long continued tragedy. It is a crime against the past, present and future, a crime which may never be forgiven nor forgotten. Though undoubtedly required by the necessities of civilization and population, it has been carried too far, and future generations may have to curse the wanton waste of the past. Our fathers had a constant grudge against trees. The best were cut into rails or hewed into sills, or used for firewood. Regular logging bees were held and tree after tree was cut, rolled together and burned. There is not a farm in the county today but would, if left in timber, have been worth six times its present value. And worst of all, this same policy is being continued. Every year forest owners, either through carelessness or ignorance, are wasting valuable property. Concerning the market value of the various crops which the farm produces the farmer is usually posted, but concerning the market value of the various trees making up his timberland he is usually ignorant. The amount of timber that has been allowed to go to utter waste in the past history of the county, because of the failure to appreciate the true value of forests, would have been sufficient, had it been preserved and sold at current prices, to have paid for every acre of land in the county. Save for occasional groves, almost all the black walnut has been removed because of its great value, and yet on every farm in the county, rows of rail fences built of black walnut and poplar, puncheon floors, rafters of old barns and sheds attest to its reckless use in the past.

In this country where all the land is in the hands of private owners, nothing can be done save through the intelligent co-operation of land owners.

No land in the county has been reforested by artificial means. A number of farmers, however, maintain groves of catalpa and black locust which furnishes material for posts and poles. Numerous instances could be cited where a few acres of black locust furnish a constant supply of posts for the fencing of farms containing hundreds of acres each. Such groves are easy to propagate and furnish the best of posts, which can not be purchased on the market for less than thirty cents each line post. The catalpa groves have not proved so successful, owing in some instances to the planting of catalpa bignonoides which is of small growth, crooked and seldom forming a well-shaped tree. The valuable variety to plant is C. speciosa, which is a very rapid grower and furnishes wood valuable for posts, ties, telegraph poles and lumber.

Not only has there been no planting of forest tracts, but there has been a constant cutting off of the remaining timberland. The following figures from the statistician's report shows this condition:

1881	67,574 acres timberland.
1882	62,983 acres timberland.
1883	69,390 acres timberland.
1884	69,451 acres timberland.
1885	46,508 acres timberland.
1886	44,183 acres timberland.
1900	7,184 acres timberland.

The discrepancies in the early returns are due to inaccurate data; the later reports are more reliable. They are sufficient to show the vast decrease in our forest area. In fifteen years 39,324 acres of timber was removed at the rate of 2,621 acres per year. If this rate were kept up all the remaining timberland would be deforested in 2.7 years, but, of course, the decrease in the amount and value of the timber would tend to lessen the annual rate of removal.

The census report for 1900 states that the number of acres in timber but not in pasture land in Union Township is 2,240. Much of this, however, is in small lots or groves and has had most of its best timber removed. This 2,240 acres is but 3.1 per cent. of total area of the township and is divided into 103 tracts or lots, only thirty-seven of which contain twenty acres or more. Of this latter number only eighteen contain as much as forty acres, and only one of 100 acres.

Ripley Township is rugged and broken toward the south and has remaining a larger proportionate acreage of forest. There are twenty-six tracts of twenty or more acres reported, making a total of 1,273 acres, comprising 59 per cent. of the total area. Much of this land is covered with beech, which, however, is not a very profitable timber. The soil, especially toward the southern part, is generally poor clay, and if stocked with young trees would soon bring much more than can be realized from the same ground at present.

Brown Township is also much broken along the course of Sugar Creek. Only fifteen tracts of over twenty acres were reported, but most of these areas are large, giving a total of 950 acres or 2.7 per cent. Much of this timber is beech, though white oak is also abundant. The region near the mouth of Indian Creek, known as Pine Hills, is covered with pine and hemlock. Some of these trees are very large with straight, towering stems reaching to lofty heights. Hundreds of seedlings are growing everywhere and if left alone will perpetuate the excellent forest condition now prevailing. Farther down the stream are the "Shades of Death," an area of 200 acres in virgin forest, especially noted for its beautiful scenery. The sides and slopes of the sharp hills and promontories are covered with a thick growth of evergreen hemlocks and cedars and the tip-top heights with pines which lift their foliage 200 feet above the brook, averting the sun's rays and filling the deep chasm with a gloom typical of the "Valley of the Shades." Here one sees typical forest conditions, the forest litter holding the moisture and feeding gradually the many pure, cold springs. This land, if deforested, would be worth practically nothing, but under proper management a large return could be secured annually from the timber growing there. This area, however, has been recommended by the State Forester as a forest reserve with the purpose of increasing its efficiency as a park. Dr. Henry Moore, of Irvington, Indiana, was chosen president of the board of control. No other recommendations have been made.

Walnut Township reports fifty-eight forest tracts containing a total acreage of 4,493 acres of 20 per cent. whole area. These forest tracts are comparatively large, thirteen of them containing 100 acres or over.

Franklin Township reports eleven forest tracts, of twenty acres or over, making a total of 420 acres, or 2 per cent. The areas are small and most of the good timber has been removed. The boulder trail passes through the western portion of the township and the land in its vicinity would be worth much more if properly covered with timber than it is in its present condition; the large number of boulders making cultivation of crops very difficult.

Sugar Creek Township reports seven tracts or 302 acres, 1.4 per cent. of total area. Most of the region is black prairie land and the timber is mostly in groves which have grown since the settlement of the country. The prevailing species are shellbark hickory and white oak.

Madison is also a prairie region and its condition of soil and forest closely resembles Sugar Creek. Seven tracts are reported, giving a total of 458 acres, though the total acreage of the township, including smaller tracts, is reported as 501 acres or 21 per cent.

Coal Creek reports but two tracts of more than twenty acres, though the total acreage amounts to 201 acres or .6 per cent. of the total area of the township.

Clark Township returns indicate four forest tracts containing over twenty acres. Only one tract contains over forty acres. The total area is 135 acres or .6 per cent.

Wayne has but eleven forest tracts, making a total of 399 acres or 2 per cent. of the total area. The tracts are small, only one containing as much as sixty acres.

Scott Township reports no forest tract containing as much as twenty acres. The total area of the timberland in the township does not exceed ninety-five acres or .4 per cent.

From this glance at the townships it will appear that the amount of available timber is very limited and most of the forests now remaining are so small, open and scattered, that the benefit derived from them is but a small per cent. of that accruing from well regulated forest areas.

The General Assembly of the State of Indiana enacted, in 1899, a forest reservation law, whereby upon any tracts of land a portion, not exceeding one-eighth of the total area, could be selected as a permanent forest reservation which should be appraised for taxation at one dollar per acre. The land to be exempted must contain 170 trees per acre, either naturally or artificially propagated. The act makes further specifications as to the maintenance of the tract, and designates what trees shall be known as forest trees within the meaning of the act. The law was a step in the right direction and has resulted in 284 exemptions covering a total area of 5,312 acres in the State. In Montgomery County, however, not a single exemption has been filed. This condition in this county is largely due to the lack of information on the subject, and succeeding years will no doubt witness a large number of exemptions.

Deforestation of the headwaters has produced a marked effect in the size and value of the county's streams. In its early history Sugar Creek was navigable for good-sized boats and was much used as a means of transportation. In 1824 William Nicholson came from Maysville, Kentucky, to Crawfordsville in a keel boat of ten tons burden which landed at the mouth of Whitlock's Spring branch. It floated down the Ohio to the mouth of the Wabash and thence was rowed up to the mouth of Sugar Creek, finally, after a long voyage, reaching its destination. Afterward two men took the same boat down to Terre Haute for a load of corn. Other instances could be cited, but these are sufficient to show the extent of the navigability of the stream which at present would scarcely float an old time flatboat. Much of this is due to the filling in of the channel with the products of the denuded fields above.

Records show that Sugar Creek has furnished a motive power for at least nineteen mills situated along its course in Montgomery County. At the present time the number does not exceed four and these are obliged to use steam during most of the summer season. As is well known, a constant water supply furnishes a most economical and reliable motive power which would tend to lessen the cost of any manufactured products. The owner of the Sperry Mill, at Crawfordsville, asserts that the cost of running the mill one day by steam power, including coal, fireman and all expenses, is $5; while the total cost of water power for *one year*, including repairs to the dam and wheel, is $40. In other words, the amount required to run the mill one day by steam would pay the cost of running the same mill by water for nearly forty days.

The amount of power exerted by the stream in its course would, if utilized, be sufficient to turn every wheel in every factory within the county. This would be of especial importance in furnishing an economical motive power for concerns under municipal ownership, thereby greatly reducing the expense of operating. But while the volume of water carried by Sugar Creek in a year has probably remained constant since the county was discovered, yet the flow is so irregular and uncertain that it is no longer of great economical importance.

Deforestation has also had a very disastrous effect upon the fish supply of our streams. In the early settlement of the country Sugar Creek was full of edible fish. It is related by an old settler that during one night in 1824, 900 fish, consisting of pike, salmon, bass and perch, were caught in a large fish trap. The settler often carried them by skiff loads from the fish trap and placed them in a pond to be retaken later and sold or used for food. Now this condition has entirely changed and but few food fishes remain in our streams. It is true that stream pollution and illegal fishing are responsible for much of this, but the decrease in the volume of water, rendering it stagnant during the summer months is almost directly the result of deforestation of the headwaters. The unusually high water at the season of spawning seriously interferes with the reproduction of the species. This sudden rise of the stream is prevented by the forest. The litter receives the rain, and, owing to its looseness and lack of capillarity, prevents rapid evaporation. The relatively low temperature of the forest is also a factor in lessening the rate of evaporation. The unevenness of the forest floor, with sunken logs and piles of debris, prevents the formation of gullies and consequently the water sinks into the ground instead of running off on the surface. It can not wear away the soil upon steep slopes, nor form sudden and disastrous freshets as in a naked and treeless region. The streams rising in woodlands may swell after a rain, but more gradually, and they will subside again more slowly. If they rise in woodland swamps, they are scarcely liable to floods at any season and tend to an even flow throughout the year.

The soil of Montgomery County is generally very rich and the disastrous effect of the removal of the forest will not be evident for many years. The land is especially adapted for agricultural pursuits, and rational farming and rotation of crops is doing much to maintain its productiveness. Yet some tracts have been cleared which are of very little use for farming purposes, and fail to yield a profit for the labor exerted upon them. We have seen large areas of good timber cut down, much of it wasted and destroyed, merely to add to the farm land an area almost worthless for cultivation. Such land should be immediately reforested with the most profitable kinds of timber, since by this means the most profitable returns can be secured.

An examination of our corn crop yields since 1873 shows the following gains:

1873-1877	24 bushels per acre.
1878-1882	31 bushels per acre.
1883-1888	37 bushels per acre.
1889-1893	32 bushels per acre.
1894-1900	42 bushels per acre.

In considering these figures we must remember that much newly cleared land, rich from forest litter, has been added yearly and tends to increase the average yield per acre.

Our wheat crops have not fared so fortunately and the averages for five year periods since 1872 show the following decrease:

1872-1876	21.18 bushels per acre.
1877-1881	15.45 bushels per acre.
1882-1886	14.21 bushels per acre.
1887-1891	13.10 bushels per acre.
1892-1896	13.30 bushels per acre.
1897-1900	11.60 bushels per acre.

The exact cause of this decrease is not known, but to the student of forestry conditions, it seems that deforestation is, in part at least, responsible.

By far the most susceptible of our crops to the changed condition is the apple. Though our statistics on this subject are very limited, yet the memory of every person of mature years will testify to the great decrease in our apple crop. The raising of perfect apples in this county is very difficult and yields such poor financial returns that the growers have almost entirely abandoned the pursuit. However, the decline in yield is by no means proportional to the decline in the number of trees. The following figures are taken from the statistician's reports for Indiana and express approximately this condition:

1879	42,007 bushels apples.
1880	37,781 bushels apples.
1881	20,476 bushels apples.
1885	14,544 bushels apples.
1886	98,933 bushels apples.
1897	3,084 bushels apples.

The yield has so decreased that at the present time we are compelled to import almost all of our apples. The immoderate ravages of hordes of insect pests is mainly responsible for this condition, though the apple rust is also very injurious. The disastrous effect of the latter, however, is probably no greater now than at previous times and will not account for the remarkable decrease in our apple crop.

Besides a decrease in our soil productiveness, the county has also lost many valuable wood industries. Until recently there was located at Crawfordsville a heading and stave factory which used large quantities of timber and furnished employment to many men. The scarcity of available timber made further operation unprofitable and the concern was moved to Arkansas. At one time the county was liberally dotted with sawmills, but now scarce a half dozen remain, and these are compelled to import a large proportion of their logs, in some cases nearly one-half.

Crawfordsville at present has but two important wood industries. The Indiana Match Company uses large quantities of cottonwood and basswood and the supply of this county was soon exhausted. For some time past the company has purchased these woods in different districts, chiefly in lower Illinois, but the new Chicago drainage canal has flooded so much of the timber country that the wood can not be gotten out. The company is in a difficult position and the scarcity of any material may cause it to close down or to be removed. The Casket Company uses annually $38,000 worth of material, turning out a finished product worth $58,500. The factory furnishes employment to forty persons, paying annually in wages, $18,000. Most of the material is shipped here. There are prospects of another industry for the manufacture of wooden novelties for which there is claimed an excellent market. In order to have the desired capacity, about thirty men would be employed at first and if the venture proved successful the capacity and working force of the plant would be doubled. The principal woods used are the maple and beech, and the county still has a good supply of the latter.

Such industries contribute largely to prosperity of the county and whatever would tend to foster them in a proper way is promoting the general welfare. The reforestation of a sufficient area would make good timber available and not only prevent the removal of our present industries but invite new ones as well.

Notes on the Cleavage Plane in Stems and Falling Leaves.

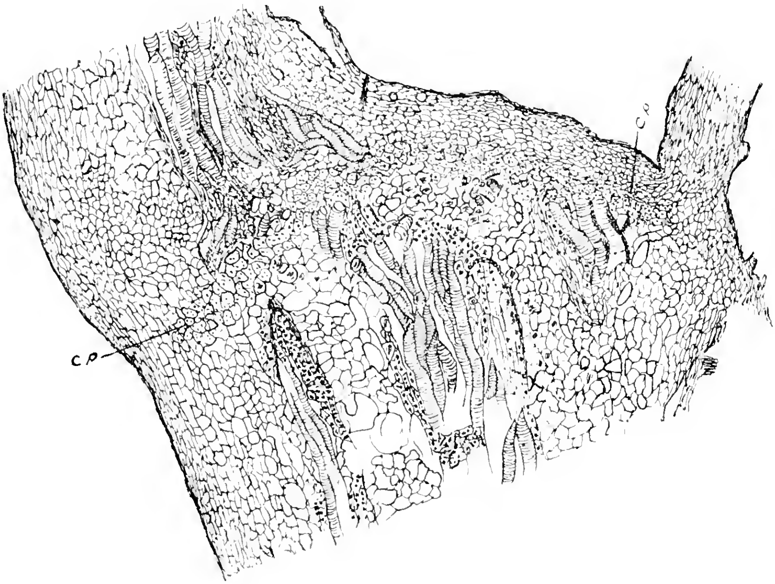
Mary A. Hickman.

Adaptation to climate and environment is nowhere better illustrated than in the forest. Especially is this true of the temperate regions where adaptation is in response to the winter cold. The deciduous trees, instead of protecting their delicate leaf structures from the severe cold of winter, have formed the habit of dropping them and again putting out new leaves when the warm season returns. The deciduous trees have developed the working powers of their leaves to such an extent that the great surface exposure and delicacy of structure make it impossible to carry them through the winter, therefore, the necessity of the deciduous habit.

However, this habit of shedding is not confined to the leaves only, for many trees annually shed twigs and branches. The dropping of twigs and branches is probably to prevent too great a density of foliage. This last habit is not restricted wholly to the deciduous trees, for some of the conifers have the same trait.

This dropping is due, not to breaking, but to growing off by the formation of a cleavage plane between both the twig, petiole and the parent stem. Thus the reason for the scars left by the shedding.

In the shedding of stems, the cleavage plane is gradually developed across the fibro-vascular system separating the stem from the parent stem with the exception of the bark and a few layers of wood cells which are easily broken. The scar is virtually formed before the falling of the stem. Marked illustrations of this habit from the deciduous trees are



found in the family Salicaceae L. The branches and twigs begin to fall before the shedding of the leaves and continue throughout the period of leaf fall. The twigs shed are green, many bearing large winter buds upon their tips. Of the conifers, the *Tsuga Canadensis* Carr., illustrates this habit very markedly. However, their twigs, when shed, are dead.*

In the shedding of leaves, we find the formation of the cleavage plane the same as in the stem. The most common method is that of a separation between the petiole and stem, as shown by the scars on the stems.

* The Self-pruning of Woody Plants.—John H. Schaffner, Ohio Nat. I., 1902, pp. 171-147

This fall the attention of the writer was called to a peculiar case of variation found in the vine *Ampelopsis veitchii* L., native of Japan, but which has been introduced into America for ornamental purposes. It clings to the walls by its very numerous disk-tipped tendrils. The leaves on the younger branches of the vine are small and entire with dentate margins, but those on the older branches are sharply three-lobed or sometimes three divided.

In this plant we find a second cleavage plane formed between the petiole and leaf blade so that instead of the leaves falling in the usual way the blade is shed and the petiole remains attached to the stem until late in the winter.

Due to the difference in density of structure in the stem and petiole, it is difficult to secure satisfactory results in the formation and structure of the cleavage plane of that region. But when, as in this plant, there is a second cleavage plane formed between the petiole and blade, it is comparatively easy to trace. There is a breaking down and spreading of the tracheary tissue and the formation of a layer of small cells, causing a complete disconnection between the tracheary tissue of the leaf and petiole, as is demonstrated by the illustration.

Some Rare Indiana Birds.

Amos W. Butler.

The following notes are supplemental to those presented at the meeting of the Academy in 1899, which were printed in the proceedings for that year:

PHALACROCORAX DILOPHUS FLORIDANUS (Aud.).

Florida Cormorant.—A bird of this species was killed September 28, 1902, at Morris Street bridge over White River, in the city of Indianapolis. It was obtained by Fletcher M. Noe.

PELECANUS ERYTHRORHYNCHOS Gmel.

White Pelican.—Two were killed on White River April 25, 1902, by Harry Sappenfield. The locality is given as between the farms of Frank C. Lory and A. H. Taylor, in Knox County. It is reported the birds will be mounted. (E. J. Chansler.)

Fletcher M. Noe informs me he saw a specimen which was killed October 12, 1902, near Martinsville, but was unable to obtain it.

C. K. Muchmore wrote me that a flock of thirty-seven White Pelicans "stopped over" at the pond of the Cincinnati Ice Company, two miles south of Laurel, September 29, 1902. Two of them were killed by a boy, Earl Masters, who brought them to my informant. The next morning he received a third specimen from Earl Bossert, of Brookville.

From another source I learn that the bird last mentioned was one of two, possibly from the same flock previously noted near Laurel.

TANTALUS LOCULATOR (Linn.).

Wood Ibis.—Though the Wood Ibises were formerly found irregularly in some numbers in southern Indiana, and doubtless were summer residents and bred, they have not been reported for several years. These peculiar birds, sometimes called "gourd heads" from their odd, naked heads and long heavy bills, were formerly found in the lower part of the White Water and Wabash valleys. To the latter they occasionally recur. With the increasing warfare upon our larger birds especially and the rapidly diminishing area of suitable range, they lessened in numbers for years, and more recently none have been observed by any one who noted them. Through the most of August and September last they were found in considerable numbers in suitable places in the lower Wabash Valley. The earliest date reported was August 10, near Montezuma, Indiana, when a single specimen was seen. The latest occurrence was from the same vicinity September 28.

The following data from Mr. D. W. Overman, of Montezuma, is interesting:

"On August 10 I saw a single specimen in a dead elm at the Goose Pond about two miles north of this place, in the Wabash bottoms. On 12th saw ten or twelve more. The 17th an old fisherman brought me a specimen, and another the 18th. From the 14th they were of daily occurrence and were seen passing north along the Wabash in flocks varying in number from four to 150 or 200. The one whose head I sent you was taken the 18th, by Mr. Chas. Doss, from a flock of twenty-five or thirty, and was 'using' along the Wabash just south of town. The specimen brought me by Mr. Tombs, of Arcadia, was taken the 18th near the town.

"I killed one August 24 at Goose Pond from a flock of thirty-five or forty. They were last reported as being seen September 28."

So we have it summed up: First seen August 10, became common about 14th, last seen September 28, stragglers from the 20th to 28th.

Wood Ibises were also reported as numerous along the Wabash River in Posey County. Paul J. Hartman, New Harmony, has very kindly reported to me such information as he has been able to collect in that county. He says: "In regard to the Wood Ibis, I will say that I have seen it. On August 12 about sundown, I saw ten. I was positive of their identity. They came down the river flying rather low, and alighting in a large willow thicket, went to roost. The next evening I saw another at the same place, but it flew on down the river. On the 15th I saw twenty. They went down the river. On the 16th, at the same place, I saw more than I could count, certainly more than a hundred. I saw all at the same point of observation, and at the same time of day, about sunset. With the exception of the first ones, they did not stop.

I find the Wood Ibises were quite common at Hodge's Landing, about six miles below New Harmony, during the middle of August. They were very tame and a number were killed. The skins were not preserved.

FLORIDA CÆRULEA Linn.

Little Blue Heron.—A specimen of this southern species which as been known to breed in suitable restricted localities in southwestern Indiana, has been received by the State Museum. It is an immature bird in the white plumage, and was killed by John Michaels near Bainbridge, Putnam County, Indiana, August 10, 1902. A few other white herons have been reported from different localities, including Posey, Knox and Kosciusko counties. Possibly some of these were of this species, but the chances are they were American Egrets, *Herodias egretta* (Gmel.) or perhaps some of them Snowy Herons, *Egretta candidissima* (Gmel.).

PHALAROPUS LOBATUS (Linn.).

Northern Phalarope.—A specimen of this rare bird was taken at Millers, Indiana, September 1, 1900, by R. S. Turtle, according to information recently received from Mr. Frank M. Woodruff, of the Chicago Academy of Sciences. This is the fourth specimen reported as taken in the State.

The gathering of peculiarly maritime species of birds along our great lakes each fall is a very interesting fact. They begin to appear about the commencement of the second quarter of August, are most numerous between the middle of that month and mid-September, and generally are scarce after October 1. Some, however, occasionally linger until cold weather. Reference has elsewhere been made to this but attention is called to it again because of information received of the occurrence of some rare species since the last report.

NUMENIUS HUDSONICUS Lath.

Hudsonian Curlew.—Mr. F. M. Woodruff states a fine Hudsonian Curlew was taken at Calumet Heights, Indiana, August 3, 1902, by R. S. Turtle. It is a very rare migrant in Indiana.

TRINGA CANUTUS Linn.

Knot.—Mr. F. M. Woodruff reports the capture of a specimen of this world-wide sea-side wanderer near Millers, Indiana, in 1901. He has kindly placed in my collection a specimen taken at the same place to verify the Indiana record.

ARENARIA INTERPRES (Linn.).

Turnstone.—Mr. Woodruff also obtained one of these birds near the same place August 9, 1902. This is early for these seashore species. They are said to be in exceptionally rich plumage.

MICROPALAMA HIMANTOPUS (Bp.).

Stilt Sandpiper.—A specimen of this rare Sandpiper was taken at Mill Pond, near Greencastle, April 19, 1899, by Alexander Black. This is the second record of which I know for Indiana. Mr. Black has kindly deposited the specimen in my collection to verify the record.

ECTOPISTES MIGRATORIUS (Linn.).

Passenger Pigeon.—The only record of the Wild Pigeon I have been able to obtain since that of June 10, 1899, was received last spring through the kindness of Mr. Fletcher M. Noe of this city. From him I learned that Mr. Chas. K. Muchmore, of Laurel, Indiana, had obtained a specimen of this very interesting bird which was taken near that place last spring, April 3, 1902. Of this Mr. Muchmore says:

"The bird, which is a beautiful male, was taken by a young man named Crowell, near his home, about two and one-half miles southwest of this place. He reported that there were two. He heard the bird cooing and shot it and brought it to me, having concluded that it was something new. You can imagine how we almost took it away from him when he unrolled it out of a bloody old newspaper and began to inquire if we knew what it was. I was convinced that I saw a flock of five Passenger Pigeons one day in the spring of 1901, but had never said much about it as I only saw them flying and at a distance and it seemed rather improbable. I used to see them occasionally in Iowa about 1882-3, and although I was then very small, the specimen was not new to me, and I, of course, at once recognized the same."

Mr. Muchmore in a recent letter says he heard of a small flock near Laurel last fall (1902).

The Catalpa Sphinx (Ceratomia Catalpæ) Destroyed by the Yellow-Billed Cuckoo (Coccyzus Americanus) in Southern Indiana.

F. M. Webster.

This paper was suggested by the receipt of a letter from Mr. A. W. Butler, calling attention to a statement made by Mr. John B. Elliott, a very observing farmer of New Harmony, Indiana, who stated that the catalpa trees in his neighborhood had, until recently, been defoliated by a large worm, but, recently, this worm had nearly disappeared, having been eaten by the Cuckoo or Rain Crow, as they are termed in the South.

There did not appear to be any doubt about the food habit of the bird, though there is but one other similar observation on record, the only question being as to the identity of the worms. Now, the catalpa, like the ailanthus, and the China tree of the Gulf States, has very few enemies, and there is no chance of mistaking the larvæ of the catalpa sphinx for any other insect. On the other hand, there is no data whatever in possession of the division of Biological Survey of the United States Department of Agriculture, showing that this bird ever attacks the catalpa sphinx, though the stomachs of ninety birds have been examined. Several other species of Sphingidæ do not fare so well. Two, *Deilephila lineata* and *Phlegethontius sexta*, are frequently taken by these birds. There hardly seems a doubt about the correctness of Mr. Elliott's observations, and I give these facts in order to show their value. The catalpa is planted as far north as extreme northern Indiana and Illinois, but the catalpa sphinx does not occur north of about the latitude of Vincennes, in this State, Flora, in Illinois and extreme southern Lawrence County, in Ohio. On the Atlantic Coast it is steadily working its way northward, being now seriously abundant about Philadelphia, which is in the latitude of Columbus, Ohio, and almost that of Urbana, Illinois. It was abundant at Flora, Illinois, as far back as 1875, but seems to have progressed no farther northward. The insect has this peculiarity: The female will deposit to the number of 1,000 eggs in a mass on a single leaf and the young are for a considerable time after hatching thoroughly gregarious, so that while a single tree or a row of trees may be defoliated by the larvæ, other trees in the neighborhood may entirely escape. This gives the enemies of the larvæ an opportunity to literally exterminate a colony in short order. Mr. W. H. Edwards, a lepidopterist of Coalburgh, West Virginia, some years ago, recorded the sudden appearance of this insect in his locality for the first in 1896, and the as sudden disappearance the following year.

The catalpa sphinx is like its food plant, a southern species; the Sphingidæ are a tropical family for that matter, and it is interesting to note that Judge Lawrence Johnson observed the attacks of the Cuckoos, both species, on these larvæ in 1883, in Alabama. The Cat Bird and the Baltimore Oriole are both known to feed upon them.

Besides the birds there are several insect enemies of the catalpa sphinx, two being species of Tachinid flies, *Euphorocera claripennis* and *Frontina frenchii*. A Hymenopter, *Apanteles congregatus* also destroys a large number of the larvæ. As I found many of these caterpillars on catalpa trees about Princeton, Indiana, late in August, 1902, with numerous eggs of the Tachinid flies attached to their bodies, there is no doubt but what they are doing their full share in keeping the insect in check.

I might say, in addition to the foregoing, that this Cuckoo is exceedingly fond of another caterpillar, *Datana angusii*, which so frequently defoliates the walnut and hickory trees in midsummer. Here, too, we have the work of the Tachinid flies previously mentioned, and while at Purdue University, several years ago, I observed a case of excessive parasitism on the larvæ of a closely allied species, *Datana contracta*. On four of the caterpillars of the latter species I counted respectively, 115, 131, 213 and 228 eggs of these parasites. I mention this, seemingly disconnected circumstances, because the same species of Cuckoo is fond of all these caterpillars, and we are met with that perpetual puzzle to economic entomologists, viz., to determine the exact economic value of an organism. If the bird ate only the unparasitized caterpillars, it would be wholly beneficial, but, on the other hand, if it devours parasitized caterpillars, it has done no good, because these would have died in any case, and has done actual harm, because it has destroyed beneficial insects.

Notes on Reared Hymenoptera from Indiana.

F. M. Webster.

The material upon which this list is based was obtained during two trips to southern Indiana, the first late in August and the last late in October, 1902, while in the employ of the United States Department of Agriculture, and making some special investigations of certain insects attacking growing wheat. My first intention was to present a paper that would include only such species as were new to science, but I have in addition to such, found so many forms that are new to the State, and others discovered by me about Lafayette, years ago, but of whose habits nothing was known, have been farther investigated, throwing new light on their life history and habits, that I later decided to include all of the Hymenoptera reared by me, but not previously reported as inhabiting Indiana. I may add that the nature of my investigations required that considerable quantities of wheat stubble, and the stems of *Elymus canadensis* and *E. virginicus*, *Tricuspis sesleroides* and *Bromus secalinus*, the latter being the common cheat of the wheatfields, be collected and the *Isosoma* and other insects inhabiting these stems secured. The stems of these grasses and the wheat stubble were collected and placed in pasteboard boxes so that everything developing within them was thus secured. It will be observed, then, that the prime object of my rearings was to determine the food plants of the *Isosoma*, the parasitic species, though of much importance, were of secondary signification in these studies.

Isosoma grande, which I reared about Lafayette, during the years 1884 to 1886, and established the fact of a dimorphism and alternation of generations before unknown among these insects in this country, was represented in my rearings from wheat stubble, collected from about New Harmony and Princeton, by the spring form *minutum*.

Isosoma tritici Fitch was also reared from wheat straw from these localities. Specimens of the latter occurring among the former are quite strongly contrasted, the latter being quite large for these insects and possessing fully developed wings, whereas the former are much smaller and wingless. Reared also from *Elymus virginicus*, an entirely new food plant for the species.

Isosoma maculatum Howard was reared in considerable numbers from the stems of cheat, *Bromus secalinus*. The species was described from individuals collected by me about Lafayette during June, 1885, and May, 1886, but the food plant has up to this time remained unknown.

Isosoma albomaculatus Ashmead, originally described from West Virginia, was reared from *Bromus secalinus* in great numbers, also to a lesser extent from the stems of *Elymus virginicus*.

Isosoma elymi French was reared in profusion from *Elymus*. This species, at one time supposed to be a wheat insect, confines itself strictly to the grasses. I have never reared it from wheat straws and have never reared *Isosoma grande* from anything else except wheat.

Isosoma (flavipes) hordei Harris was reared from stems of *Elymus canadensis* and in such numbers as to give economic importance to the fact. The rearing of the Joint Worm species, *I. hordei*, and one of the wheat straw worm species, *I. tritici*, from *Elymus*, both of which are wheat insects, shows very plainly that though the farmer may overcome these in his cultivated fields, unless he is careful to destroy these grasses growing along roadsides and in uncultivated fields, a continual reinfestation will be going on, and he must fight his foes in the grasses as well as in his cultivated grains. Besides these, there is a species of Isosoma, of which I have only been able to rear the male, but the larvae of which infest the stems of *Tricuspis sesleroides*, and I have reared these from stems collected near Orleans, Indiana. There is probably still another species of *Isosoma*, at present not distinguishable from *I. hirtifrons* Howard. This last had until now been known only from rye straw in California. I did not rear this from Indiana, but in Illinois the common cheat, *Bromus secalinus*, appears to be its sole food plant. The larvae are found in the stems, and as the stems of cheat in Indiana contain an abundance of larvæ it is not unlikely that those of this species are among them. It is not unlikely to be found infesting rye also.

Torymus sp? This is parasitic on the Isosoma larvæ infesting the stems of *Tricuspis*.

Another species of parasitic Hymenoptera has been determined as a new species of a new genus of the family *Encyrtidæ*.

Eurytoma nov. sp. This was reared from the stems of *Elymus canadensis*, the adults emerging in late August.

Parapteromalus isosomatis Ashmead, nov. gen. et. sp. This is parasitic on a cell inhabiting *Isosoma*, affecting *Elymus*. The adults appear in late summer and at once proceed to oviposit in the occupied cells of the Isosomas. That is to say, they have developed in the bodies of their hosts while the latter have been in the process of development and, now, oviposit in the fully grown larvæ, there being thus two broods of the parasite to one of the host.

Coccidencyrtus flavus Ashmead, nov. sp. This is doubtless connected in some manner with a coccid that inhabits the stems of *Elymus*.

Oligosita americana Ashmead, nov. sp. This is an egg parasite and belongs to a genus not before reported from America. A single species is known from Europe and three from the island of Ceylon.

Elasmus websteri Ashmead, nov. sp. Reared from either the stems of Elymus or from the stubble of wheat, in either case it is probably in some way connected with some species of Isosoma.

Xanthocncyrtus nigroclavus Ashmead, nov. gen. et. sp. Reared from stems of *Elymus*, but not probably in connection with the Isosomas.

The following were reared in considerable numbers from leaves and stems of grasses about Champaign and Urbana, Illinois, within which the host insects were feeding, and doubtless are to be found in Indiana also.

Polyneura citripes Ashmead, nov. sp. Reared from stems of *Eragrostis poaoides*, an egg parasite whose exact host is unknown.

Pedobius websteri Ashmead, nov. sp. Parasitic on a dipterous leaf miner affecting *Panicum proliform* by mining in the tips of the leaves. As I have found the same leaf attack in various localities in Indiana, presumably done by the same dipterous insect, it is not at all unlikely that the parasite is also found in Indiana, as I have reared them in great numbers from about Urbana, Illinois. Only one other species of this genus is known, and it is also a dipterous parasite.

Preliminary List of Gall-Producing Insects Common to Indiana.

Mel T. Cook.

For the past two years the writer has been very much interested in gall-producing insects and in the structures produced by them. Among other very interesting phases of this problem is the question of distribution. We know very little of the distribution throughout the country and nothing of the distribution in Indiana.

My collection of galls includes over 200 species, collected in the states of Illinois, Indiana and Ohio. Those collected in Indiana are all from Putnam County and about seventy species are included. Of this number, I have accurately determined forty species. These forty species represent five orders (including Acarina) and eighteen genera. The host plants represent ten orders, twelve families and fourteen genera.

The order and families of the host plants are the following:

Orders.	*Families.*
Salicales,	Salicaceae.
Juglandales,	Juglandaceae.
Fagales,	Fagaceae.
Urticales,	Ulmaceae.
Rosales,	Hamamelidaceae. Rosaceae. Caesalpinaceae.
Sapindales,	Aceraceae.
Rhamnales,	Vitaceae.
Malvales,	Tiliaceae.
Gentianales,	Oleaceae.
Campanulales,	Compositeae.

The following is a list of the insects and host plants known positively to occur in Indiana:

HEMIPTERA.

1. Hormaphis hamamelis, Fitch—Hamamelis Virginiana L.
2. Colopha ulmicola, Fitch—Ulmus Americana L.
3. Pemphigus ulmi-fusus, Walsh—Ulmus Americana L.
4. Schizoneura Americana, Riley—Ulmus Americana L.

5. Phylloxera caryae-avenae, Fitch—Hicoria alba (L) Britton.
6. Phylloxera caryae-globuli, Walsh—Hicoria alba (L) Britton.
7. Phylloxera caryae-fallax, Riley—Hicoria alba (L) Britton.
8. Phylloxera caryae-caulis, Fitch—Hicoria alba (L) Britton.
9. Phylloxera caryae-depressa, Shimer—Hicoria alba (L) Britton.
10. Phylloxera vastatrix, Planchon—{ (Vitis vulpina L. / (Vitis bicolor LeConte.
11. Pachypsylla celtidis-mammae, Riley—Celtis occidentalis L.

LEPIDOPTERA.

12. Trypeta solidaginis, Fitch—Solidago Canadensis L.
13. Gelechia gallae-solidaginis—Solidago Canadensis L.

DIPTERA.

14. Cecidomyia verrucicola, O. S.—Tilia Americana L.
15. Cecidomyia pilulae, Walsh—Quercus sp. (many species).
16. Cecidomyia salicis-strobiloides, Walsh—Salix sp——.
17. Cecidomyia salicis-semen, Walsh—Salix sp——.
18. Cecidomyia salicis-siliqua, Walsh—Salix sp——.
19. Cecidomyia salicis-aenigma, Walsh—Salix sp——.
20. Cecidomyia gleditschae, O. S.—Gleditsia triacanthos L.
21. Cecidomyia solidaginis, Loew—Solidago Canadensis L.
22. Cecidomyia pellex, O. S.—Fraxinus Americana L.

HYMENOPTERA.

23. Andricus seminator, Harris—Quercus alba L.
24. Andricus petiolicola, Bassett—Quercus sp——.
25. Andricus palustris, O. S.—Quercus palustris Du Roi.
26. Andricus clavula, O. S.—Quercus alba L.
27. Andricus papillatus, O. S.—Quercus sp——.
28. Amphibolips inanis, O. S.—Quercus rubra L.
29. Amphibolips confluentus, Harris—Quercus sp——.
30. Callirhytis tumifica, O. S.—Quercus alba L.
31. Holcaspis centricola, O. S.—Quercus palustris Du Roi.
32. Holcaspis globulus, Fitch—Quercus alba L.
33. Biorhiza forticornis, Walsh—Quercus alba L.
34. Acraspis erinaceae, Walsh—Quercus alba L.
35. Rhodites bicolor, Harris—Rosa sp——.

ACARINA.

36. Phytoptus abnormis, Garman—Tilia Americana L.
37. Phytoptus acericola, Garman—Acer saccharinum L.
38. Phytoptus quadripes, Shimer—Acer saccharinum L.
39. Phytoptus ulmi, Garman—Ulmus Americana L.
40. Erineum anomalum—Juglans nigra L.

From the above lists it will be seen that we have representatives from every order of insects which produce galls, except Coleoptera.

Doubtless the number of gall-producing insects in Indiana will far exceed 300 species. I should be very glad if members of the Academy will send specimens to me. Specimens may be sent either fresh or dry or in formalin. Always send enough of the host plant to enable determination.

Notes on Deformed Embryos.

Mel T. Cook.

It is well known that extremes of temperature will produce malformed embryos, but it is also probable that malformations may result from other causes.

Last spring the students in my class in embryology found a very large number of deformed chick embryos. The most common malformation was two or more blastoderms, but in many cases the embryos did not

develop beyond the formation of the primitive streak. The farthest developed and most remarkable deformity was in the case of two embryos so placed that anterior ends were joined and the posterior ends extending in opposite directions. Judging from the mesoblastic somites, the embryos were about forty-eight hours of incubation, there being eleven well-defined somites in one and sixteen in the other. The neural canal was partially closed, but only one brain vesicle in each case was developed. Between the two anterior ends was a mass of much distorted structures and apparently including several gill arches.

The eggs were secured from reliable parties, and I have every reason to consider them fresh and that they had been properly cared for. My assistant assures me that the temperature of the incubator was regular and that all conditions were normal.

The slide from which the drawing was made was prepared by Mr. Charles Sudranski.

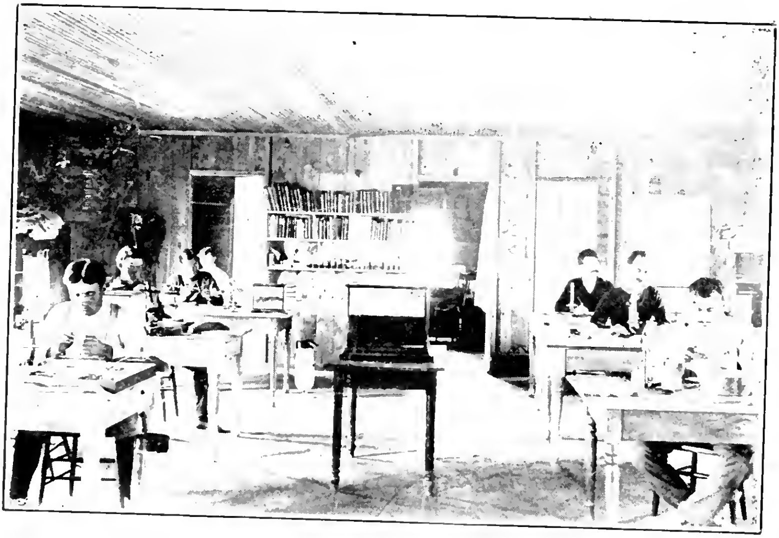
The Lake Laboratory at Sandusky, Ohio.

Mel T. Cook.

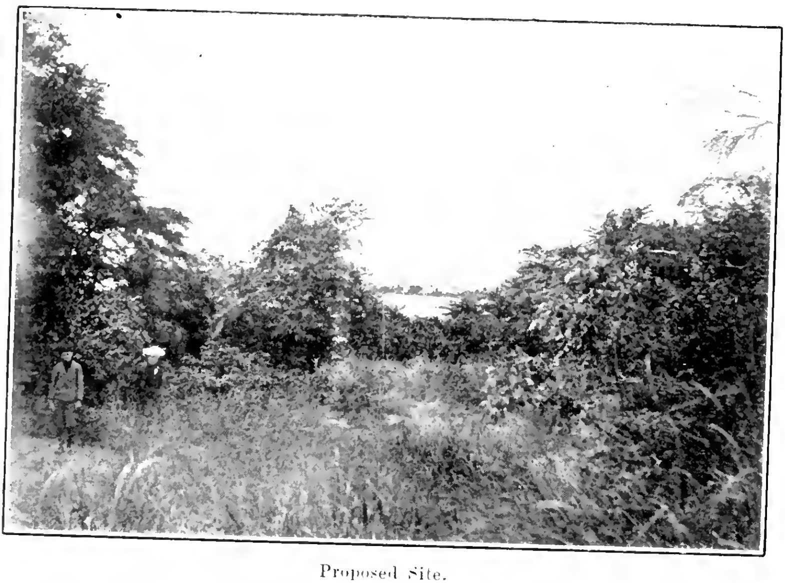
The past few years has witnessed a wonderful increase in facilities for biological work. Among the most noticeable features has been the establishment of summer laboratories especially adapted for biological research until we now have six marine and a larger number of inland laboratories. Since the character of biological work is so dependent upon the locality, and since each locality presents certain problems peculiar to itself, each of these laboratories has certain advantages over its friendly rivals and the itinerant biologist has the opportunity of reaping the benefits from all. He meets his fellow-worker and studies the varied fauna and flora under the most favorable conditions.

Among the earliest of these laboratories was the Lake Laboratory at Sandusky, Ohio, which was first opened in 1895, under the direction of Professor Kellicott, of the Ohio State University. In 1898 Professor Kellicott died and the laboratory came under the direction of his successor, Prof. Herbert Osborn, the present director.

The laboratory was at first intended for investigation only, and for the first four seasons was used by only three or four workers. In 1899 there were fourteen investigators and it was then decided to offer regular courses; this was done in 1900 and each succeeding year. For the past three seasons the increase in interest has been very pronounced. In 1902 there were twenty-four students and six instructors; of the twenty-four



Upper Floor, Lake Laboratory.



Proposed Site.

students, sixteen were graduates and eight of these were engaged in investigations.

The laboratory is under the control of the Ohio State University and under the direct management of the President of the University and of the director. The equipment consists of three boats and the necessary dredges for working on the aquatic fauna and flora. The microscopes, microtomes, other apparatus and library are supplied from the Ohio State University laboratories.

Thus far the work has been conducted in the building of the Ohio

Cedar Point Beach, Looking West.

State Fish Commission, but appropriations have been made for the erection of a new building especially for this work. It is expected that this building will be ready for use in 1903. This will give more and better facilities to meet the increasing demands. Ample arrangements will be made for the general courses, both for students and for teachers in the secondary schools. Special efforts will be made to accommodate advanced students in graduate courses and to provide opportunities for independent research by investigators in the many fields of biology.

While the control of the laboratory will probably remain with the Ohio State University, other institutions will be invited to coöperate and every effort will be made to make the laboratory of special service to the biologist of the inland states.

The location is accessible from all parts of the Central West. The climate is healthful and conducive to summer work.

The flora is one of the richest in the country. According to Mosely's "Sandusky Flora" it contains 300 more species than have been reported from any other locality of like dimensions in the State of Ohio. The flora is also more extensive than that reported from other parts of North America. Most plants native to Ohio, with the exception of those characteristic of the Ohio River counties and Sphagnum swamps, are found within the range of the Sandusky Flora. It also includes 165 species not reported in the Canadian catalogue and sixty-seven species not known in Michigan, and many species characteristic of western and southern regions.

This wonderful flora is due largely to the climate and geology, the lake protecting the south shore from the cold winds of the north and thus allowing many southern plants to extend their northern limits.

The lake, the bays, the marshes, the rivers, the deep ravines, the rocky shore line, the mud and sand beaches, the sand dunes, the various kinds of soil, the prairie, and the woods, all tend to give desirable conditions for this very rich and striking flora.

All of the above conditions, together with the varied food supply furnished by the rich flora, give an equally varied and remarkable fauna.

REPORTS FROM THE INDIANA UNIVERSITY BIOLOGICAL STATION AT WINONA LAKE.*

a. The Individuality of the Maternal and Paternal Chromosomes in the Hybrid Between Fundulus Heteroclitus and Menidia Notata.

W. J. Moenkhaus.

[Abstract.]

In the hybrid between *Fundulus heteroclitus* and *Menidia notata* it is possible to distinguish the chromosomes that come from each parent. The chromosomes of *Fundulus heteroclitus* are long and straight while those of *Menidia notata* are short and slightly curved. This difference they maintain in the hybrids. They can best be distinguished during the anaphases. They can not be distinguished in the resting stage. During the first two cleavages each kind of chromosome remains grouped bilatterally upon the spindle. After the second cleavage they become mingled upon the spindle, but the two kinds still retain their individuality and can readily be identified They have been thus traced to a late cleavage stage, as far as was attempted.

b. An Extra Pair of Appendages Modified for Copulatory Purposes in Cambarus Viridis.

W. J. Moenkhaus.

Among the crayfishes used for dissection in the laboratory we came upon a specimen that had three pairs of abdominal appendages modified for copulatory purposes. This is the first time I have ever seen such abnormality and, furthermore, have not been able to find mention in literature of a similar occurrence. I have, therefore, thought it worth while to make a note of it.

The specimen belonged to the species viridis and was about three inches in length. Unfortunately the specimen had been so much mu-

*Contributions from the Zoölogical Laboratory of Indiana University under the direction of C. H. Eigenmann. No. 53.

tilated in the dissection by the time the abnormality was noticed that it was out of the question to get a photograph of all the appendages in position. I, therefore, preserved the appendages and give herewith a drawing of the posterior view of both.

The first and second pairs of appendages were modified in the usual way and in no way differed from the corresponding appendages in the normal males of the same species. The additionally modified third pair

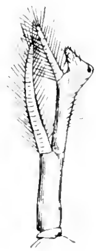


Fig. 1.

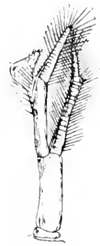


Fig. 2.

resemble in plan almost exactly the second pair. The exopod and the segmented flabellum of the endopod are much less reduced and much more extensively provided with feathered setæ than the second pair. They are of about the same size and in position converge and fit against the second pair of appendages much in the same manner that these do against the first. Whether they were in any way functional I am, of course, unable to say.

c. Description of a New Species of Darter from Tippecanoe Lake.

W. J. Moenkhaus.

During the summer of 1896, while collecting large quantities of Percina caprodes in Tippecanoe Lake, a single large specimen of darter was taken which could not be identified with any described species. I thought then and since, until recently, that it might be a hybrid between Percina caprodes and Hadropterus aspro because of evident intermediate characters. After holding the specimen for six years with the hope that other specimens might be taken, I last year published a note in the Proceedings of the Indiana Academy* under the title "An Aberrant Etheostoma" in

*For 1902, pp. 115-116.

which I briefly described the specimen and compared it with Percina caprodes and Hadropterus aspro. Last summer the sandbars on the south side of the east end of the lake were again extensively seined and among some 500 or 600 Percina caprodes two small specimens—probably that summer's brood—were taken which, beyond a doubt, are similar to the specimen which had been taken six years previously in a part of the lake three or four miles distant. Among a peck of darters from a part of Tippecanoe Lake that the labels do not indicate, collected in 1898 by some students of the Indiana University Biological Station, I found three similar specimens, making in all six specimens of this type from different parts of the lake. There can no longer be any doubt that we have to do with a distinct species and, so far as I can determine, the species is undescribed. This new species is among the most beautiful and largest of the darters. It gives me the greatest pleasure to name the species for Dr. Barton Warren Evermann, icthyologist, of the U. S. Fish Commission.

HADROPTERUS EVERMANNI Moenkhaus.

(New Species.)

Head 4; depth 6.16; D. XVI, 14; A. II, 11; scales 8—79—9.

The form of the body is much like that of *H. aspro*, rather elongate, fusiform, somewhat compressed posteriorly, but less pointed anteriorly. Mouth moderately large, maxillary reaching to the pupil; the cleft of mouth almost horizontal, lower jaw included; eye large, about equaling snout; interorbital rather broad, flat; gill membranes free from isthmus and separate; opercular spine and flap well developed; preopercle entire.

All scales ctenoid; nape with fewer, smaller, embedded scales; median ventral line in one specimen provided with a row of closely set, slightly enlarged scales, a second specimen has three or four such scales, the remaining specimens are without scales; the breast naked; opercle with closely set ctenoid scales slightly smaller than those on the body; cheeks with fewer still smaller, embedded ctenoid scales; lateral line complete, slightly arched over pectorals.

Pectoral and ventral fins about equal in length, measuring one and one-third in head; origin of spinous dorsal one-third the distance between the snout and base of caudal; origin of the soft dorsal and the anal equidistant from the snout, one and one-half in body length; the spinous dorsal somewhat longer than the soft dorsal and the latter than the anal; these three fins are about the same height, the order of their height in an ascending series being spinous dorsal, soft dorsal, anal; their height equals two in head.

The color patterns suggest an intermediate type between *Percina caprodes* and *Hadropterus aspro.* Sides with about nineteen large, distinct black blotches which, especially along the middle region, alternate with smaller ones, these often being the ventral ends of more or less well developed transverse bars. The dorsal side with a series of large quadrate blotches alternating and anastomosing with variously developed transverse bars. The color pattern is of the transverse type rather than the longitudinal characteristics of *H. aspro* and *macrocephalum*. In the older specimen this dorsal pattern becomes more diffuse and less regular. Dorsal two-thirds of opercle and the upper part of cheek, black. A distinct black band extends downward and another, more diffuse, forward from the eye. Both dorsals and the caudal fin, barred, pectorals indistinctly so; ventrals and anal, plain. A black spot at the base of the caudal.

TABLE OF MEASUREMENTS AND COUNTS OF ALL THE SPECIMENS.

Number of specimen	1	2	3	4	5	6	Av.
Length of body........	77.00	49.00	50.00	55.00	49.00	51.00	....
Head in length.........	1.05	3.82	3.84	3.93	3.92	3.92	3.91
Depth in length........	6.16	7.00	6.25	6.11	6.30	....	6.36
Eye in head...........	3.80	3.65	3.42	3.79	3.90	4.30	3.81
Snout in head..........	3.95	4.00	3.82	4.66	4.17	4.33	4.14
Maxillary in head	3.58	3.65	3.71	1.66	4.17	4.23	4.00
Interorbital in head....	1.63	5.13	5.20	4.66	4.17	5.20	4.83
Pectorals in head	1.36	1.28	1.30	1.21	1.56	1.30	1.33
Ventrals in head	1.31	1.42	1.32	1.40	1.39	1.44	1.38
Spinous D. from snout.	3.20	2.88	2.92	3.23	3.06	3.18	3.08
Soft dorsal from snout.	1.60	1.58	1.66	1.57	1.58	1.59	1.59
Anal from snout	1.64	1.58	1.61	1.62	1.58	1.59	1.60
Dorsal fin—	XVI.14	XIV.14	XV.14	XIV.13	XIV.15	XIV.13	
Anal fin—	II.11	II.10	II.10	II.11	II.11	II.11	
Scales—	7-79-9	9-84-12	9-84-11	8-82-11	9-82-12	8-84-11	82

The species is most closely related to *Hadropterus aspro* and *Hadropterus macrocephalum*. From the former it differs most strikingly in the color pattern, especially that of the dorsal side, which is transverse in type rather than longitudinal, and in the greater number of scales, which in this species are ctenoid instead of cycloid, on the cheeks and opercles.

Type No. 9785. Museum Indiana University.

Cotype No. 9786. Museum Indiana University.

Cotypes have also been deposited in the U. S. National Museum, U. S. Fish Commission, Museum of Stanford University and British Museum of Natural History.

d. Myxomycetes of Lake Winona.

Fred Mutchler.

With the advice and consent of Dr. C. A. King, I decided to take the time not required in teaching during the Station Session of 1902 in making a systematic study of the Myxomycetes of the lake neighborhood and this report shows the result of the work.

The season was one especially favorable for such a study, inasmuch as the frequent warm rains were very conducive to a luxuriant growth of all kinds of fungi.

This list is by no means complete, though I feel sure that it contains the majority of the forms indigenous to the region. Had it been possible to continue the study for another month I feel sure that the list would have been very materially increased, for myxomycetes were as plentiful at the close as they were at the opening of the station work.

Quite a number of specimens were collected on special excursions to Turkey Lake, Tippecanoe River, and North Manchester. I have included in this list species found on those trips that I did not find at Winona. The locality of such species is indicated in every case. All others were collected in the immediate neighborhood of the lake.

Didymium nigripes I found growing October 20, on Sphagnum that I brought to Clark University from the lake. On November 21 I noticed the same species growing on rabbits' dung that I had also brought from there.

My first attempt was to follow the classification and nomenclature as given in Lister's Mycetozoa. I soon found, however, that there are species here not given in that work, and I therefore used McBride's Myxomycetes of North America in connection with it.

The list including eighty-six species belonging to twenty-one genera is as follows:

1. Ceratomyxa porioides (Alb. and Schw.) Schroeter. Very common on decayed wood from July 1 to August 10. Frequently found covering almost the entire surface of decaying trunks.

2. Physarum viride Pers. Collected at least on three different trips, June 27, July 13, and July 20. On bark of fallen trees.

3. P. pulchripes Peck. Found in one collection, July 3. On bark of an old oak stump.

4. P. nutans Pers. Collected in considerable quantities from bark of fallen elm, July 9.

5. P. polymorphum. Found spreading in large patches over bark of a beech stump and on blades of grass and leaves of briars nearby, July 14. Turkey Lake.

6. P. nefroideum Rost. Brought into the laboratory several times. Collected from bark of fallen cottonwood, July 17.

7. P. galbeum Wingate. On oak bark, July 18.

8. P. auriscalpium Cooke. On decaying leaves. Turkey Lake, July 14.

9. P. nucleatum Rex. Not common. Bark of fallen ash, July 20.

10. P. maculatum McBr. On decaying wood in considerable quantity, July 24.

11. P. didermoides Rost. A single specimen collected on a decaying sycamore stump, July 21.

12. P. nodulosum Cooke and Balfour. On fallen trunks, July 15.

13. P. globuliferum Pers. July 31. Decayed wood.

14. P. obrusseum Berk and Curtis. Collected from a fallen poplar trunk near North Manchester, August 3.

15. P. melleum Mass. Found in small quantity on decaying leaves in woods near North Manchester, August 3.

16. P. citrinum Schumacher. Collected along with *P. melleum*, North Manchester, August 3.

17. P. cinereum Pers. Found on a growing fern frond in woods near Tippecanoe River, August 5.

18. Physarella mirabilis Peck. Found literally covering the inside of a hollow sycamore stump near the biological laboratory, July 7.

19. Tilmadoche compacta Wingate. One specimen collected on oak bark, July 30. Does not seem to be plentiful.

20. Spumaria alba D. C. Very common on stems and leaves of herbaceous plants throughout the month of July.

21. Fuligo septica Gmelin. Most common of any species collected. Could be found any day throughout the season.

22. F. violacea Pers. Rare, collected from decayed oak stump, July 19.

23. Leocarpus vernicosus Link. Only a small quantity collected from the bark of an oak log, July 29.

24. Tubulina fragiformis Pers. Quite common on decaying wood during the month of July.

25. T. stipitata Rost. Only a single specimen. Collected from decayed oak stump, July 18.

26. Craterium leucocephalum Ditmar. Found frequently on bark of twigs, July 20 and 29.

27. C. minimum Berk. and Curt. Found only once. Blades of grass, July 31.

28. Didymium crustaceum Fries. On green blades of grass and leaves. Turkey Lake, July 14.

29. D. nigripis Fries. Found growing on Sphagnum and rabbit dung collected at Winona Lake.

30. Stemonitis fusca variety genuina Roth. Collected in abundance from decaying wood, July 4.

31. S. fusca variety rufescens Roth. A single specimen from decayed oak stump, June 25.

32. S. splendens Rost. Quite common on all kinds of decaying wood, June, July and August.

33. S. Smithii McBr. Found in great tufts at base of decaying oak stump, June 26.

34. S. maxima Schweinitz. Quite common. July.

35. S. pallida Wingate. Collected in small quantity on bark of fallen oak, July 10.

36. S. Morgani Peck. Collected in plentiful quantities on decayed oak trunk, July 16.

37. S. Carolinensis McBr. Found growing, July 17, on the stump where *S. Smithii* had been collected June 26. *S. Smithii* was not found at this time.

38. S. herbatica Peck. Single specimen. Blades of grass. July 17.

39. S. Virginiensis Rex. Collected from oak bark along with *S. nigrescens*, July 14. Turkey Lake.

40. *S. nigrescens* Rex. Turkey Lake, July 14.

41. *S. Webberi* Rex. On fallen elm. July 14. Turkey Lake.

42. *S. confluens* Cooke and Ellis. Collected in considerable quantities from bark of fallen oak trunk, July 20. Probably rare.

43. *Comatricha stemonitis* Sheldon. Quite common on decaying wood. Collected frequently during July.

44. *C. irregularis* Rex. On fallen cottonwood trunk, July 17.

45. *C. Subsdorfii* Ellis and Everhardt. Single specimen collected July 30, on an old rail fence.

46. *C. typhoides* Rost. Found quite plentiful on dead wood near North Manchester, August 3.

47. *C. equalis* Peck. Not common. Collected from a board fence July 30.

48. *Dictydium umbilicatum* Schrader. Collected in great abundance on various kinds of decaying wood during the month of July.

49. *Cribraria tenella* Schrader. Collected in large quantities on very badly decayed wood, June 25 to July 28.

50. *C. dictydioides* Cke. and Balf. Very common. Quite a large decaying oak trunk was found by the elementary students, while collecting, July 17, that was literally covered with this species.

51. *C. microcarpa* Pers. Taken in substantial quantities from decaying wood at Turkey Lake, July 14. Also near Tippecanoe River, August 5.

52. *C. macrocarpa* Schrader. On rotten wood, July 30.

53. *C. minutissima* Schweinitz. This species taken only once but in considerable quantity then. On a lichen covered oak trunk, July 20. On account of its smallness it is probably often overlooked by collectors.

54. *Arcyria incarnata* Pers. Very common. Collected many times on all kinds of decayed wood, June 26 to August 20.

55. *A. cinerea* Pers. Found abundantly during July on decayed wood.

56. *A. flava* Pers. On decaying maple, July 4.

57. *A. punicea* Pers. Perhaps the most common of the *Arcyrias*. Collected on almost every trip during the entire time the station work was going on.

58. *A. ferruginea* Sauter. Found growing on old decaying cornstalks, July 4.

59. *A. incarnata nodulosa* McBr. On decaying birch, July 10.

60. *A. digitata* Pers. Quite common on decaying maple. The sporangia are usually collected in tufts of from four to twelve. July 10.

61. *A. pomiformis* Rost. Found along with *A. digitata*, July 10.

62. *A. vitellina* Phillips. Turkey Lake. July 14.

63. *A. Œrstedtii* Rost. Growing on decayed wood—maple and cottonwood, July 23.

64. *A. magna* Rex. On decaying trunks. Tippecanoe River, August 5.

65. *A. albida* Pers. Very common on dead wood of various kinds. July, August.

66. *Hemitrichia clavata* Rost. Collected from decaying watery trunks, July 3.

67. *H. rubiformis* Lister. Very common. Usually found growing on the watery decaying wood under the bark of fallen trunks. Sporangia are often sessile.

68. *H. intorta* Lister. On decaying oak, July 17.

69. *H. stipitata* Mass. Only a small specimen collected from water soaked wood, July 21.

70. *H. serpula* Rost. Found in abundance in the inner bark of water soaked wood. Tippecanoe River, August 5.

71. *Ophiotheca chrysosperma* Currey. Collected July 20 and 28, on inner bark of fallen willow trunks.

72. *O. Wrightii* Berk. and Curt. Collected in considerable quantity on inner bark of fallen elm trunks July 23.

73. *Oligonema nitens* Rost. Collected in small quantity in decaying wood near North Manchester, August 3.

74. *O. flavidum* Mass. Found along with *O. nitens*, North Manchester, August 3.

75. *Perichaena corticalis* Rost. Collected in small quantity on fallen elm trunk under outer bark, July 30.

76. *P. variabilis* Rost. On inner bark of willow trunk, July 30.

77. *Trichia contorta* Rost. Collected only in small quantity, July 8, in decayed wood of oak stump.

78. *T. affinis* DeBary. Found in considerable quantity in decaying maple, July 8.

79. *T. fallax* Pers. Quite common on various decaying woods, July 10.

80. *T. favoginea* Pers. Collected quite frequently on various woods during the month of August. More abundant than any other member of the genus.

81. T. scabra Rost. Collected from decayed wood near Tippecanoe River, August 5.

82. T. persimilis Karst. Single specimen collected July 26. Decayed elm.

83. T. Iowensis McBr. Found growing in rotten wood near Tippecanoe River, August 5.

84. Lycogala exiguum Morg. Not common. Collected only once. June 26.

85. L. flavo fuscum Rost. Several specimens collected from water soaked decaying wood. Turkey Lake, July 14.

86. L. miniatum Pers. Very common on all kinds of decaying trunks. This species was found on almost every collecting trip.

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c. The Plankton of Winona Lake.

Chancey Juday.

Winona Lake is one of the numerous lakelets found in northern Indiana. It is located in Kosciusko County about one mile (1.6 kilometers) southeast of the city of Warsaw. Concerning the physical features of the lake but little need be said as two hydrographic maps showing many of these points, have been published; one by Large in 1896 (Proc. Ind. Acad. Sci., 1896) and another by Norris in 1901 (Proc. Ind. Acad. Sci., 1901). The lake is irregular in outline and has an average length north and south of about one and an eighth miles (1.8 kilometers) and an average width east and west of about seven-tenths of a mile (1.1 kilometers) with a large bay extending westward from the north end. It has an area of about 0.9 of a square mile (2.3 square kilometers) and a maximum depth of eighty-one feet (twenty-five meters). Two small creeks flow into the southeastern portion of the lake and there are several large springs along the east side.

The data for this paper were collected at the Indiana University Biological Station during the summer of 1901. I wish to acknowledge my indebtedness to Dr. C. H. Eigenmann, Director of the Station, for many courtesies shown me. I am also much indebted to Mr. Clarence Kennedy and Mr. Heilman C. Wadsworth for their valuable assistance both in making the observations and in the tedious work of counting the material.

TRANSPARENCY.

The transparency of the water was determined by means of a Seechi's disk, about fifteen centimeters in diameter. The depth at which this disk just disappeared from view varied from 2.1 meters as a minimum to 2.5 meters as a maximum.

TEMPERATURES.

The thermophone and deep sea thermometer were not in working order so that the temperatures had to be taken by means of a pump and hose. This method, of course, is subject to considerable error and the results were found to be of comparatively little value except to determine the location and extent of the thermocline, so that the distribution of the plankton with regard to this region, might be studied.

The temperature observations were made in the deepest part of the lake, and they consisted of eight sets in July and ten sets in August. During July there was very little wind so that the upper stratum of water was not disturbed to any great extent. As a result this stratum accumulated considerable heat during this period. The surface temperature, taken at a depth of eight or ten centimeters, averaged 28.0° C. for the eight sets of observations, with 31.2° C. as a maximum.

During August, however, the wind was much stronger and the upper stratum of water was much more thoroughly stirred up. As a result, the average surface temperature for the ten sets of observations was 25.0° with a maximum of 26.0.°

The thermocline consisted of a stratum of water three meters in thickness. The difference in temperature between the top of this stratum and the bottom of it varied between 9.0° and 12.0°. In July it extended from four meters to seven meters, and in August from five meters to eight meters. The downward movement was doubtless due to the stronger winds prevailing in August.

The change in bottom temperature during the two months was very slight, 7.5° being the minimum and 8.0° the maximum.

METHODS.

The plankton observations as well as the temperature observations were made in the deepest part of the lake and by the pump method. An ordinary pitcher pump, 1-inch garden hose, and a plankton net whose straining part was made of Dufour's No. 20 bolting cloth, were used. The quantity of water strained for a catch was the amount produced by forty strokes of the pump, which averaged 22.5 liters.

The counting method was used to determine the relative abundance of the various plankton forms. In most cases 20 per cent. of the material obtained in a catch was counted, and the results thus obtained for the various forms were multiplied by five in order to determine the number of individuals in a whole catch. Whenever a catch contained a comparatively small number of individuals, for example, the catches near the surface in day time, the whole catch was counted. Also, all the individuals of the larger forms, such as Epischura and Leptodora, which are readily recognizable with the naked eye, were counted.

The sets of observations may be divided into five groups:

1. Twenty sets of day catches which were made not earlier than 9 a. m., nor later than 4 p. m.

2. Six sets of night catches which, with one exception, were made between 9 p. m. and midnight. On September 2, a series was made as early as 8 p. m., but this, however, was an hour and a half after sunset.

3. Four sets of evening catches were made. These were begun shortly before sunset and continued at half hour intervals an hour or more after sunset.

4. The morning observations were begun one and a half to two hours before sunrise and were continued at thirty minute intervals until after sunrise. Six sets of these were made.

5. In August there were two sets of observations in which catches were made at the surface at regular intervals during the entire night. Both series were begun before sunset and continued until after sunrise. Catches were made at half hour intervals until 8 and 9 p. m., respectively, then every hour until 3 and 4 a. m., respectively, and again at half hour intervals until after sunrise. The results of these observations are shown in Figs. 1 to 4.

The first and second groups covered the entire depth of the lake (twenty-five meters), while the catches of the third and fourth groups were confined to the upper four meters. The fifth group consisted of surface catches.

THE PLANKTON FORMS.

PHYTOPLANKTON.

The phytoplankton was made up of three forms, Clathrocystis, Coelosphaerium and Oscillaria. Clathrocystis was much more abundant than the other two forms as it made up about 75 per cent. of the total quantity of phytoplankton.

CRUSTACEA.

Copepoda.—My thanks are due Prof. C. Dwight Marsh for his determination of the following copepods:

Epischura lacustris Forbes.

Diaptomus oregonensis Lillj.

Diaptomus birgei Marsh.

Cyclops pulchellus Koch.

Cyclops brevispinosus Herrick.

Cyclops leuckarti Sars.

Cyclops albidus Jurine.

Cyclops prasinus Fischer.

Cyclops serrulatus Fischer.

Ergasilus.

The following concerning Diaptomus birgei is quoted from Professor Marsh's letter: "The finding of D. birgei is of great interest to me. I described the species some years ago from a few specimens from New Lisbon, Wisconsin, and have never seen a specimen since. I had begun to fear that I had described a freak form and that the species would not stand; but here comes the creature in the proper proportions. It is a little queer that I should have found it only in two such widely separated localities, but doubtless it lives at some intermediate locations."

Cladocera.—The following limnetic forms were found:

Daphnia hyalina Leyd.

Daphnia pulex De G. var. *pulicaria* Forbes.

Daphnia retrocurva Forbes.

Diaphanosoma brachyurum Sars.

Ceriodaphnia lacustris Birge.

Leptodora hyalina Lillj.

Chydorus.

Bosmina.

Littoral forms:

Pleuroxus procurvatus Birge.

Pleuroxus denticulatus Birge.

Eurycercus lamellatus O. F. M.

Acroperus harpae Baird.

The following genera were represented by at least one species each. *Alona*, *Graptoleberis*, and *Simocephalus*.

Cypris and *Corethra* larvae were found in some of the catches.

ROTIFERA.

Four members of this group were specifically identified, *Triarthra longiseta*, *Anuraea cochlearis*, *Anuraea aculeata*, and *Notholca longispina*. The other members of the group belonged to the genera *Asplanchna*, *Polyarthra*, and *Mastigocerca*.

CHANGE IN QUANTITY OF PLANKTON.

These observations covered too brief a period, July 10 to September 3, to show much concerning the increase or decrease of the various plankton constituents. In general, it may be said that there was comparatively little change. There was apparently a slight increase of the phytoplankton, due mainly to an increase of Clathrocystis. Only two forms of the crustacea showed any change. During August, there was a perceptible increase of Diaptomus and Cyclops. They were found to be twice as numerous the first of September as the last of July and first of August.

DIURNAL MOVEMENT.

Epischura lacustris. This form was not found regularly in the day catches as it was present in only six of the twenty day series. On these six occasions it was confined to the thermocline, that is, between five and seven meters. It was taken, however, in the surface catches of the six night series. The time of its appearance at the surface varied from half an hour to an hour and a half after sunset and it disappeared from the surface about an hour before sunrise. In the all-night series of August 5-6, it was found in only one catch. This was at 9 p. m., five individuals per 100 liters of surface water. In the all-night series of August 27-28, it reached a maximum of 140 per 100 liters at 8 p. m.

Diaptomus.—As noted above, two species were present, but they were not counted separately. For the most part, Diaptomus remained in the upper ten meters of the lake as those found below this depth constituted less than 5 per cent. of the total number of individuals taken in either a day or a night series. They were found at the surface in sixteen of the twenty day series, but, with two exceptions, there was a marked increase in the number of individuals at the surface at night. This increase varied from five to twenty-five fold. The two exceptions were surface catches made on cloudy days. These differed but little from the night surface catches. The increase at the surface usually began about sunset and the greatest decrease occurred half an hour to an hour before sunrise.

Fig. 1 shows the surface conditions for Diaptomus in the two all-night series. The vertical spaces represent the number of individuals per hundred liters of surface water and the horizontal spaces represent the time between 6 p. m. and 6 a. m. The curves show a striking similarity of conditions although the observations were separated by a time interval of three weeks. They show that the maximum number was found at the surface at 7:30 p. m. on both occasions. Both also show a decided decrease during the next half hour, a second but smaller rise at midnight, a third near morning, and a fourth is indicated for the period immediately following sunrise. Diaptomus was not found in the surface catch on August 5 at 11 a. m. and there were 160 per 100 liters on August 27 at 9 a. m.

Cyclops.—Several species were present but no attempt was made to count them separately. They were distributed through the entire depth of the lake. They were found at the surface in all the day catches. In general, the night increase was comparatively small as it did not exceed five fold. There was little or no difference between the surface catches made on cloudy days and those made at night.

The curves of Fig. 2 represent the status of Cyclops in the two all-night series. The early evening conditions differ a great deal as there is no maximum in the curve for August 27-28 corresponding to the 7:30 p. m. maximum of August 5-6. Beyond this, however, the curves are very similar. The surface catch on August 5 at 11 a. m. showed a total of 160 Cyclops per 100 liters and there were 200 on August 27, at 9 a. m.

Nauplii.—They were found throughout the entire depth of the lake and showed no evidence of a movement.

Ergasilus.—This form was irregularly distributed in the upper six meters and showed no movement.

Daphnia hyalina.—In this species, the young and the adults were counted separately. The ratio between them was very variable. The young constituted from 10 per cent. to 78 per cent. of the entire number of individuals of a series. The young predominated near the surface on bright sunny days and the adults predominated in the deeper strata. In all but one set of observations, 70 per cent. to 95 per cent. of the total number of *D. hyalina*, were found in the upper seven meters and in this one instance 60 per cent. were in this region.

Usually a few young were found at the surface in the daytime. Likewise adults were found at the surface on two cloudy days but, on clear days, they were at a depth of one to two meters. In three sets of observations, adults appeared at the surface about half an hour after sunset, and on a fourth occasion about sunset. In five sets of morning observations, the time of their disappearance from the surface varied from nearly two hours before sunrise as a maximum to thirty minutes before sunrise as a minimum.

Figs. 3 and 4 represent both young and adult in the all-night series. It will be noted that the curves for young and adult in each series cross and recross each other, showing that the ratio between them was very variable. The two curves for adults do not show the similarity that the curves for Diaptomus and Cyclops do. In fact, if plotted together, they cross each other several times, one curve showing an increase of individuals at the same hour that the other shows a decrease. In the first series, August 5-6, the adults reached a pronounced maximum at 8 p. m., while in the series of August 27-28, two equal maxima were observed, one at 7:30 p. m. and the other at 10 p. m.

There is the same lack of similarity between the curves representing the young. The first series showed a maximum of young at 8 p. m. and the second at 4:30 a. m.

Daphnia pulicaria.—It occupied the region between the middle of the thermocline and the bottom. It was usually most numerous within one to three meters of the bottom. There was practically no diurnal movement. Adults were found at the surface in one evening catch and at a depth of only one meter in a night catch. These were the only indications of a movement.

Daphnia retrocurva.—It was rarely found at a greater depth than seven meters. Both young and adult were one to three meters below the surface on clear days. Both appeared at the surface in the evening about half an hour after sunset. In the morning, however, the adults left the surface before the young. The young usually disappeared about sunrise while the adults moved down from the surface an hour or more before sunrise. The surface maximum of young and adults combined, was found three-quarters of an hour after sunset in the first all-night series and half an hour later in the second, about 8 p. m. in each case.

Diaphanosoma brachyurum.—A comparatively small number of this species was found. It was rather irregular in its movements but, in general, it appeared at the surface thirty to forty-five minutes after sunset and left the surface an hour or more before sunrise. It was found at a depth of one meter, usually, in the daytime, and rarely occurred in catches below a depth of seven meters.

Ceriodaphnia lacustris.—This form was confined to the upper four meters and was present in very small numbers. There was no diurnal movement shown by it.

Leptodora hyalina.—Only a small number were found. It occurred in only five of the twenty day series. In these five instances, it was confined to the region of the thermocline, that is, between four and eight meters. Both young and adult appeared at the surface in the evening from thirty to forty-five minutes after sunset. The young left the surface about an hour before sunrise and the adults half an hour or more earlier.

Chydorus and *Bosmina* were found in very small numbers. No diurnal movement was noted.

Cypris.—There was, apparently, an extended horizontal migration of Cypris as it was found in a third of the morning and evening series, and these observations were made in the deepest part of the lake. In the daytime, however, Cypris was never found in the limnetic region of the lake but in the littoral region.

A few *Corethra* larvae were found in and below the thermocline in the daytime. In a few instances they came to the surface at night.

Rotifera.—The rotifers showed no diurnal movement. With respect to their vertical distribution, they form three groups:

1. *Mastigocerca*, *Polyarthra*, and *Aspianchna* were confined to the upper five, six and seven meters respectively, or the region in and above the thermocline.

2. *Anuræa aculeata* and *Triarthra* occupied the region below a depth of ten meters. They were usually most abundant within two or three meters of the bottom.

3. *Anuræa cochlearis* and *Notholca longispina* were found through the entire depth of the lake.

MAXIMUM NUMBER AT SURFACE.

This diurnal migration must not be taken to mean that the individuals of the various species concerned, congregate at the surface at night in such numbers as to form what might be called a "swarm," for no such aggregation was noted. This is shown by the fact that *Diaptomus*, *Cyclops* and *Daphnia hyalina*, in a majority of the night observations, were more numerous at a depth of one or two meters or even deeper, than at the surface. It simply means that the upper stratum, one or two meters in thickness, is sparsely populated on bright, sunny days, but that this rêgion is more or less densely populated at night.

Blanc (1898) and Fordyce (1900) found the greatest number of crustacea at the surface at 4 a. m. My observations do not agree with their results. Figs. 1 to 4 do not show a morning maximum with the exception of young *Daphnia hyalina* in the second series. On the other hand, *Diaptomus* reached a maximum at 7:30 p. m., adult *D. hyalina* at 7:30 and 8 p. m., and *Cyclops* at 7:30 p. m. and midnight. Also, each of the other forms showing a diurnal movement, reached its maximum about 8 p. m.

CAUSES OF DIURNAL MOVEMENT.

Various theories have been advanced to account for this phenomenon. It has been ascribed to various factors such as food, temperature, light, gravity, and in some cases chemical stimuli. Experiments on several of the crustacea which show diurnal movement, seem to show that light is the primary factor. But generally, there are other factors involved which may modify the effect of light to a very considerable degree, thus making the phenomenon complex instead of apparently very simple.

The migrating forms of Winona Lake may be separated into two groups. The first group includes those whose day position bears a more or less direct relation to the intensity of the sunlight. *Daphnia hyalina* and *retrocurva*, *Diaptomus*, and *Cyclops* belong to this group. The Daphnias desert the upper meter or two on bright, sunny days and the other two members occupy this region in rather limited numbers. But, on cloudy days, all are found in this region in nearly as large numbers as at night. This seems to show that light is the primary factor controlling their movements. They move down to avoid intense light and then move up into this region again as soon as the intensity of the light is sufficiently decreased.

Epischura, *Leptodora*, and *Corethra* larvæ belong to the second group. The depth to which these descend in the daytime did not depend, apparently, upon the intensity of the sunlight as they were found at the same depth on cloudy as on clear days. Besides, it does not seem probable that sunlight alone would cause them to descend to so great a depth, that is, five to seven meters or more, especially since the transparency of the water was so low, 2.1 to 2.5 meters. Therefore, it seems reasonable to suppose that some other factors are very largely responsible for their movements.

Daphnia pulicaria might also be added to this group. While it showed only a very slight tendency toward diurnal movement in Winona Lake, it did show distinct and regular migrations in one of the Wisconsin lakes upon which the writer made observations. In the latter lake the same as in Winona Lake, it remained in and below the thermocline in the daytime and in neither case was its day position affected by the intensity of the sunlight. In general, the diurnal migration of all the members of this group, seems to be much more akin to the "nocturnal habits" of many other animals, than are the movements exhibited by the members of the first group.

Some crustacea upon which experiments have been performed, have shown that they are attracted by diffuse light. If this were true of all crustacea, and if it were to hold true for them in their natural haunts as well as in the laboratory, then one might suppose that there would be morning and evening surface increases of about equal proportions. Furthermore, it would not be unreasonable, perhaps, to expect moonlight to produce an appreciable effect, if the crustacea were attracted by diffuse light. For the most part, however, the truth of this supposition is not confirmed by the crustacea of Winona Lake. With the exception of the young *Daphnia hyalina* in the second all-night series, there was no morning surface increase comparable in every way to that of the evening.

Diaptomus was the only other form that showed any tendency toward a considerable surface increase after midnight, but its morning increases were much smaller than those of the evening. Then, too, moonlight had no appreciable effect upon the diurnal movement of any of the crustacea.

SUMMARY.

1. There was comparatively little change in the quantity of plankton.

2. Diurnal movement was shown by *Epischura*, *Diaptomus*, *Cyclops*, *Daphnia hyalina* and *retrocurva* *Diaphanosoma*, *Leptodora*, and *Corethra* larvae.

3. These various forms reached a maximum at the surface about 8 p. m.

4. Light is a very important factor in the movement of *Diaptomus*, *Cyclops*, and *Daphnia hyalina* and *retrocurva*. It is, apparently, not so important a factor in the movement of *Epischura*, *Daphnia pulicaria*, *Leptodora*, and *Corethra* larvae.

5. Diurnal movement was not affected by moonlight.

LITERATURE CITED.

Blanc, 1898. Le Plankton nocturne du Leman. H. Blanc. Arch. des sci. physiq. et nat., T. 6, 1898.

Fordyce, 1900. The Cladocera of Nebraska. Charles Fordyce. Trans. Amer. Micro. Soc., Vol. XXII, pp. 119-174, 1900.

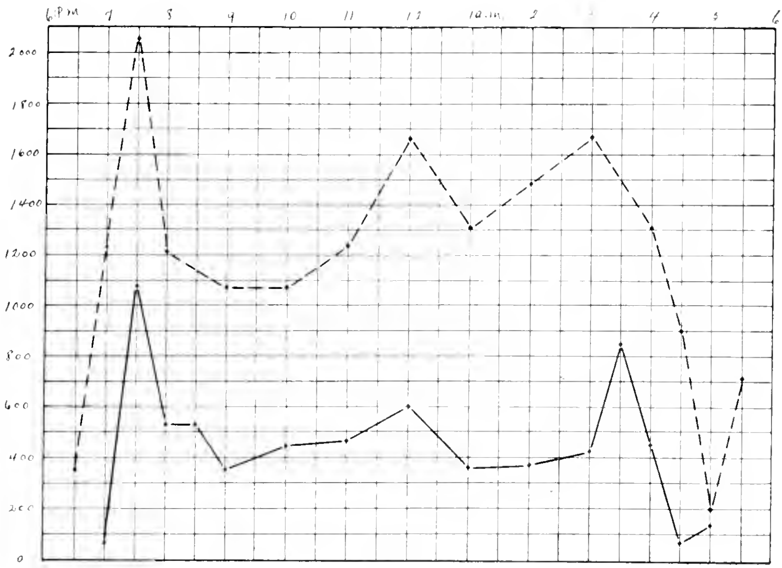
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Fig. 1.

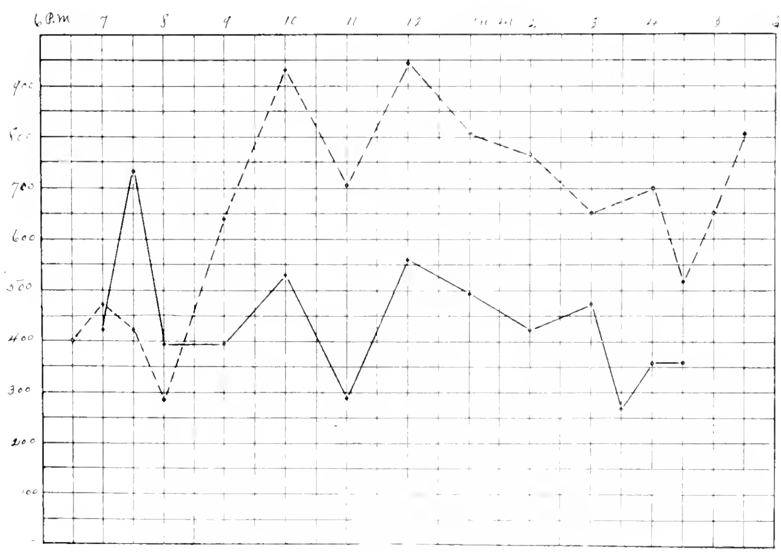
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Fig. 2.

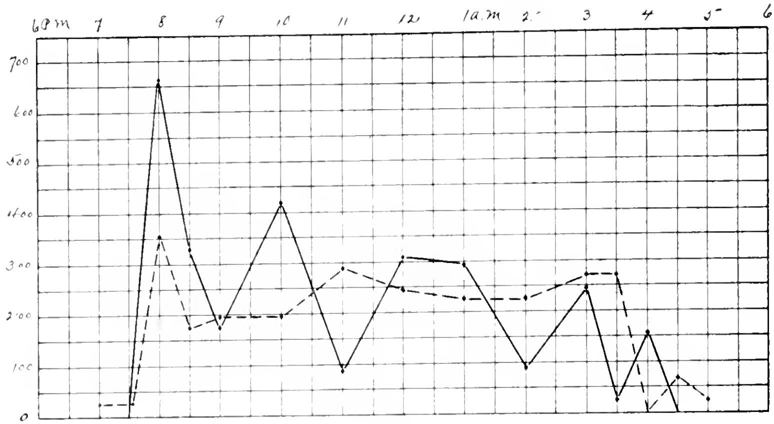
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Fig. 3.

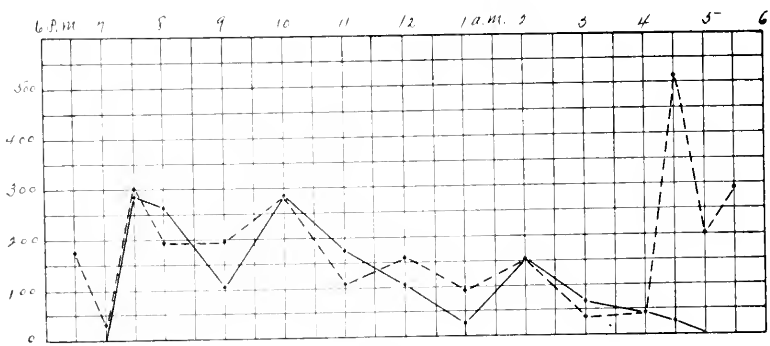
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Fig. 4.

EXPLANATION OF FIGURES.

Fig. 1. *Diaptomus.* Scale, one vertical space equals 100 individuals per hundred liters of surface water.

— — — — — — August 5–6.
.... August 27–28.

Fig. 2. *Cyclops.* Scale, one vertical space equals 50 individuals per hundred liters of surface water.

———————— — — August 5–6.
.... August 27–28.

Fig. 3. *Daphnia hyalina.* Scale, one vertical space equals 50 individuals per hundred liters of surface water.

— — — — — — Adult. } August 5–6.
.... Young. }

Fig. 4. *Daphnia hyalina.* Scale, one vertical space equals 50 individuals per hundred liters of surface water.

———————————— Adult. } August 27–28.
.... Young. }

f. The Birds of Winona Lake.

Clarence Guy Littell.

During the summer of 1902, from June 21 to August 28, while a student at the Indiana University Biological Station I devoted all of my time to a field study of the birds about Winona Lake. I present here my notes on the occurrence and habits of the birds observed.

The region about Winona Lake was fully described in the Proceedings Indiana Academy of Science for 1901 and a detailed description is not necessary. Suffice it to say that the lake is surrounded by swamps, flooded in times of extreme high water, and by hills reaching a height of forty feet. The vegetation varies from the aquatics in the margin of the lake to swamp-grasses and bushes in the marshes, and to oak forests on the hills.

Observations on birds were all made within a radius of one mile from the lake shore. In the following list the numbers in brackets refer to the A. O. U. Code and Check-list.

[6] *Podilymbus podiceps* (Linn.). Pied-billed Grebe.

This Grebe is not common around Winona Lake. I have only seen it twice, both times near the reedy shores of the western side.

[190] *Botaurus lentiginosus* (Montag.). American Bittern.

I have flushed this bird several times in a small swamp at the south-eastern corner of the lake, but have been unable to find a nest.

[191] *Ardetta exilis* (Gmel.). Least Bittern. Fig. 3.

This bird is rather common in the small swamps bordering on the lake, but owing to the lateness of the season when I arrived, I was able to find but one nest which contained at the time three pure white eggs. I found this nest on July 23, in the middle of a swamp. It was a platform of grasses set in the swamp grass.

[194] *Ardea herodias* Linn. Great Blue Heron.

This bird has been identified flying over the lake several times. I have never flushed it.

[201] *Ardea virescens* Linn. Green Heron.

This species is common around the lake and undoubtedly nested in the vicinity in numbers in the spring. I found several old nests that I believe were built by this bird.

[214] *Porzana carolina* (Linn.). Sora.

I flushed three of these rails in a cornfield near a swamp, in the latter part of July. After a short flight they dropped into a marsh, and I failed to find them again.

[256] *Totanus solitarius* (Wils.). Solitary Sandpiper.

This bird is probably not rare around the lake although I flushed it but three times. It stays in rather removed places. Twice I saw it on a sandbar on the western side of the lake.

[263] *Actitis macularia* (Linn.). Spotted Sandpiper.

The most common wader around the lake.

[273] *Ægialitis vocifera* (Linn.). Killdeer.

Common. Often seen along railroad and on golf links.

[289] *Colinus virginianus* (Linn.). Bobwhite. Figs. 1 and 2.

Very common.

[316] *Zenaidura macroura* (Linn.). Mourning Dove. Fig. 4.

Very common around the lake, nesting all through the summer in all sorts of places. It seems to prefer places near lake shore. I found one nest on a brush pile, about twenty feet from the lake in a very exposed position; another in a tree overhanging the lake, in a small hollow, where the limb joined the trunk. The nest in the latter case consisted of two or three dead leaves.

[325] *Cathartes aura* (Linn.). Turkey Buzzard.

Common.

[331] *Circus hudsonius* (Linn.). Marsh Hawk.

Common around the lake. Nests in marshy places near small inlets.

[333] *Accipiter cooperi* (Bonap.). Cooper's Hawk.

Not common. I have identified one specimen while flying.

[337] *Buteo borealis* (Gmel.). Red-tailed Hawk.

Not rare. I have identified it several times. It is, however, much more common farther south.

[360] *Falco sparverius* Linn. Sparrow Hawk.

Not rare. I have identified it several times, but it is not common.

[368] *Syrnium nebulosum* (Forst.). Barred Owl.

Rare. One specimen was shot here in the summer of 1901. Personally, I have never seen it here.

[373] *Megascops asio* (Linn.). Screech Owl.

Common. Breeds in numbers although all young were out when I arrived.

[375] *Bubo virginianus* (Gmel.). Great Horned Owl.

I have heard this owl twice during the summer. Probably not very common.

[387] *Coccyzus americanus* (Linn.). Yellow-billed Cuckoo.

Very common. Breeds commonly all during summer.

[388] *Coccyzus erythrophthalmus* (Wils.). Black-billed Cuckoo. Figs. 5, 6, 7 and 8.


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Common, but not easily seen. I found one nest on the side of a rather steep hill, the female was sitting on the nest. I took a negative of her just as she was. I then scared her off the nest and found that she only had one egg. This was on the morning of July 13. I came back every morning and made negatives of her on the nest in different positions, afterwards scaring her off, but I found only one egg until July 17. At three o'clock in the afternoon of the 17th I found two eggs. The eggs were smaller than those of the Yellow-billed Cuckoo and did not have the bluish cast. The nest is a much better affair than the Yellow-billed Cuckoo builds. By the 18th I could approach my hand within eighteen inches of the cuckoo before she left the nest. Whenever she left her nest she generally flew about thirty feet and then sat perfectly motionless until I left. She hardly ever uttered a sound. Her positions on the nest were at times rather acrobatic. This is illustrated to some extent by the photographs. On July 24 the first egg was hatched into one of the ugliest young birds I have ever seen. On July 26 egg number two had disappeared but the young cuckoo was thriving. On July 27 feathers were pretty well started. On July 28 everything was as usual, on the afternoon of the 30th the bird had disappeared. It did not seem ready to leave the nest but probably the mother coaxed it off early on account of my visits.

[390] *Ceryle alcyon* (Linn.). Belted Kingfisher.

Very common. I found one nest in a railroad bank. Another in a steep bank along a creek.

[393] *Dryobates villosus* (Linn.). Hairy Woodpecker.

Four individuals of this species were seen this summer.

[394] *Dryobates pubescens* (Linn.). Downy Woodpecker.

Very common.

[402] *Sphyrapicus varius* (Linn.). Yellow-bellied Sapsucker.

Common.

[406] *Melanerpes erythrocephalus* (Linn.). Red-headed Woodpecker.

Very common. These Woodpeckers have become very tame, especially on the Winona Assembly ground. They frequently hop around in the road like English Sparrows.

[412] *Colaptes auratus* (Linn.). Flicker.

Very common.

[417] *Antrostomus vociferus* (Wils.). Whip-poor-will. Figs. 9, 10, 11, 12, 16.

Common. Often heard, but rarely seen. I found one nest on June 27. I was crossing an old and rotten rail fence at the top of a woody embank-


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ment which sloped off sharply to Cherry Creek. The hill was covered with young willows, weeds and old dry leaves. Large red oaks were scattered plentifully here and there. The top rail on the fence broke with my weight and I dropped with a crash on the other side. It seemed that at almost the same time, I heard a loud chuck. About five feet in front of me a female Whip-poor-will was lying; she looked as if I had fallen upon her. She lay with outspread wings, with head and tail up, the middle part of her body sagging down as if her back were broken. Somewhat deceived, I started toward her but she edged away, still going through various contortive tricks. I looked around and stepped cautiously in the direction from which I thought she came, the frightened bird, all the while, giving a series of angry chucks. Finally in a bunch of poison ivy, I found an elliptical brown and lilac spotted egg in the least indentation in the dry leaves. About six inches away was the shell of another egg. But where was the young bird? At last I saw it; not only saw it but comprehended that it was a young Whip-poor-will. It lay close to the egg, and looked something like a piece of mouldy earth. A few feet away it seemed to fade right into the ground. It was perfectly helpless and was apparently not more than an hour old. I took a negative of it and left immediately so as to allow the mother to go back on the nest. When I stole back softly, in five minutes, she was brooding. She resembled perfectly the dead leaves around her. If she had not been frightened by the breaking rail, I would never have discovered her. I left at eleven o'clock (June 21) and returned at four o'clock that afternoon and the unhatched egg was chipped in one place. I reached the nest next morning at eight o'clock and young Whip-poor-will No. 2 was just out of the shell. There was still a piece of shell sticking to the down on its back. I judged that No. 2 was about twenty-one hours younger than No. 1. I took a negative of the two young ones and left. I had read that a mother Whip-poor-will carried her young away a distance if they are handled. I resolved, therefore, although I did not put much faith in the statement, to build a pen around the nest. This I did on the afternoon of June 28. When I went up softly I could now put my hand within two feet of the old female before she would move. When she did go she jumped up in a hurry, kicking the young several inches apart, where they lay very still. She would fall within three or four feet of me and go through the broken back performance, giving at the same time hoarse but vigorous chucks. After


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a time she would fly off twenty or thirty feet and sit either on a stump or lengthwise on a limb or log. She always sat lengthwise with her head toward me and apparently did not move an eyelid while I was there. I would scarcely leave the nest until she would be back brooding. Her flight was always perfectly noiseless. In leaving the nest the bird never emitted a sound, but as soon as she fell to the ground she always gave the same rapid series of hoarse chucks.

Her large full eye was always very noticeable at such times. I returned at 9 a. m. June 29. The young one No. 2 was just about two-thirds the size of the older one. The day was cold and raw and the older bird commenced to utter a shrill peet. This sound was perfectly indistinguishable to me at a distance of ten feet. However, it reached the ears of the mother who sat thirty feet away. She immediately became restless and commenced to fly from one object to another until I took the hint and left. I was scarcely forty feet away when I saw the mother fly to the nest.

I returned at 4 o'clock in the afternoon of the same day (July 29). The older of the young ones could now toddle around some and was not quite as helpless. The mother bird in rising kicked the two little birds about two feet apart. The younger lay perfectly still where she kicked it, but the older one toddled on about one foot farther and hid under a leaf where it was perfectly indistinguishable.

On the next day, June 30, the older bird could run quite lively for a short distance. It ran with extended wings, as a quail does. The younger was still helpless. On this day I searched the entire neighborhood to see if I could scare up the male bird. I had never seen him yet. I hunted in vain. I returned to the nest and while gazing at the mother bird brooding I saw to my astonishment a large mosquito light on her head near the base of her bill. The mosquito probed around awhile and then crawled out to the very tip of her bill, stayed there meditating for a minute and then flew away. All the while the mother bird never moved a muscle.

I returned to the pen on the morning of July 1 and found the birds where I had left them. The younger bird could now move around pretty lively, but was much smaller than the other. The old bird was getting accustomed to my presence now, so that I could photograph her with the lens of the camera not more than three feet from her, without scaring her from the nest. After taking the negative I approached my hand within six inches of her before she quietly but quickly flew away. She still per-

sisted in her acrobatic tricks to try to draw me away from the nest and she did in fact go through this same performance every time I visited her.

On the next day, July 2, I scared the mother from the nest by touching her on the head and the two little Whip-poor-wills both ran and hid under a leaf. It took some little time for me to find them again. The older now had promise of future feathers. Nothing was visible on the younger but down.

July 3, when I attempted to scare the mother bird from the nest she flew around my head quite fiercely, touching my ear once with her wing and then fell to the ground in her usual attitude of broken-back misery. The older of the two young ones now had the beginning of some mottled feathers.

At 9 o'clock on the following morning, July 4, I arrived at the pen. Imagine my surprise and chagrin to find the enclosure empty. Apparently I was wrong and Whip-poor-wills did carry their young away. I decided she could not carry them very far away so I commenced to beat the bushes around the pen. About ten feet north of the pen I flushed the mother bird. I looked down just in time to see young Whip-poor-will No. 1 run under a leaf but did not see No. 2 at all. I looked around under the leaves for a few minutes and finally discovered No. 2 sitting calmly on an old leaf right before my eyes. I brought them together and photographed them. It was a warm day and they were directly in the sun's rays. In a short time I noticed that their throats began to vibrate rapidly and each uttered a few shrill peets. Both, then, almost simultaneously toddled off and stopped in the shelter of a little weed. I left them and examined the pen. I found several places where even the old Whip-poor-will could get through. I therefore decided that she had coaxed them to follow her instead of carrying them. So, to prove it, I brought a box with the bottom knocked out and about one and one-half feet high, and placed this over the nest. I reasoned that if she carried them she could carry them out of that box without any trouble; if she coaxed them they could not get out as one and one-half feet was too much for the young ones.

I returned three days later, July 7. The family were still there just as I had left them. Whip-poor-will No. 1 now had a much better coat of feathers, and quills were beginning to appear on No. 2. I made a visit to the nest once every day now for four days and after scaring the Whip-poor-will off would retire to a distance and then slip back softly. I found that the mother bird invariably lit on the edge of the box before going to


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the nest. She always lit on the north side of the box. No new developments appeared until four days later, on July 11. When I arrived at fifteen minutes of nine on the following morning, I set my camera down and walked boldly up to the nest to inspect. A little noise never scared the old bird. When I got about five feet from the box a bird sprang out, but not the homely little female. This was a Whip-poor-will undoubtedly, but it had a white ring around its neck and also displayed two dazzling white tail feathers. At last I had found the male brooding. He did not fall at my feet as did the female but flew to a log about thirty feet away, eyed me with evident disapproval, uttered a few protesting chucks and then with a flirt of his white tail feathers vanished among the bushes. I now turned to the nest and to my surprise found only one bird there and that was Whip-poor-will No. 2. It was all made plain now. The mother had succeeded in getting the older one to fly over but the younger was not able to do so. Therefore, she had spirited the older away, leaving her mate to brood the younger. I retreated about thirty feet and sat down to watch developments. In about ten minutes the male Whip-poor-will appeared, lit on the edge of the box opposite to the side that the female always lit on, sat there two or three minutes and then dropped in. I approached and tried to get a photograph of him but he absolutely refused to sit for me and so I left. I returned twice the next day, July 12, to get a negative, but he was just as wild as ever. When I arrived at the box at 8:30 the following morning, July 13, the box was empty; the last bird had flown. Thus is the history of the family for sixteen days, that being the time required for them both to fly. They would have probably remained near the old nest several days longer if they had been undisturbed.

[420] *Chordeiles virginianus* (Gmel.). Night Hawk.

Not rare. I saw it three times during the summer.

[423] *Chætura pelagica* (Linn.). Chimney Swift.

[428] *Trochilus colubris* Linn. Ruby-throated Humming bird.

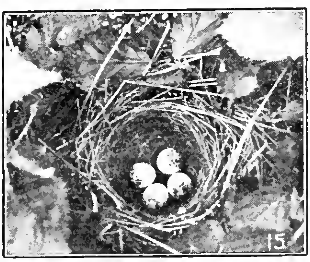
Rather common. I have been unable to find a nest but have seen this bird very often.

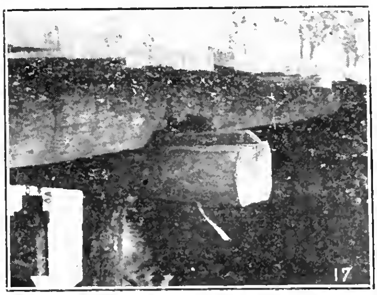
[444] *Tyrannus tyrannus* (Linn.). King Bird.

Very common. One of the liveliest and commonest birds around the lake.

[452] *Myiarchus crinitus* (Linn.). Great Crested Flycatcher.

Common.





[456] *Sayornis phœbe* (Lath.). Phœbe. Fig. 17.

Common. Breeding all through the summer. I found one nest under the veranda roof of one of the hotels. I took the negative shown in Fig. 17 on July 7. The nest was under a small bridge near the station. It contained four young almost ready to fly.

[461] *Contopus virens* (Linn.). Wood Pewee.

Very common. These birds are very common in the Assembly grounds and have become tame. I found several nests; one with fresh eggs on July 21.

[467] *Empidonax virescens* (Vieill.). Acadian Flycatcher.

I shot one of these July 7, the only one I have identified during the summer.

[477] *Cyanocitta cristata* (Linn.). Blue Jay.

Very common. These birds have become very tame in the park, eating remains of lunches, etc. I have often seen one take a bath in a certain little trough of running water; crowds of people passing within eight or ten feet. I found one nest under the porch roof of one of the cottages.

[488] *Corvus americanus* Aud. Crow.

Common. These birds' lives seem to be a burden to them around the lake on account of the numerous Kingbirds who attack them at every opportunity.

[494] *Dolichonyx oryzivorus* (Linn). Bobolink. Fig. 13.

Common. These birds are to be found in large flocks around the lake in boggy meadows. I have found several nests. Fig. 13 represents a nest in a clump of swamp grass on the edge of a small swamp.

[495] *Molothrus ater* (Bodd.). Cowbird. Fig. 14.

Common. These birds seem to have a preference for the nest of the Maryland Yellow-throat. It is an exceptional thing to find a nest of this little warbler without its young Cowbird or Cowbird eggs. The negative of the two cowbird's eggs in the nest of a Maryland Yellow-throat was taken July 1.

[497] *Xanthocephalus xanthocephalus* (Bonap.). Yellow-headed Blackbird.

Rare. I have seen only one of these birds this summer. It was sitting on an old fence post in a dense swamp.

[498] *Agelaius phœniceus* (Linn.). Red-winged Blackbird.

Very common. These birds nest in large numbers around Winona Lake.

[501] *Sturnella magna* (Linn.). Meadow Lark. Figs. 18 and 19.

Very common. Numerous nests were found on the golf links near the lake until the middle of August. The photographs of the Meadow Lark's nest were taken July 17. On July 25 the young had left the nest.

[506] *Icterus spurius* (Linn.). Orchard Oriole.

Not common. I have only seen three pairs this summer.

[507] *Icterus galbula* (Linn.). Baltimore Oriole.

Common.

[511b] *Quiscalus quiscula æneus* (Ridgw.). Purple Grackle.

Very common. This bird is quite common in the park. It is found extensively also in meadows a mile or so back from the lake.

[529] *Spinus tristis* (Linn.). American Gold Finch.

Common. These beautiful birds are quite common around the lake. I have often seen them taking a bath at a certain sandy beach on the southeast shore of the lake.

[540] *Poocætes gramineus* (Gmel.). Vesper Sparrow.

Not rare. This sparrow is fairly common in the higher meadows back of the lake.

[—] *Passer domesticus* (Linn.). English Sparrow.

Very common.

[542a] *Ammodramus sandwichensis savanna* (Wils.). Savanna Sparrow.

Not common. I shot two of these sparrows in a bushy pasture, rather higher than surrounding fields. They are very difficult to see as they run through the grass and will rise only as a last resort.

[546] *Ammodramus savannarum passerinus* (Wils.). Grasshopper Sparrow.

Rare. I shot one of these sparrows in a clover field. It is the only one I have identified here this summer.

[547] *Ammodramus henslowii* (Aud.). Henslow's Sparrow.

Rare. I have succeeded in taking one of these sparrows in a wet meadow. It arose from a tuft of grass and dived into a willow bush.

[560] *Spizella socialis* (Wils.). Chipping Sparrow.

Common. This sparrow does not seem to breed here as commonly as in most places in this State.

[563] *Spizella pusilla* (Wils.). Field Sparrow. Fig. 15.

Very common. The photograph was taken July 11. The nest was situated about six inches above the ground in a clump of grass.

[581] *Melospiza fasciata* (Gmel.). Song Sparrow.

Very common. Always to be seen, rain or shine, sitting on the top of small willow trees near the lake on the eastern side. The photograph of its nest was taken July 8.

[584] *Melospiza georgiana* (Lath.). Swamp Sparrow.

Not rare. I have seen only five or six of these dark colored sparrows this summer.

[587] *Pipilo erythrophthalmus* (Linn.). Towhee.

Very common. A bird whose power of song is of no mean order. Always to be found among the hazel bushes around the lake scratching among the dead leaves. I found a nest with eggs as late as August 20. They keep singing throughout August. With the exception of the Wood Pewee this is the most abundant species seen about the lake in August.

[593] *Cardinalis cardinalis* (Linn.). Cardinal Grosbeak.

Common. To be heard at all times of day from some lofty perch.

[595] *Habia ludoviciana* (Linn.). Rose-breasted Grosbeak.

Not rare. I have seen this beautiful bird several times and heard it much oftener. It is generally flitting around in a double row of old willows in the park.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[598] *Passerina cyanea* (Linn.). Indigo Bunting.

Very common. Its song is one of the most persistent all through the summer.

[604] *Spiza americana* (Gmel.). Dickcissel.

Not common. This bird is not as common as in southern and central Indiana. I have only seen ten or twelve individuals this summer.

[608] *Piranga erythromelas* Vieill. Scarlet Tanager. Fig. 20.

Common. I have succeeded in finding but one nest of this bird this summer but they are doubtless fairly common. I photographed the nest on August 2. It then contained three eggs. The nest was on the horizontal limb of a red oak, about six feet from the trunk and twelve feet from the ground.

[610] *Piranga rubra* (Linn.). Summer Redbird.

Rare. I have seen but one individual of this species.

[611] *Progne subis* (Linn.). Purple Martin.

Common.

[612] *Petrochelidon lunifrons* (Say). Cliff Swallow.

Not rare. This bird is not often seen. It is more common inland than near the lake.

[613] *Chelidon erythrogaster* (Bodd.). Barn Swallow.

Common. Often seen skimming the air near and over the lake.

[614] *Tachycineta bicolor* (Vieill.). Tree Swallow.

Common. Living in dead trees close to the lake. Often seen skimming over the surface of the lake seemingly within three or four inches of the water.

[616] *Clivicola riparia* (Linn.). Bank Swallow.

Common. Found nesting in the bank of the railroad and various places.

[619] *Ampelis cedrorum* (Vieill.). Cedar Bird.

Not common. I have seen three pairs this summer. On August 19 I found a pair of these birds in a swamp with two young. They had left the nest.

[622] *Lanius ludovicianus* Linn. Loggerhead Shrike.

This bird is not very common around the lake. I have seen two individuals. Their nesting time is so much earlier than when I arrived that all that did nest here had left to wander over the country.


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[624] *Vireo olivaceus* (Linn.). Red-eyed Vireo.

Common. Probably much more common than they seem, as they are rather hard to identify if they do not sing. A most curious bird. I have seen one of these little birds follow me over one hundred yards from pure curosity apparently.

[627] *Vireo gilvus* (Vieill.). Warbling Vireo.

Fairly common. This little bird is much oftener heard than seen. It prefers lofty perches, generally around damp places. I have in mind a very large willow near the lake shore, in swampy ground, that often offers a perch for one of these songsters.

[628] *Vireo flavifrons* Vieill. Yellow-throated Vireo.

Not common. At least I have not often recognized it.

[636] *Mniotilta varia* (Linn.). Black and White Warbler.

Rare. I have seen but one specimen of this warbler. It was picking industriously at an old gnarled root of a white oak. The tree was on the bank of Cherry Creek, about one half a mile up from the mouth. I searched all around the tree but could find no signs of a nest.

[652] *Dendroica aestiva* (Gmel.). Yellow Warbler. Fig. 21.

Very common. This bird's nest is very often found in young willows and in rose bushes around the lake. In this region they seem to prefer swampy places for nesting. I have frequently seen males of this species with the chestnut stripes few or wanting entirely. The nest in the photograph was taken on July 1. It was situated in a wild rose bush on the edge of a swamp.

[658] *Dendroica rara* (Wils.). Cerulean Warbler.

Rare. I have noted two of this species. I shot one of them. It was hunting over the bark of an old oak, up in the topmost branches. The other one was in the top of a large sycamore.

[674] *Seiurus aurocapillus* (Linn.). Oven Bird.

Rare. The rather damp forests do not seem to be adapted to this bird. I secured one specimen and recognized it at another time.

[675] *Seiurus noveboracensis* (Gmel.). Water Thrush.

Not rare. This is a hard bird to identify and is perhaps more common than it seems. I have found one nest on the bank of Cherry Creek.

[676] *Seiurus motacilla* (Vieill.). Louisiana Water Thrush.

Not rare. To be seen at times along Cherry Creek and the lake shore. They are very quick in their movements and hard to see.

[677] *Geothlypis formosa* (Wils.). Kentucky Warbler.

Not rare. These birds inhabit the low wet woods so abundant in this region. I have found one nest here.

[681] *Geothlypis trichas* (Linn.). Maryland Yellow-throat. Figs. 22, 23, 24, 25.

This is the most common warbler around Lake Winona. In fact it is, probably, excepting the song-sparrow, the most common songster here. I have found numerous nests; generally in rather damp ground at the bottom of a clump of weeds, about four or five inches up. When you approach the nest of eggs the female will noisily drop over the side and run away through the weeds, from which it is almost impossible to flush her. When their young are hatched they resent intrusion, often flying by you within three or four feet.

On the morning of July 23, I found a nest containing three eggs of the Maryland Yellow-throat and one of the Cowbird. It was in a bunch of weeds within six inches of the ground. The place was rather damp and about twenty yards from the lake shore. It was so cleverly concealed I would never have found it had not the female jumped up. I took a negative and left, coming back twice a day till July 26. On my first trip in the morning the eggs were still unhatched but at 3 o'clock in the afternoon I found the Cowbird and one Maryland Yellow-throat hatched and another almost out as the shell was chipped considerably. I came back at 5 o'clock and the second Maryland Yellow-throat was out.

On coming back next morning things were the same; two birds and one egg. The young Maryland Yellow-throats kept their mouths open all the time while the Cowbird never opened its mouth. The young Maryland Yellow-throats were continuously struggling to maintain their place and keep the Cowbird from smothering them.

On the 28th the extra egg had disappeared and was not to be seen around the nest.

On the 29th things were as usual and on the 30th they were also the same. On the 31st the last born Maryland Yellow-throat had disappeared and was not to be seen around the nest. The Cowbird and the remaining Maryland Yellow-throat had feathered out pretty well by this time. On August 4 the Cowbird was occupying the entire nest and the Maryland Yellow-throat was sitting on the edge. They were both ready to leave. In the afternoon at 4 o'clock the nest was empty. The vociferous cries of the old birds assured me that they were in the weeds thereabouts, and so I left them.

[683] *Icteria virens* (Linn.). Yellow-breasted Chat. Fig. 26.

Not common. I found only one nest of this bird. It was in a bush three feet up on a steep bank sloping down Cherry Creek from Chicago Hill. I photographed it on July 13. It then contained three eggs.

[687] *Setophaga ruticilla* (Linn.). American Redstart.

Common. This little bird is often seen flashing from some perch after an insect and then returning to its lookout again. I found one nest in the fork of a sapling about eight feet up.

[704] *Galeoscoptes carolinensis* (Linn.). Catbird. Fig. 27.

Very common. Nesting in damp thickets largely. The nest in the photograph was discovered July 2. It was situated in a bush in swampy ground near the lake shore.

[705] *Harporhynchus rufus* (Linn.). Brown Thrasher.

Very common. A bird having, as a rule, extreme devotion to nest and seemingly without fear when disturbed.

[718] *Thryothorus ludovicianus* (Lath.). Carolina Wren.

Rare. I have seen but one specimen of this wren and that was about four miles away from the lake, near an old abandoned log hut. I hunted diligently for a nest but failed to find one or to see the mate.

[721] *Troglodytes aëdon* Vieill. House Wren.

Not common. I have seen but nine specimens of this wren during two months of summer. I can not account for it as twenty or thirty miles from here they are common. The large number of Jays in the park and around the lake may have something to do with it.

[724] *Cistothorus stellaris* (Licht.). Short-billed Marsh Wren.

Rare. I noticed one of these birds sitting on a reed in a marsh, singing. The marsh was full of the long-billed wren, but I have only seen the short-billed wren once in this locality.

[725] *Cistothorus palustris* (Wils.). Long-billed Marsh Wren.

Common. They are confined to the little swamps around the lake. I found twenty-six nests within twelve square feet in one swamp. The nests are globular with a very small entrance in one side which often takes quite a search to find. They are generally lined with vegetable down or moss.

[727] *Sitta carolinensis* Lath. White-breasted Nuthatch.

Common. These birds are often seen around the lake. I have watched a pair hunt over a willow within four feet of my window.

[728] *Sitta canadensis* Linn. Red-breasted Nuthatch.

Rare. I have seen one specimen in company with a pair of White-breasted Nuthatches. These were hunting on some large oaks near Tippecanoe River, a few miles away from the lake. They worked within twenty feet of me at one time.

[731] *Parus bicolor* Linn. Tufted Titmouse.

Common. Generally to be heard and then seen.

[735] *Parus atricapillus* Linn. Chickadee.

Very common. To be seen about the first of August in large flocks among the trees. Noted by their wheezy note and industrious tapping.

[751] *Polioptila cærulea* (Linn.). Blue-gray Gnatcatcher.

Not common. I have seen only four individuals.

[755] *Turdus mustelinus* Gmel. Wood Thrush.

Common. Their music is often heard around the lake.

[761] *Merula migratoria* (Linn.). Robin.

Very common.

[766] *Sialia sialis* (Linn.). Bluebird.

Not common. Bluebirds seem to avoid this locality for some reason. I have not seen over thirteen or fourteen specimens this summer.

DESCRIPTION OF FIGURES.

Figure 1. Nest of a Bob White just as found.

Figure 2. The same nest with the grass which concealed it pushed aside. The eggs themselves were not touched.

Figure 3. The nest and eggs of a Least Bittern. It is a mere platform of swamp grass about two feet above the water. The water was about three feet deep.

Figure 4. The nest of a Mourning Dove. The nest was in a very exposed position on a brush pile. It was about twenty feet from the lake shore.

Figure 5. The nest and eggs of a Black-billed Cuckoo. It was on the hanging limb of an oak about five feet from the ground.

Figure 6. The same nest with one young bird.

Figure 7. A back view of the Black-billed Cuckoo sitting on her nest.

Figure 8. A side view of the Black-billed Cuckoo on her nest.

Figure 9. Nest of Whip-poor-will with a young Whip-poor-will, of part of the shell it came from and of an unhatched egg.

Figure 10. A view of the two young Whip-poor-wills, showing difference in size, caused by about twenty-one hours difference in age.

Figure 11. Female Whip-poor-will brooding in a pen place around the nest.

Figure 12. Whip-poor-will lengthwise on a log, resembling a knot.

Figure 13. Bobolink's nest in a clump of swamp grass. One side of the clump of grass is cut away to expose the nest.

Figure 14. Nest of a Maryland Yellow-throat with two Cowbird eggs.

Figure 15. Field Sparrow's nest and eggs.

Figure 16. Female Whip-poor-will brooding. The two young have their heads out in front. They are in a box placed around them after she had coaxed the young away from the first pen.

Figure 17. Phoebe's nest with young.

Figure 18. Nest of a Meadowlark.

Figure 19. The same nest with the grass pushed aside so as to expose the eggs.

Figure 20. The nest of a Scarlet Tanager. It was on a horizontal limb of a red oak, placed about six feet from the trunk of the tree and about twelve feet from the ground.

Figure 21. The nest and young of a Summer Warbler. The nest was in a wild rose bush.

Figure 22. The nest and three eggs of a Maryland Yellow-throat and one of a Cowbird.

Figure 23. One young Cowbird, two young Maryland Yellow-throats and one egg of the Maryland Yellow-throat.

Figure 24. One surviving young Maryland Yellow-throat and the young Cowbird. Same nest as in Fig. 22.

Figure 25. The young Maryland Yellow-throat pushed upon the edge of the nest by the Cowbird, while the Cowbird comfortably fills the nest. Same nest as in Figs. 22 and 24.

Figure 26. The nest and eggs of a Yellow-breasted Chat. The nest is situated in the fork of a bush about two and one-half feet from the ground.

Figure 27. The nest and eggs of a Catbird. The nest was in a bush at the edge of a swamp.

9. A List of the Dragonflies of Winona Lake.

Clarence Hamilton Kennedy.

The dragonflies in the list below were collected by the writer during the summer of 1900 and by Mr. E. B. Williamson and the writer during the summer of 1901. The writer is especially indebted to Mr. E. B. Williamson for assistance and encouragement in the work.

The region indicated in this paper by the term "Winona Lake" includes not only the present body of water of that name but also the lowlands surrounding it, which, together with the present lake-bed once formed the bed of a much more extensive body of water. There are thus included the two short tributaries of the present lake, Cherry Creek and Clear Creek, and also about a quarter of a mile of the present outlet down as far as the old glacial dam. This gives a small, well-defined region in which, with the exception of the surroundings afforded by larger streams, are included nearly all types of dragonfly environment, swamp, meadow, woodland, lake and stream.

Consequently the number of species found is relatively large. The list, if we count *Sympetrum assimilatum* as a distinct form, now numbers forty-five species. It is fairly complete for the smaller kinds but will probably have several additions yet from among the larger, swift-flying, rarer species.

The outlet as far as the old glacial dam should be well worked. Here will probably be found several stream inhabiting species not at present included in the list. Thorough collecting during May and June might add a species or two not found later in the season. Practically no collecting has been done previous to June 25.

1. *Calopteryx maculata* (Beauvois).

This species is extremely abundant in the heavy shade along the banks of Cherry Creek during the early and middle summer. In 1900, after a few heavy rains about the 1st of August their numbers were greatly diminished.

2. *Hetærina americana* (Fabricius).

Common in the old outlet below the first wagon bridge. A male was taken at the mouth of Cherry Creek about the first of August, 1900.

3. *Lestes disjunctus* Selys.

A male and female taken by Mr. E. B. Williamson in the swamp south of the lake on July 13, 1900. One female taken by the writer south of the lake July 23, 1900.

4. *Lestes rectangularis* Say.

Four males taken by Mr. E. B. Williamson in the swamp south of the lake, July 13, 1900. One male taken by the writer at the same place, July 6, 1901.

5. *Lestes vigilax* Hagen.

One female was taken August 15, 1900, south of the lake.

6. *Lestes inequalis* Walsh.

One female was taken in the spatterdock beds on the south shore of the lake, July 8, 1901.

7. *Argia putrida* (Hagen).

Occasional on the sand bank and pier at the mouth of Cherry Creek.

8. *Argia violacea* (Hagen).

Fairly common about the water. This species is especially abundant along the banks of Cherry Creek during August.

9. *Argia sedula* (Hagen).

One specimen, a male, was taken July 8, 1901, along the south shore of the lake.

10. *Argia tibialis* (Rambur).

Three males of this species were taken south of the lake, July 13, 1900, E. B. Williamson.

11. *Argia apicalis* (Say).

Two males were taken by Mr. E. B. Williamson, south of the lake, July 13, 1900. One female was taken by the writer July 26, 1901, in the same swamp.

12. *Nehalennia posita* (Hagen).

Common in the grass about the laboratory.

13. *Nehalennia irene* (Hagen).

One specimen, a male, was taken by Mr. E. B. Williamson near the Biological Station, June 22, 1901.

14. *Enallagma hageni* (Walsh).

This species is common in the vegetation along the shores of the lake until the middle of July.

15. *Enallagma carunculatum* Morse.

Common everywhere about the lake. Next to *En. signatum* this is the most common species of *Enallagma* about the lake.

16. *Enallagma aspersum* (Hagen).

"A single female was taken June 27, 1901, in the woods on Chapman Hill, near Winona Lake. The female of this species of *Enallagma* is so distinctively colored that I do not hesitate to record the species for the State on such scanty material."*

17. *Enallagma traviatum* Selys.

This species is common on the willows and in the sedges about Winona Lake until the middle of July.

18. *Enallagma geminatum* Kellicott.

Very common on the willows near the laboratories until the middle of July. They have generally become rare by August 1.

19. *Enallagma exsulans* (Hagen).

This species occurs with *En. tranatum*, *En. geminatum* and *En. carunculatum*. It is common until August 1.

20. *Enallagma antennatum* (Say).

This species is common about the laboratories during June. One male was taken, July 6, 1901, along the south shore of Winona Lake.

21. *Enallagma signatum* (Hagen).

This is the most abundant form of *Enallagma*. It is especially abundant over the lily beds where it reaches its maximum abundance during the latter part of the summer after most other *Enallagmas* have disappeared.

22. *Enallagma pollutum* (Hagen).

This species is common on the lily beds along the south shore of Winona Lake during July where it appears only at dusk, probably remaining secreted in the dense vegetation of the adjoining swamp during the daytime. One specimen, a male, was taken on the lily beds at the old outlet August 17, 1900, by Dr. Howe.

23. *Ischnura verticalis* (Say).

This is common about the sedges and lily beds. The females are apparently much more abundant than the males, especially is this so among those found in the sedges and grasses.

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* E. B. Williamson, Proceedings Indiana Academy of Science, 1901, p. 119.

24. *Progomphus obscurus* (Rambur).

Taken along the shore in front of the laboratories during the latter part of June, 1901. E. B. Williamson.

25. *Dromogomphus spinosus* Selys.

Taken during July several times at Winona Lake. E. B. Williamson.*

26. *Boyeria vinosa* (Say).

Occasional in the woods about the lake, where they are generally found flying slowly in and out among the bushes hunting small diptera.

27. *Basiaeschna janata* (Say).

One specimen, a female, was taken August 5, 1900, in the bacteriological tent by Mr. Showers. The specimen is not at hand. The late date makes us doubt the identification.

28. *Anax junius* (Drury).

This species is common during the early summer about the shores and over the lily beds. A few badly frayed individuals remain the entire season.

29. *Epicordulia princeps* (Hagen).

Common during the entire summer along the shores of the lake, over the lily beds, and back over the swamps and meadows. It is a very strong flier and is on the wing from dawn to dark, never being seen to alight, and seldom seen in copulation.

30. *Tramea lacerata* Hagen.

This is common about the shores and over the lily pads the entire summer. It is a high, swift flier and, though common, is seldom taken.

31. *Perithemis domitia* (Drury).

This little dragonfly is common over the lily and potamogeton beds. Of the two sexes the males are much the more abundant.

32. *Celithemis eponina* (Drury).

Very common over the lily and potamogeton beds during the middle and latter part of summer. Constantly pairing.

33. *Celithemis elisa* (Hagen).

This very pretty species is moderately common in the swamp south of Winona Lake during the middle and late summer.

34. *Sympetrum rubicundulum* (Say).

This species is very common in the meadows and fields about the lake during the latter part of summer. It is especially common south of the

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*Proceedings Indiana Academy of Science, 1901, p. 121.

lake. Though a good flier it spends most of its time alighted on some weed or fence. A male of Var. *assimilatum* Uhler was taken July 30, 1900, by Mr. Cyrus Rutor.

35. *Sympetrum obtrusum* (Hagen).

One specimen, a female, taken July 13, 1900, was doubtfully referred to this species by Mr. E. B. Williamson. This species should be fairly common.

36. *Sympetrum vicinum* Hagen.

Two females were taken during the summer of 1900, one by Dr. J. R. Slonaker, and one by the writer.

37. *Sympetrum corruptum* (Hagen).

"Near Winona Lake, August 10, 1901, one male. Miss N. O. Harrah."*

38. *Mesothemis simplicicollis* (Say).

Common during the entire summer over the lily beds, along the sandy shores and over the sloughs and swamps.

39. *Pachydiplax longipennis* (Burmeister).

Generally associated with *Mesothemis simplicicollis*, but very much less abundant.

40. *Libellula basalis* Say.

This is the most conspicuous species of dragonfly about the lake, and of the larger forms the most abundant. It is found everywhere over the meadows and swamps, along the shores and over the lily beds.

41. *Libellula incesta* Hagen.

Seldom. One male was taken on the lily bed at the outlet, July 28, 1900. Another was seen earlier in the season flying slowly up and down Cherry Creek.

42. *Libellula cyanea* Fabricius.

Occasional. Associated with *Mesothemis simplicicollis* and *Pachydiplax longipennis* over the lily beds.

43. *Libellula pulchella* Drury.

Next to *Libellula basalis* this is the most abundant of the larger species. Common in nearly all situations.

44. *Plathemis lydia* (Drury).

This species is common about the drain ditches in the fields south of the lake. An occasional specimen is seen near the mouth of Cherry Creek.

A *Tramea*, either *carolina* or *onusta*, was seen in 1901 several times about the laboratories. Also in the field just back of Chapman Hill a *Pantala*,

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* Williamson, Proceedings Indiana Academy of Science 1901, p. 120.

probably *hymenaea*, gave the collectors several wild chases. Both *Celethemis fasciata* and *Libellula semifasciata* are almost certain to be taken sooner or later.

b. A New Diagnostic Character for the Species of the Genus Argia.

Clarence Hamilton Kennedy.

The following paper was undertaken at the suggestion of Mr. E. B. Williamson, to whom the writer is also indebted for other suggestions and for much of the material examined.

The paper is the result of an attempt to find some character, if possible structural, by which the females of the five species of Argia found in Indiana could be separated.

The characters generally used in the classification of Odonata are the venation of the wings, the shape of the prothorax, the shape of the abdominal appendages, and the color pattern. A distinction upon the basis of venation has not been attempted. The color pattern is notoriously inadequate, and after careful comparison I find that the structure of the prothorax and abdominal appendages is equally so.

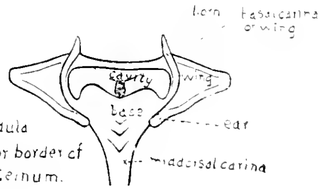
After a close study of the thorax a structure was discovered rarely, if ever, used in classification, which in the case of the five Indiana species is sufficiently different to separate the females readily. This is the peculiar shield-shaped structure on the anterior end of the mesepisternum. I can find no mention of this very peculiar structure except in Selys' "Synopsis des Agrionines." Here, just as I was finishing this paper, I found the following, in which Selys recognizes the diagnostic value of this character in the case of the females of the genus Argia: "De grandes difficultés se présentent pour donner les diagnoses des quarante-six espèces (Argia) Américaines, dont plusieurs sont trèsvoisines les unes des autres. Les appendices anals des mâles et *les lames du devant au thorax* des femelles fournissent, il est vrai, pour la plupart, des caractères positifs; mais ils eussent rendu les diagnoses très-longues, et ces organes ne pouvant etre bien vus qu' avec un certain grossissement, j'ai cherché dans les diagnoses de ce Synopsis, à me passer de ces caractères, qui seront réservés pour une monographie spéciale."*

* De Selys-Longchamps, Synopsis des Agrionines, Bulletins de l'Academie royale de Belgique, 2me série, tome XX, No. 8, p. (9).

As far as I know the "*monographie speciale*" was never published.

Calvert, too, in a paper which has just appeared on the genus *Argia*, recognizes this structure.*

This structure occurs, as far as I have examined, in all the native genera of the Zygoptera, but it is lacking entirely in the Anisoptera or possibly is replaced there by the low transverse carina across the extreme anterior end of the mesepisternum. It is found on the same general plan in the different genera, consisting of a heart-shaped enlargement of the mid-dorsal carina, on either side of which is a triangular wing with its apex running down to the mesinfraepisternum.



Argia sedula
Anterior border of mesepisternum.

In the genus Argia a more or less oblong depression (cavity—see figure above), bounded on either end by the high basal carina of either wing (see figure above) occurs in front of the heart-shaped end of the mid-dorsal carina. The basal carina of each wing ends in front in a horn, and behind, in the case of the females of four of the five species, in an ear-like lobe (the ear—see figure above). In the male no elaborate expansion into an ear occurs. The most striking differences in this structure are those of the size and shape of the ears. As these ears are absent in the males, for them the structure loses most of its diagnostic value. However, for interest in comparison, figures of this structure as it occurs in the males of the five species are shown in the plate (see Plate II, Figs. 1, 3, 5, 7 and 9). By reference to them it will be seen at once that, in the male, this structure is of a more generalized type than in the female. The structure as found in the male is nearer the general type found in related genera.

The above would seem to indicate that this structure is a sexual organ functioning in the female and merely passively present in the male. One would at once jump at the conclusion that it is the organ by which the male holds the female during the act of copulation. The cavity would

*Calvert, Bull. Mus. Comp. Zool. Nov. 1902.

seem especially fitted for the insertion of the abdominal appendages of the male. But from direct observation it is known that the male holds the female by the prothorax, probably by the encircling groove at its anterior end. Moreover, because this structure is covered by the posterior lobe of the prothorax, it would be impossible for the male to reach it. See Plate II, Fig. 2.

Nevertheless this structure must in some way be involved in the act of copulation. It is interesting to note that in the Anisoptera where the male holds the female by the head instead of by the thorax this peculiar structure is not developed at all.

But whatever its function, or whether it has a function or not, its form is sufficiently different in the females of the different species of Argia, and sufficiently constant among those of any given species to warrant its use in classification. How far this structure is good in showing relationships, it is difficult to say. According to it *putrida* would fall in a very distinct group by itself. *Apicalis* would fall by itself. *Violacea*, *sedula*, and *tibialis* would fall in a group by themselves, in which *violacea* and *sedula* would be much more closely related than either to *tibialis*.

A key to females may be constructed as follows:

A. The ears entirely absent. The whole structure wide laterally and narrow from front to back............................*apicalis*.

AA. The *posterior edge* of each wing produced into a broad rectangular lobe. The median longitudinal fossa of the base broad and shallow ....*putrida*.

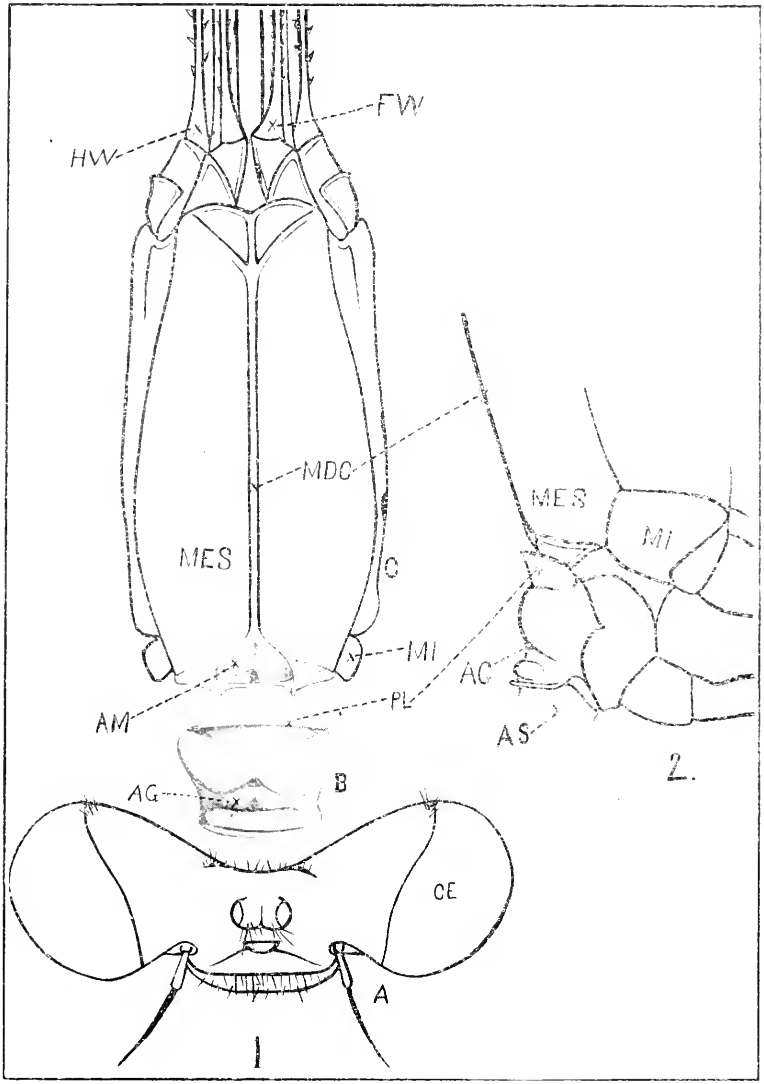
AAA. The *posterior angle* of each wing produced into an ear. The median fossa relatively deep.

B. The apex of each ear pointing forwards and upwards. The entire structure relatively deep from front to back. *tibialis*.

BB. The apex of each ear pointing upwards and backwards.

C. The cavity very narrow. The ears broad and flat. *violacea*.

CC. The cavity of usual width. The posterior edge of each ear turned up.......................*sedula*.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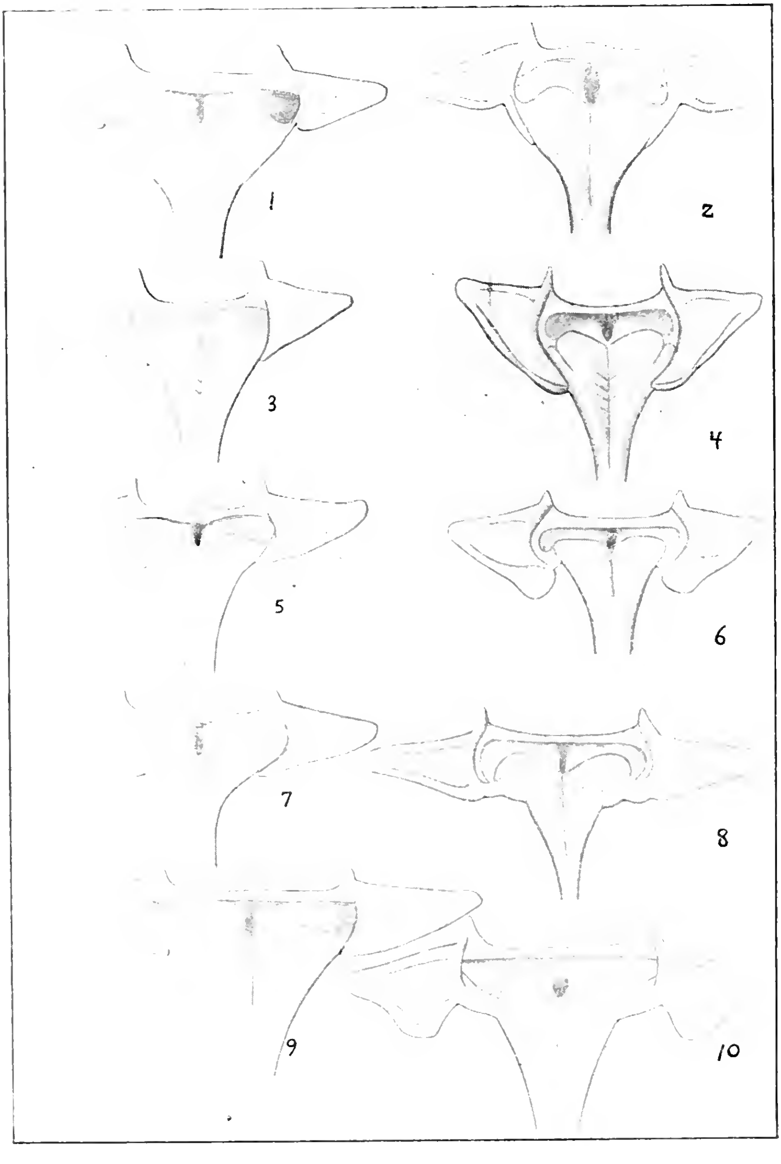
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EXPLANATION OF THE PLATES.

Plate I.

The drawings were made with a camera lucida, using a Bausch and Lomb 1/6 objective with the lower lens removed and a 2-inch eyepiece.

Fig. 1. *Argia apicalis* (Say). Bluffton, Ind., August 18, 1900, E. B. Williamson. Dorsal view of head, prothorax, and mesothorax of ♂, disjointed.

A—Head. *CE*, compound eye.

B—Prothorax. *PL*, posterior lobe. *AG*, anterior groove.

C—Mesothorax, the metathorax showing underneath. *AM*, anterior end of mesepisternum. *MDC*, middorsal carina. *MES*, mesepisternum. *MI*, mesinfraepisternum. *HW*, hindwing. *FW*, forewing.

Fig. 2. *Argia apicalis* (Say). Bluffton, Ind., August 18, 1900, E. B. Williamson. Lateral view of prothorax, and mesothorax.

AS—Articulating surface for head. Other lettering as for Fig. 1.

Plate II.

The drawings were made with a camera lucida, using a Bausch and Lomb 1/6 objective and 2-inch eyepiece.

1. *Argia tibialis* (Rambur). Bluffton, Ind., June 17, 1901, E B. Williamson. Anterior end of mesepisternum of ♂.

2. *Argia tibialis* (Rambur). Bluffton, Ind., June 17, 1901, E. B. Williamson. Anterior end of mesepisternum of ♀.

3. *Argia sedula* (Hagen). Fort Wayne, Ind., July 18, 1901, E. B. Williamson. Anterior end of mesepisternum of ♂.

4. *Argia sedula* (Hagen). Fort Wayne, Ind., July 18, 1901, E. B. Williamson. Anterior end of mesepisternum of ♀.

5. *Argia violacea* (Hagen). Tippecanoe River, Ind., July 2, 1901, E. B. Williamson. Anterior end of mesepisternum of ♂.

6. *Argia violacea* (Hagen). Pittsburg, Pa., June 15, 1899, E. B. Williamson. Anterior end of mesepisternum of ♀

7. *Argia apicalis* (Say). Bluffton, Ind., June 2, 1901, E. B. Williamson. Anterior end of mesepisternum of ♂.

8. *Argia apicalis* (Say). Bluffton, Ind., June 2, 1901, E. B. Williamson. Anterior end of mesepisternum of ♀.

9. *Argia putrida* (Hagen). Bluffton, Ind., June 17, 1901, E. B. Williamson. Anterior end of mesepisternum of ♂.

10. *Argia putrida* (Hagen). Fort Wayne, Ind., July 18, 1901, E. B. Williamson. Anterior end of mesepisternum of ♀.

Investigation of the Action Between Manganese Dioxide and Potassium Chlorate in the Production of Oxygen.

Edward G. Mahin.

The method for preparing oxygen by heating mixtures of potassium chlorate and manganese dioxide has been used by chemists for some time. Since, however, the manganese dioxide comes out unchanged at the end of the process, yet considerably lowers the temperature necessary for decomposition of potassium chlorate, its exact function has been and is yet imperfectly understood.

There is not only a practical, but also a very interesting theoretical question involved in the explanation of the reaction taking place in this process, and it was the desire for obtaining further light on certain points that led Professor Ransom and the writer, at the suggestion of the former, to jointly undertake a study of the facts. Some questions, the settlement of which was to be attempted, were: 1. Does variation in proportion of potassium chlorate and manganese dioxide affect the temperature at which oxygen is evolved, and, if so, what mixture yields it at the lowest temperature? 2. Is the action continuous when the mixture is heated for a long period at or just above the decomposition temperature, and what are the products? 3. Heating for a period just below this temperature, are any intermediate products formed and what are they? 4. To notice any new facts brought out by the experimental work.

Search of the literature shows that the men who have performed the most important work upon this particular phase of the subject are McLeod, Brunck and Sodeau. McLeod had noticed the well-known fact that a gas resembling chlorine was evolved with oxygen, and in 1889, published a statement of experimental work, deducing the following reactions:

$$2\ Mn\ O_2 + 2\ K\ Cl\ O_3 = K_2\ Mn_2\ O_8 + Cl_2 + O_2.$$
$$K_2\ Mn_2\ O_8 = K_2\ Mn\ O_4 + Mn\ O_2 + O_2.$$
$$K_2\ Mn\ O_4 + Cl_2 = 2\ K\ Cl + Mn\ O_2 + O_2.$$

Upon this basis he explained the supposed fact that free chlorine is evolved only at the beginning of the process, since chlorine is liberated by the first reaction and at the lowest temperature, and that corresponding to this free chlorine, there was a certain amount of undecomposed potassium manganate at the end. In 1893 Brunck argued that if these reactions took place, the residue should either be alkaline or contain potassium manganate, or permanganate, and that he could obtain no evidence that either was the case. He brought forward experimentai evidence to prove that the evolved gases did not contain more than a mere trace of chlorine and affirmed his belief that the odor and the property of bluing starch and potassium iodide paper was due to ozone. In 1894 McLeod stated that when the gases were led through alkaline silver nitrate solution, and this later acidified, a precipitate was obtained which corresponded in quantity with the alkalinity of the residue in the generator. He could obtain no evidence of ozone. Some further work was done by these men but they did not apparently succeed in settling the point at issue.

Sodeau, in 1901, proved that the action of manganese dioxide, barium sulphate, sand, and other supposedly inert bodies increased the evolution of oxygen not mechanically, but chemically.

EXPERIMENTAL.

The apparatus used in the experimental part of the present investigation was very simple. Hard glass test-tubes five inches in length, with side necks, were used for heating the mixtures, these being placed in a bath of Wood's fusible metal, heated in a thick cast-iron cup large enough to accommodate five tubes. A thermometer was also placed in the metal. Short delivery tubes, with ends drawn to a narrow aperture, led to a vessel for collecting the evolved gases in test-tubes over water.

The manganese dioxide used was Merck's "Artificial Pure," and previous to using was heated for several hours in an open dish over a free flame, in order to remove moisture; it was then placed in a glass stoppered bottle for keeping. Eimer and Amend's potassium chlorate was dried for six hours at 105°-110° for this purpose. It was not labeled "C. P." but tested free from chlorides both before and after drying.

The first mixtures were made in the following molecular ratios of manganese dioxide to potassium chlorate: 10:1, 2:1, 1:1, 1:2, 1:10. These were ground together, placed in the tubes, and slowly heated. At 150°-165° a gas was evolved from all, showing the presence of oxygen by means of a glowing spark, and giving a strong odor of chlorine or chlorine oxide. This odor is certainly not that of ozone and may be either chlorine or chlorine oxide, or both. In this paper it will be provisionally called chlorine. It was noticed that considerable moisture collected upon the upper parts of the generator tubes, indicating that at least one of the substances still contained moisture.

Other portions of the same mixtures as above were dried in their tubes for several hours at 100°-105°. Chlorine was evolved upon heating to 122° but no oxygen was evidenced by a spark. At 135° the rate of evolution of oxygen was approximately in direct proportion to the amount of manganese dioxide used, this being the reverse of the case when the materials were not dried. This, however, is not stated as a definite law.

Four other mixtures were more carefully dried, then heated in the bath. Chlorine was evolved at 140°, oxygen at 168°.

It was early seen that no reliable results could be obtained so long as the manganese dioxide held moisture. To determine whether this substance was hygroscopic, and if so, roughly the amount of water taken up, some freshly dried material was weighed in a closed bottle, then allowed to stand open for definite periods, weighing after each period. In twenty minutes its weight increased approximately 1 per cent.; after one and a half hours, 3 per cent.; after forty-five hours, 6 per cent.

To determine the difference in behavior due to this moisture, two mixtures were prepared: In (X) the manganese dioxide was dried over a free flame, weighed in a glass-stoppered bottle and the weighed potassium chlorate added. The other mixture (Y) was of potassium chlorate and ordinary undried manganese dioxide; both were molecular mixtures. In this and future experiments chlorine was tested for by starch and potassium iodide paper. At 125° (X) gave no chlorine or oxygen, (Y) gave large quantities of chlorine but no oxygen. Much moisture collected in (Y). At 148° a steady stream of oxygen came from (Y), continuing as long as heated. No trace of chlorine or oxygen came from (X).

More manganese dioxide was purified by digesting in cold distilled water, then washing until free from chlorides. The wash water contained small amounts of manganese and calcium. The washed mass was dried for two and a half hours at 200°-210°.

Four tubes were now filled with mixtures in molecular proportions, transferring the manganese dioxide quickly at 200° to the hot weighing bottle, cooling, weighing, adding the ground and weighed potassium chlorate, and mixing. The mixtures were quickly transferred to the tubes, the delivery tubes of which were in this case guarded with granular calcium chloride. A tube of dry potassium chlorate was heated with the others, in order to judge the amount of expanding air forced over.

The tubes were kept at 135°-140° for four and a half hours; no gas was over beyond that due to simple expansion, and not the slightest trace of either chlorine or ozone was found in any generator tube. No oxygen could be discovered. The mixtures upon testing were found to contain a considerable amount of chlorides. The temperature was raised to and kept at 150° for three hours and no chlorine or oxygen was produced. The quantity of chlorides seemed to be increased. At 173° all of the tubes began to evolve oxygen and so long as this temperature was maintained a steady but slow stream of oxygen was produced. No trace of chlorine, chlorine oxide or ozone was produced as high as 180°.

At this point the work was stopped for lack of time. Thus far a few conclusions may be provisionally advanced:

The conditions under which oxygen is ordinarily produced are not ideal, and the moisture always present materially influences the reactions. This moisture makes possible the production of oxygen at a lower temperature than in the case of dry materials, also the formation of chlorine or chlorine oxide, or both, as low as 125° and before oxygen is evolved. This may be due to hydrolysis of the potassium chlorate or chloride, thus allowing oxidation by the manganese dioxide. It is possible and even probable that no chlorine would be evolved at any temperature within the ordinary range of heating, if the materials were entirely free from moisture. In such a case, McLeod's explanation must fail, since if it be true, the formation of free chlorine is a necessary step in the evolution of oxygen.

This point, with others mentioned, will be more fully investigated by future work, and it is hoped that some facts of interest may be brought out during the investigation.

Action of Heat on Mixtures of Manganese Dioxide With Potassium Nitrate and With Potassium Bichromate.

J. H. Ransom.

The fact that different metallic oxides mixed with potassium chlorate cause the latter to evolve oxygen at considerably lower temperatures than when heated alone has long been known, though the nature of the chemical action involved is not with certainty established. No work has been done, so far as I am aware, to see what the effect of these oxides might be on other substances decomposable by heat.

It seemed, therefore, of interest to investigate the subject, and especially the action of manganese dioxide on various substances, as the results might throw some light on the action between it and the chlorate.

The substances chosen for the preliminary work were potassium nitrate and potassium bichromate. When potassium nitrate is heated to a high temperature it loses one-third its oxygen and forms the nitrite. If molecular proportions of the nitrate and manganese dioxide are mixed and heated in a metal bath, little if any evolution of oxygen occurs below 285° C. Between that temperature and 350° C. there is a constant, though not rapid, evolution of a gas which gives the usual test for oxygen. The amount, however, is not large, and during the heating there are formed brown oxides of nitrogen. In the same bath was a tube containing the same weight of pure dried potassium nitrate but there was no evidence of any decomposition. During the heating some moisture collected in the colder part of the tube, but whether this had any effect in causing the decomposition of the mixture, as is found in the case of the chlorate, has not yet been determined.

When potassium bichromate is heated alone in a free bunsen flame little or no oxygen is evolved even at the highest temperature obtainable. When mixed with manganese dioxide, however, a steady stream of gas is evolved at a comparatively low temperature. The decomposition begins at 285° but does not increase greatly in rapidity up to 350°. The temperatures at which the nitrate and the bichromate decompose are so nearly the same that a similarity of action is suggested. Whether the oxygen comes from the oxide, the other substance or from both has not yet been determined. That the oxide has some effect in producing the evolution of oxygen is certain. The investigation will be continued along this and related lines and the nature of the actions will be thoroughly studied as soon as time permits. It will also be of interest to know whether such oxides as the one used will lower the temperature at which substances ordinarily decompose, but without the evolution of oxygen. Such a substance would be ammonium nitrate. This subject will also be inquired into. In the meantime I wish to reserve this field of investigation.

Criticism of an Experiment Used to Determine the Combining Ratio of Magnesium and Oxygen.

James H. Ransom.

In some of the modern laboratory manuals for use in general chemistry work an experiment is described whereby a weighed amount of magnesium powder is oxidized in a covered crucible until a constant weight is obtained. The increase in weight has been assumed to be due to oxygen, and thus the ratio of the two elements in the oxide easily calculated.

My students have performed this experiment during the last two years but have not been able to secure sufficiently concordant results to make it appear to them as illustrating the law of constant composition.

Some observations are readily made in performing the experiment. The product, except perhaps at the surface, is not white, as is magnesium oxide, but of a gray color, due evidently to a mixture of substances of different colors. Also the crucibles at the end of the experiment are coated within with a black substance which can not be removed even on scouring with sand; and the crucibles lose in weight.

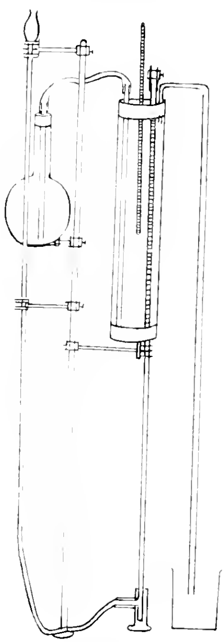
Examination of the product of burning shows that on treatment with small amounts of water ammonia is evolved, thus indicating that magnesium nitride is one of the substances present. As in this compound the ratio of the elements is 1:388 while in the oxide it is 1:667 it follows that from this standpoint the increase in weight must be less than the theory. Again, on treating the product with fairly concentrated hydrochloric acid a disagreeably odorous gas is evolved which at times is spontaneously combustible. It is, without doubt, hydrogen silicide from magnesium silicide formed by the action of magnesium on the crucible material. On treating with acid as above described there always remains a black insoluble amorphous residue mixed with white particles which under a hand-lens look like silica. The black mass when heated on platinum foil changes to a white powder which resembles silica. Apparently the black portion is silicon. It is conceivable that a part of the silicon after being formed, and during the heating, is oxidized by the air; and as it unites with nearly twice as much oxygen as does the same weight of magnesium, it might equalize the loss of the oxygen content due to the causes already indicated. Thus can be explained the nearly theoretical results so often obtained. But at best these results must remain a matter of chance and the experiment, seemingly so simple, but in reality so complicated, can not well be put into the hands of students doing their first work in chemistry.

Modifications of the experiment which will avoid these sources of error are in the mind of the writer, but have not been subjected to test for lack of time. Should they prove successful I shall be pleased at some future time to communicate them to the Academy.

An Apparatus for Illustrating Charles's and Boyle's Laws.

James H. Ransom.

Some difficulty having been experienced in making clear to students the changes in the volumes of gases due to the simultaneous changes in



temperature and pressure, it seemed that a clearer notion could be given by having a single piece of apparatus to illustrate their laws. Such an apparatus, a cut of which is presented, was devised to overcome the difficulty. It consists of an ordinary graduated gas burette connected with a reservoir for mercury and surrounded by a water jacket which in turn is connected with a flask containing water. The flask and jacket are so arranged that water of any desired temperature can be siphoned from the former through the latter, thus heating the gas in the burette to any temperature between 0° and 100° C. A thermometer inserted in the jacket indicates the temperature of the water. At the beginning of the experiment the water in the jacket should be at the room temperature, and the flask should hold several times the volume of the jacket. By the method of siphoning the change in tempeature is so gradual that the gas is heated to the water temperature almost as rapidly as the latter passes through, and there is no danger of breaking the burette. With the apparatus each law may be deduced separately with a fair degree of accuracy. Then the two laws united and the results compared with those found mathematically from a combination of the two. The idea of absolute zero is illustrated in a very clear and convincing way. If desirable the burette may be filled with different gases, and thus it may be shown that all obey (practically) the same laws.

Some $\triangle_2$-Keto-R-Hexene Derivatives.

James B. Garner.

A study of the reactions which might be brought about between benzöin and unsaturated aldehydes, ketones, and esters through the agency of cold (15° C.) alcoholic sodium ethylate, was begun several years ago[1]. At that time it was found that benzöin is added to benzalacetone giving rise to a 1.5 diketone which by loss of water and ring formation, is converted into 3-4-5-triphenyl-4-oxy-$\triangle_2$-keto-R-hexene. This substance had previously been prepared by Professor Alexander Smith[2], using potassium cyanide as condensing agent[3]. When sodium ethylate is used as condensing agent, the yield is much greater, the reaction takes place more smoothly and the product formed is purer than when potassium cyanide is used. Knoevenagel has made an exhaustive study of the $\triangle_2$-keto-R-hexene de-

[1] Dissertation, Chicago, 1897, p. 17.
[2] Berichte, 26, 65.
[3] Amer. Chem. Jour. XXII, 250.

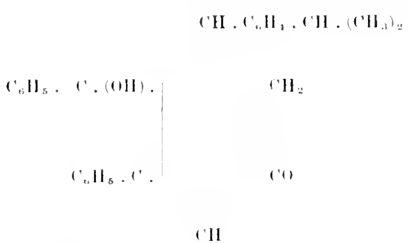
rivatives. He has found, (1) that substances of the type of acetoaceticether and aliphatic aldehydes[1], and aromatic aldehydes[2], condense in the presence of diethylamine or piperidine to form 1.5 diketones, and that these diketones, with loss of water and ring formation, are converted into Δ_2-keto-R-hexene derivatives: (2) that desoxybenzöin adds itself to substances of the type benzalacetylacetone forming 1.5 diketones, which, by loss of water and ring formation, yield Δ_2-keto-R-hexene derivatives.

Recently the study has been extended to include the reactions which might take place between the ketols—benzöin, cuminoin, furoin, anisoin and piperonoin—and the unsaturated ketones-benzalacetone, cuminalacetone, p-methoxy-benzalacetone, and piperonylenacetone. In all the reactions, Δ_2-keto-R-hexene derivatives are formed, except in those in which furoin is used. Under no conditions has it been possible to bring about any interaction in any of the experiments in which furoin is used. All of the other reactions progress smoothly and excellent yields are obtained in each case. It has been ascertained also, that in place of the unsatured ketone, a mixture of the corresponding aldehyde and acetone may be used and the course of the reaction is in no way changed, but the yield is materially increased. To insure the completion of the reactions, however, it is necessary to boil the mixtures for fifteen minutes on the water-bath. Equal volumes of a ten per cent. solution of sodium hydroxide may be used instead of the alcoholic sodium ethylate and the same reactions will take place but the yields are very much poorer.

In the present paper the study is limited to the consideration of only those cases, which will in a general way, indicate, (1) the nature of the products formed and, (2) the extent to which the reaction is applicable.

I. ADDITION OF BENZÖIN TO CUMINALACETONE.

3-4-diphenyl-5-cumyl-4-oxy-Δ_2-keto-R-hexene.



[1] Ann. 281, 25. Ann. 288, 321.
[2] Ann. 303, 223.

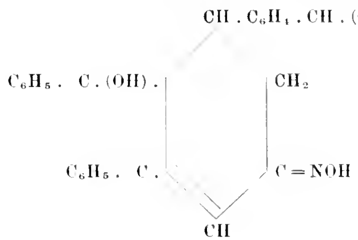
For the preparation of this Δ_2-keto-R-hexene derivative, one molecule (6 gr.) of benzöin is dissolved in boiling absolute ethyl alcohol (100cc.), and to this solution is added one molecule (5.32 gr.) of cuminal-acetone. This mixture is treated with an alcoholic solution (4cc.) of sodium-ethylate (.5 gr. sodium in 30cc. absolute ethyl alcohol). The mixture becomes deep red in color and upon standing in a cool place for two hours deposits clusters of needle-like crystals. The crystalline mass is filtered off and after washing with absolute ethyl alcohol is recrystallized twice from glacial acetic acid. Clusters of long, fine, white needles result which melt at 231°. It is insoluble in ligroin (40-60), ether, and cold alcohol, but dissolves readily in hot benzene, glacial acetic acid and chloroform.

Calculated as $C_{27}H_{26}O_2$.	Found.
C 84.80	84.67
H 6.81	6.92

If a mixture of one molecule each of cuminol (4.2 gr.) and pure acetone (1.7 gr.) is used instead of the cuminalacetone, it has been established by several comparable experiments that it is necessary that the reaction shall be carried on at the temperature of the water bath for fifteen minutes. Upon the cooling of the mixture, the Δ_2-keto-R-hexene derivative separates in a relatively pure condition. By repeated additions of 4cc. of sodium ethylate at a time, additional quantities of the substance are obtained which make the yield almost quantitative. Experiments were made using the total quantity of sodium ethylate solution (12cc.) required for the quantitative completion of the reaction, and it was found that the reaction took an entirely different course, resulting in the formation of the sodium ethylate addition product of benzöin[6].

The condensation takes place readily when 15 grs. of a 10% solution of sodium hydroxide are used in place of the 4cc. of sodium ethylate solution.

Oxim of 3-4-diphenyl-5-cumyl-4-oxy-Δ_2-keto-R-hexene.

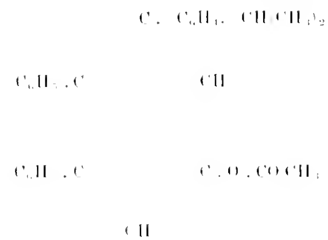


[6] Dissertation, Chicago, 1897, p. 4.

This oxim is obtained by boiling a mixture of one molecule (1 gr.) of the $_2$-keto-R-hexene derivative with three molecules (.56 gr.) of hydroxylamine hydrochloride and one and one-half molecules (.56 gr.) of sodium carbonate dissolved in ethyl alcohol (140cc.) for forty-five minutes, using a return condenser. One-half of the alcohol is distilled off and the residue on cooling deposits white crystals, which, when they have been recrystallized from a mixture of benzene and ligroin, melt at 221–3°. The substance is easily soluble in hot alcohol, cold ether, acetic acid, and hot benzene, but very sparingly soluble in hot ligroin (40–60°).

Calculated as $C_{27}H_{27}O_2N$.	Found.
N. 3.53	3.72

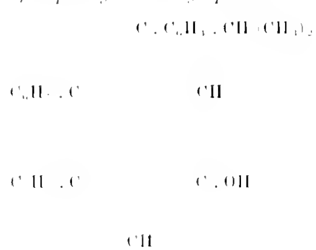
3-4-diphenyl-5-cumyl-phenol-acetate.



This body is prepared by boiling the $_2$-keto-R-hexene derivative with excess of either acetic anhydride or acetyl chloride for thirty minutes. The mixture assumes a yellowish-red tint, and yields a solid substance only when it is poured into a large excess of water. The white amorphous mass recrystallizes from hot ligroin (40–60°) in bunches of long needles, melting at 98°. It is soluble in cold glacial acetic acid, benzene, ether and alcohol, but is sparingly soluble in ligroin.

Calculated as $C_{29}H_{26}O_2$.	Found.
C 85.72	85.50
H 6.40	6.62

3-4-diphenyl-5-cumyl-phenol.

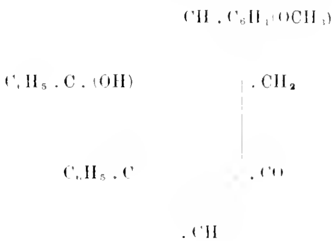


The acetate is boiled upon a water-bath with alcoholic potassium hydroxide for fifteen minutes. The mixture resulting is poured into excess of dilute hydrochloric acid, and a white mass is obtained. The amorphous phenol is recrystallized from hot alcohol. It forms white needles, which melt at 155°. It is readily soluble in cold chloroform, benzene and ether, but sparingly soluble in hot ligroin (40–60°).

Calculated as $C_{27}H_{24}O$.	Found.
C 89.00	88.96
H 6.60	6.87

II. ADDITION OF BENZOIN TO ANISYLIDEN ACETONE.

3–4–diphenyl–5–anisyl–4–oxy– $_2$ keto–R–hexene.



The 3–4–diphenyl–5–anisyl–4–oxy– $_2$–keto–R–hexene is prepared by the condensation of one molecule (6 gr.) of benzöin, either with one molecule (5 gr.) anisylidenacetone, or with one molecule each of anisaldehyde (3.9 gr.) and of pure acetone (1.7 gr.) under exactly the same conditions which were used in the preparation of 3–4–diphenyl–5–cumyl–4–oxy– $_2$–keto–R–hexene. The substance crystallizes in bunches of needles, either from hot glacial acetic acid, or absolute alcohol, and melts at 233.5°. However the amount of alcohol required is large—for each gram, 70cc. of hot absolute alcohol are required. It is soluble in hot benzene and chloroform, but insoluble in ether and ligroin (40-60°). With cold concentrated sulphuric acid, a deep red coloration is produced.

Calculated as $C_{25}H_{22}O_3$.	Found.
C 81.08	80.91
H 5.95	6.03

Oxim of the 3–4–diphenyl–5–anisyl–4–oxy– $_2$–keto–R–hexene.

For the preparation of the oxim, a method, analogous to that described in the preparation of the oxim of 3–4–diphenyl–5–cumyl–4–oxy– $_2$–keto–R–hexene, is used. After recrystallization from hot alcohol, it melts at 196°.

It is soluble in hot glacial acetic acid, chloroform, and benzene, but insoluble in ether and ligroin (40-60°).

Calculated as $C_{25}H_{23}O_3N$.	Found.
N. 3.63	3.85

Acetate of 3–4–diphenyl–5–anisyl–phenol.

This product is obtained by boiling the Δ_2-keto–R–hexene derivative with acetyl chloride on the water-bath for ten minutes. The mixture assumes a deep red coloration. Nothing separates on cooling. When excess of water is added, however, an amorphous mass separates which, upon crystallization from hot ligroin (40-60°) or from aqueous alcohol, melts at 141^5–2°. It is soluble readily in cold benzene, ether, glacial acetic acid and chloroform; sparingly soluble in hot benzene and aqueous alcohol.

Calculated as $C_{27}H_{22}O_3$.	Found.
C 82.22	82.40
H 5.59	5.84

3–4-diphenyl–5–anisyl–phenol.

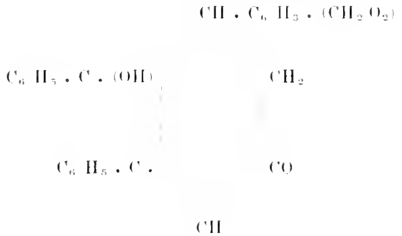
The acetate upon saponification with alcoholic potassium hydroxide yields the phenol. The reaction requires only fifteen minutes heating upon the water-bath to complete it. The product, which is obtained when the resulting solution is poured into dilute hydrochloric acid, is recrystallized from a mixture of alcohol and ligroin (40-60°) and melts at 159–60°. It is readily soluble in cold ether, benzene, chloroform and acetic acid, and almost insoluble in hot ligroin.

Calculated as $C_{25}H_{20}O_2$.	Found.
C 85.24	85.17
H 5.68	5.93

This phenol reacts vigorously at the ordinary temperature with cold concentrated nitric acid and yields nitro derivatives. These nitro bodies will be investigated later.

III. ADDITION OF BENZOIN TO PIPERONYLENACETONE.

3-4-diphenyl-5-piperyl-4-oxy-Δ_2-keto-R-hexene.



One molecule (6 gr.) of benzoin and one molecule (5.9 gr.) of piperonylenacetone are dissolved in hot absolute ethyl alcohol (100cc.) and a solution (4cc) of sodium ethylate (.5 gr. sodium in 30cc. absolute alcohol) is added. As in all these condensation reactions with sodium ethylate, this mixture assumes a deep red coloration. Upon standing for two hours rosettes of yellow needle-like crystals separate. These crystals, upon recrystallization from glacial acetic acid, are obtained in fine white glittering needles, melting at 240°. The substance is soluble in hot chloroform; sparingly soluble in hot benzene and alcohol; and insoluble in ether and ligroin (40-60°).

Calculated as $C_{25} H_{20} O_4$.		Found.
C	78.12	78.00
H	5.21	5.38

The method above described for the preparation of 3-4-diphenyl-5-piperyl-4-oxy-Δ_2-keto-R-hexene does not progress as smoothly and as completely as when one molecule each of piperonal (4.25 gr.) and of pure acetone (1.7 gr.) is used in place of the piperonylenacetone, and the reaction is carried out at the temperature of the water-bath. The crystals obtained by this method are very pure and clean, and the yield is almost quantitative, especially if the mother liquor is treated again with more sodium ethylate and the mixture again boiled.

Ten per cent. sodium hydroxide solution also effects the condensation. However the yield is poor.

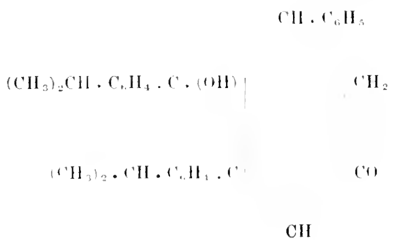
Oxim of 3–4–diphenyl–5–piperyl—4 oxy–$\triangle_2$–keto–R–hexene.

This oxim is prepared in an analogous method to that described previously for the preparation of oxims. When recrystallized from a mixture of alcohol and ligroin, crystals are formed melting at 190–1°. It is soluble in hot alcohol, cold ether, chloroform, and hot benzene, and is insoluble in ligroin (40–60°.)

Calculated as $C_{25}H_{21}O_4N$.	Found.
N 3.51	3 78

IV. ADDITION OF CUMINOIN TO BENZALACETONE[7].

3–4–dicumyl–5–phenyl–4–oxy–$\triangle_2$–keto–R–hexene.



Cuminoin, in general, reacts less rapidly than benzoin and the yields of $\triangle_2$–keto–R–hexene derivatives are poorer.

One molecule (6 gr.) of pure cuminoin[8] and one molecule (3 gr.) of pure benzalacetone dissolved in hot absolute ethyl alcohol (60cc.) are treated with a solution (6cc.) of sodium ethylate (.5 gr. sodium in 30cc. absolute alcohol). Upon the addition of the sodium ethylate, the mixture turns deep red, and after standing for six hours clusters of needles separate. By recrystallizing twice from glacial acetic acid, pure 3–4–dicumyl–5–phenyl–4–oxy–$\triangle_2$–keto–R–hexene is obtained. It melts at 214°. It is soluble in cold acetic ether, chloroform, hot benzene and ligroin (110–120°); insoluble in cold alcohol, ligroin (40–60°), and ether. The yield is about 27% of the theoretical.

Calculated as $C_{30}H_{32}O$.	Found.
C 84.90	84.77
H 7.54	7.83

[7] Dissertation, Chicago, 1897, p. 19.
[8] Berichte, XXVI, 64.

Oxim of the 3–4–dicumyl–5–phenyl–4–oxy– $_2$–keto–R–hexene.

A molecule of the substance dissolved in alcohol was boiled with three molecules of hydroxylamine hydrochloride for an hour. On cooling, nothing appeared, but after the larger portion of the alcohol had been distilled off in the water-bath a solid separated, which on being well washed with water and recrystallized from a mixture of benzene and ligroin (40–60°) gave fine white needles melting at 208°. It may be recrystallized also from aqueous alcohol. The analysis shows it to be the monoxim.

Calculated as $C_{30}H_{33}O_2N$.	Found.
3.11	N 3.30

The substance is easily soluble in cold acetic acid, benzene, and acetic ether; insoluble in ligroin (40–60°).

3–4–dicumyl–5–phenyl–phenol acetate.

This body can easily be prepared by boiling the Δ_2-keto–R–hexene derivative with a mixture of acetic anhydride and anhydrous sodium acetate for forty-five minutes, or until the mixture becomes decidedly pink in color. The solution is then poured into a large amount of cold water and allowed to settle. After recrystallization from glacial acetic acid, it is obtained in large bunches of long radiating fibers, and melts, when pure, at 122°. It is soluble in cold benzene, chloroform, ether, and ligroin (40–60°), in hot alcohol and acetic acid.

Calculated for $C_{32}H_{32}O_2$.	Found.
85.71	C 85.60
7.14	H 7.55

The acetyl derivative, when hydrolyzed by means of alcoholic potash yields 3–4–dicumyl–5–phenylphenol.

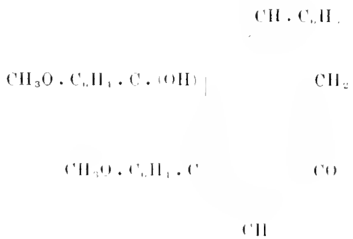
By warming the acetate in a water-bath for ten minutes with four molecules of alcoholic potash and pouring into dilute hydrochloric acid, an amorphous mass is obtained which crystallizes from warm alcohol in large thin plates, melting at 137°. This substance is soluble in cold acetic ether, benzene, chloroform, ether and hot ligroin (40–60°); insoluble in caustic soda.

Calculated as $C_{30}H_{30}O$.	Found.
C 88.66	88.26
H 7.39	7.99

The addition reactions of cuminoin with cuminalacetone, piperonylenacetone and anisylidenacetone are being studied at present, and I hope to be able soon to publish the results obtained.

V. ADDITION OF ANISOIN TO BENZALACETONE.

3–4–dianisyl–5–phenyl–4–oxy–Δ_2–keto–R–hexene.



Anisoin adds itself to the ethylene grouping much more readily than either cuminoin or benzoin to yield the expected 1.5 diketone, but the readiness with which this 1.5 diketone loses water to form the corresponding Δ_2–keto–R–hexene derivative is markedly less. In fact the 1.5 diketone constitutes the major portion of the reaction product. Attempts to prepare the 1.5 diketone pure, *i. e.*, free from the Δ_2–keto–R–hexene derivatives, have failed partially. However, its approximate melting point has been obtained, namely, 168-174°. When boiled with the ordinary solvents in which it is soluble, the 1.5 diketone loses water and forms the Δ_2–keto–R–hexene derivative, which melts at 207°.

The mixture of the 1.5 diketone and the Δ_2–keto–R–hexene derivative is prepared as follows:

One molecule (4.4 gr.) of anisoin and one molecule (2.38 gr.) of benzalacetone are dissolved in absolute ethyl alcohol (62cc.) and to the mixture sodium ethylate solution (4cc.) is added. The solution becomes deep red and upon standing for two hours deposits a large mass of crystals (2.4 gr.). The solid is filtered off and washed well with absolute alcohol. A trial determination of the melting point shows that the product is a mixture. It melts at 168–74° and 204°. The mother liquor from the crystals upon treatment with more sodium ethylate solution yields more of the same products (.4 gr.) Upon recrystallization from either of three solvents—benzene, alcohol or acetic acid—fine white needle-like crystals are obtained, having a constant melting point of 207°. It is soluble in chloroform, slightly soluble in ligroin, and insoluble in ether.

Calculated as $C_{26}H_{24}O_4$.	Found.
C 78.00	77.62
H 6.00	6.13

The acetate and oxim have been prepared, but as yet no analyses have been made, but the physical properties determined correspond very closely with those of the other $_2$-keto–R–hexene derivatives which I have prepared.

An investigation of the reaction of anisoin with cuminalacetone, piperonylenacetone and anisylidenacetone is being carried on.

Geology of the Jemez-Albuquerque Region, N. M.

Albert B. Reagan.

(Abstract.)

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GENERAL DESCRIPTION.

The Jemez-Albuquerque Region described in this paper, is in northwestern New Mexico between longitude 106,° 20′ and 107° W. and latitude 35° and 36° N. Roughly speaking, it is a triangle with its apex toward the south. It is bounded on the southeast by the San Dia Mountains, on the southwest by the Rio Puerco, and on the north by the upper plateau of the Jemez Mountains. Its principal river is the Rio Grande, and its commercial center is Albuquerque. The Santa Fe Railroad enters the region at the northeast, near Thornton, and passes through it, just to the east of the Rio Grande to Albuquerque. At this point the road branches, one branch of the system going to El Paso, Texas, the other, the Atlantic and Pacific, to California and the Pacific coast.

GENERAL SURVEY.

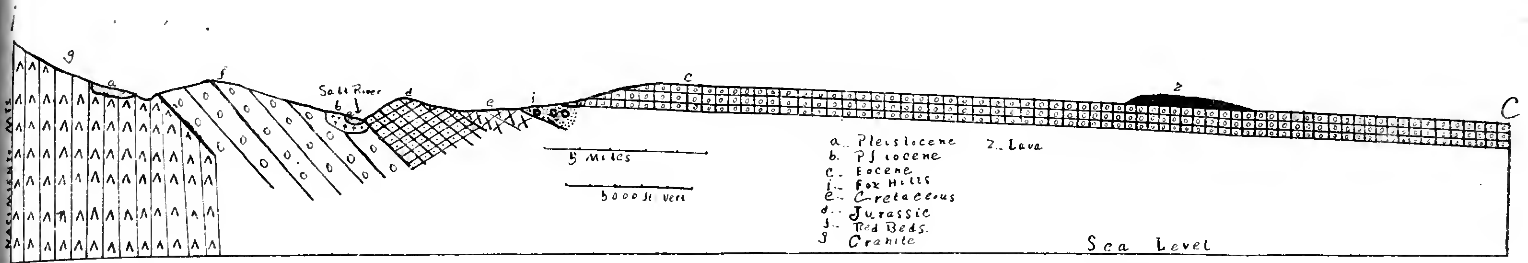
This section, as a whole, is one vast desert area, sparsely covered with grass, piñones, red cedar, sage brush and cactus, except in the valleys where there is sufficient water for irrigation. In these valleys corn, wheat, fruit and beans are raised by the natives and Mexicans. To consider the entire area again, it presents two basin-shaped districts, the Rio Puerco and the Rio Grande, with the strata in each respective basin dipping in general toward its center. The separating line at the north between these basins is the Nacimiento Mountains, the west wing of the Jemez uplift. It is continued at the south in a line of hills which decrease in altitude as they recede from the main range. The two basins merge into one below Albuquerque. The whole area is faulted and much broken and high escarpments often still mark the fault lines. Examples of such escarpments are the San Dia Mountains, Mesa Blanco, and one on each side of the Red Beds just south of the Jemez range. There is also evidence that the Nacimiento Mountains were, originally, the result of a drop on their western side. The resulting escarpment has been worn down and subsequently covered in part by sedimentations that it is not so strong in relief as the San Dia escarpment; the Carboniferous strata which flank this range on the east are entirely wanting to the west of these mountains. Mesa Blanco was left an escarpment by a drop on its northern side of more than 1,600 feet, 1,000 feet of which still remain. The escarpment to the east of the Red Bed mesa is now 900 feet in height and the escarpment to the west of the same mesa is 1,200 feet. On its western margin the strata of this mesa dip toward the east at a great angle, and at a greater angle toward the west on its eastern side. The whole country, as is indicated above, is extremely broken up; the rivers in their process of base-leveling have chiseled their channels deep into the rock. Great dikes and numerous volcanoes puncture the strata; and lava-flows cover hundreds of square miles of its surface. The dip of the whole region, when a dip is noticeable, is usually away from the mountains at an angle ranging from 15° to 90.° In many places the region is a bad land country. Where the lava is superimposed on it, it is of the "mal pais" type; and where the lava is wanting, especially along the break-lines, "mauvaises terres." The culminating points of the area under consideration are, the crest of the San Dia Mountains, the monolith Mt. Cabizon on the Rio Puerco and Mt. Pelado, the culminating point of the Jemez Mountains.

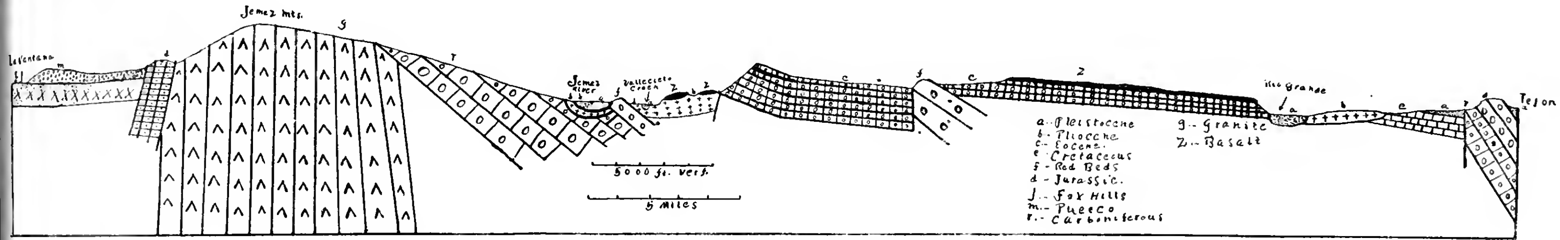
NATURE OF ROCKS.

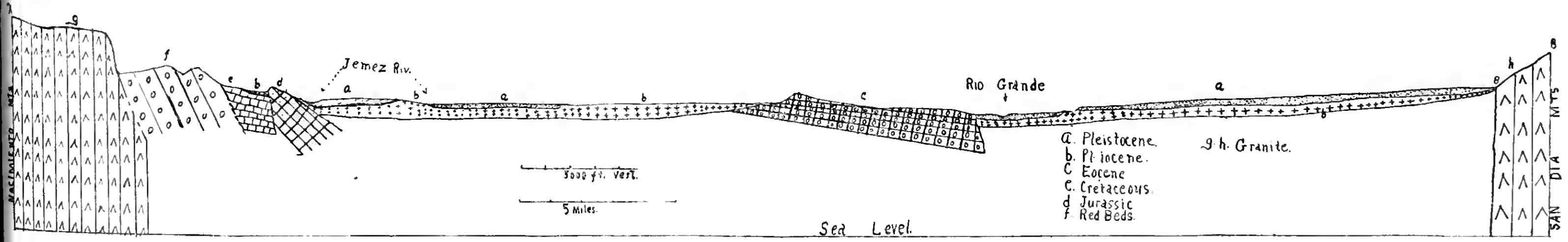
The rocks of this region are intrusive, eruptive and sedimentary.

The intrusive rocks are the cores of the respective mountain districts of Jemez and San Dia, and the dikes throughout the entire area. They are granites, porphyries, gneisses, etc. The eruptive rocks are volcanic

Geology of the Jemez-Albuquerque Region, N M
By Albert Breagan
JEMEZ PLATEAU
SULPHUR SPRINGS
VANTANA
NACIMIENTO MTS
SODA DAM
JEMEZ HOT SPRINGS
CAÑON
SPRINGS
JEMEZ
SAN YSIDRO SPRINGS
MESA BLANCO
RANGE
SANTA ANNA
ZIA MESA
BERNALILLO VOL'S
BERNALILLO
SAN FELIPE VOL'S
ALBUQUERQUE VOL'S
ALBUQUERQUE
RIO GRANDE
SAN DIA MTS
Zea Marls (Eocene)
Placita Marls (Pleistocene)
Basalt (Lava)
Pliocene
Fox Hills
Red Beds
Pierre
Carboniferous
Granite
Fort Union
Permian
Jurassic (Gypsum)
Tufa
Labradorite
Rhyolite
Volcano
Town
Springs
6 miles
3 miles


NACIMIENTO MTS
Salt River
C
5 Miles
5000 ft. Vert.
a. Pleistocene
b. Pliocene
c. Eocene
i. Fox Hills
e. Cretaceous
d. Jurassic
f. Red Beds
g Granite
z. Lava
Sea Level


Jemez mts.
La Ventana
Jemez River
Vallecito Creek
Rio Grande
Tejon
5000 ft. Vert.
5 miles
a. Pleistocene
b. Pliocene
c. Eocene
e. Cretaceous
f. Red Beds
d. Jurassic
J. Fox Hills
m. Pueeco
r. Carboniferous
g. Granite
z. Basalt


NACIMIENTO MTS
Jemez Riv.
Rio Grande
SAN DIA MTS
5000 ft. Vert.
5 Miles
a. Pleistocene.
b. Pliocene.
c. Eocene
e. Cretaceous.
d. Jurassic
f. Red Beds.
g. h. Granite.
Sea Level.

plugs, lavas and tuffs. The lavas are basalt, trachyte and rhyolite. Obsidian also occurs in large quantities on the Jemez Plateau. The sedimentary deposits are the country rocks of nearly the entire region where not covered with lava. They were laid down in the seas and lakes that surrounded the islands which now form the high mountains of San Dia and Jemez. These deposits date back well into the Carboniferous, and continue almost without break to the recent times.

RIVERS.

The rivers of the region are the Rio Puerco, the Jemez and the Rio Grande. The Rio Puerco, as we have seen, closes in on the west the region discussed in this paper; the Jemez River and its tributaries drain the south and also the southwest slopes of the Jemez Mountains; and the Rio Grande passes south through the section east of the Jemez Mountains, and west of the San Dias. The Rio Puerco and the Jemez rivers are tributaries of the Rio Grande.

MOUNTAINS.

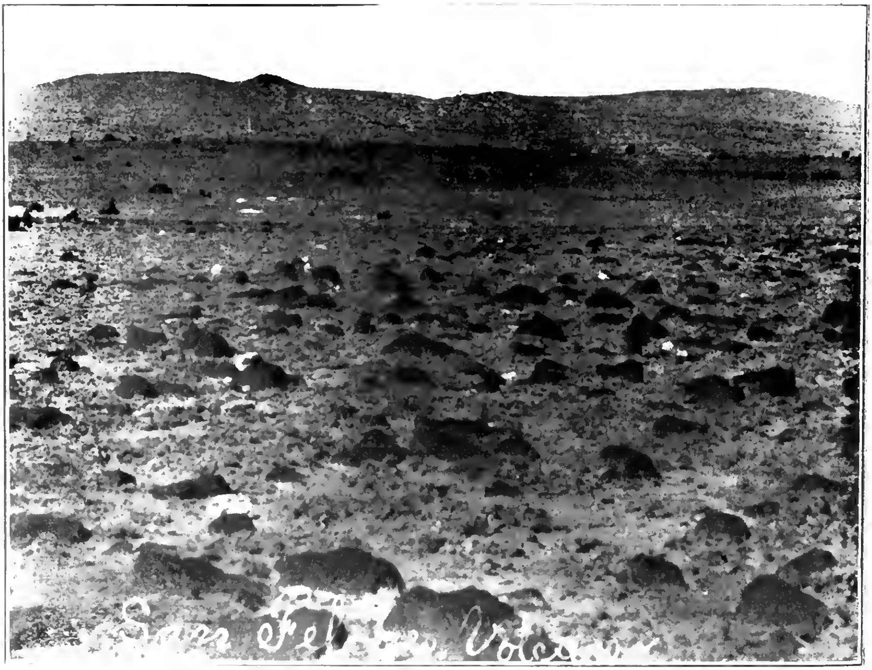
The mountains, as has been stated, are the San Dia and Jemez. The former was caused by a fault of 11,000 feet along their western side, 7,000

Little Pigmy Volcano.

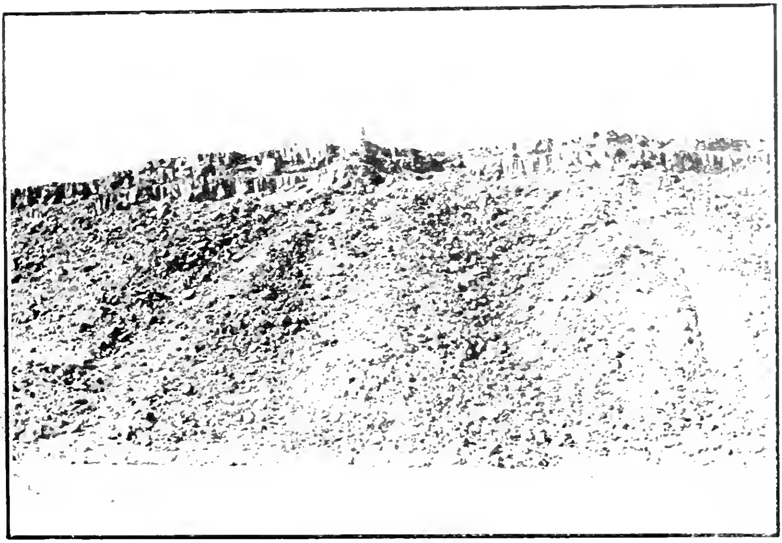
feet of which still remain, as an escarpment. Their core is granite, their cap Carboniferous. The latter (the Jemez Mountains) have a core of red granite, overlaid in most cases, with hundreds of feet of volcanic debris, except along the west wing of the group where the crest is granite.

STRATIGRAPHY.

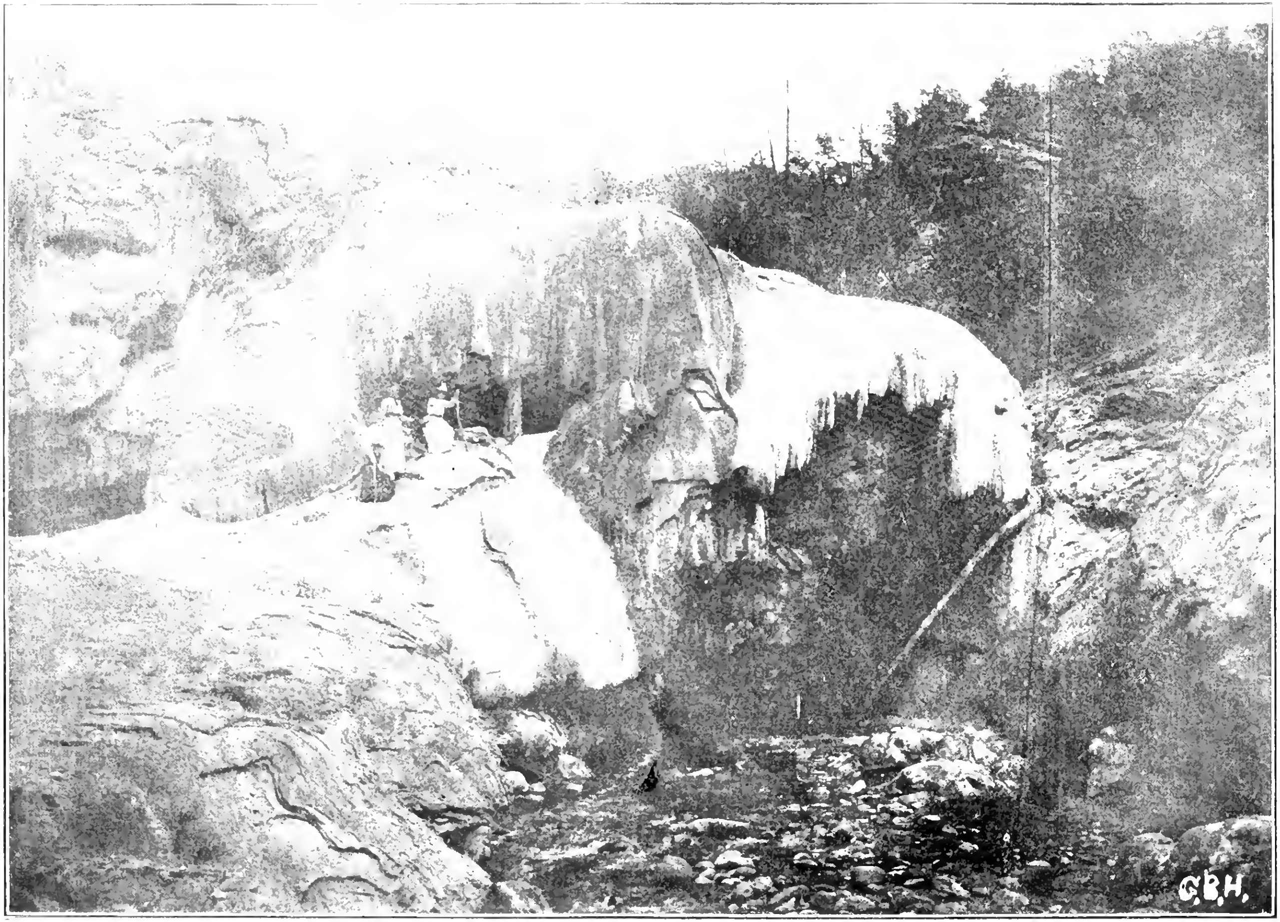
At the close of Carboniferous times or earlier, the Jemez Mountains were uplifted, and associated with their development are to be found large intrusions of granites and porphyries occupying an axial position. During the period of mountain building the western flank of the Jemez was faulted off. These mountains were subsequently surrounded by a shallow Jurassic sea, in which were deposited red sandstones and shales to a thickness of 2,600 feet. Then came the Jurassic revolution. The mountains were re-elevated and the Jurassic strata to the west of the mountains were faulted and tilted to a nearly vertical position. At this time the volcanoes near Pelado became active, and poured out the great rhyolitic sheet which now on the plateau covers the granite porphyritic core of the Jemez range, over which these same volcanoes, at a later time,



hurled out 120 feet of pumiceous tuff. These mountains were still islands in Cretaceous times, but their area then was much greater than formerly. In this period the mountains seem to have been gradually rising until in the Fort Union epoch great swamps covered the entire country, the sea being obliterated for a time. In these swamps vegetation was luxuriant, and the vegetable matter laid down in them forms today the coal fields of northwestern New Mexico. At the close of the Fort Union epoch, there was a slow subsidence. The Puerco was deposited on the Fort Union, and then the Eocene on that, the whole series being conformable. Then



there came a violent change. The whole country was elevated above the sea, much faulted and broken up, and blocked basins on a grand scale resulted. These depressions were the lakes of Pliocene times. One large lake existed in the vicinity of Jemez, and another in the Rio Grand Valley. The lake at Jemez was filled up with the Jemez marls by the tributaries of the Jemez River; and the Rio Grande Lake was silted up with the Albuquerque marls, probably by the tributaries of the river which at present occupies that valley. When these lakes were almost filled, there was a further re-elevation of the country, and the rivers at once commenced to cut down their respective channels; but this deepening of their


G.B.H.

channels was suddenly arrested by the seismic disturbances and the lava flows of Post-Tertiary times. The former changed the incline of the river channels, and the latter dammed up the rivers, thus forming lakes. In these lakes were deposited the Pleistocene marls of the river valleys. At the close of the Pleistocene, these lakes in turn were obliterated and the country took on the general appearance that it has today.

ECONOMICS.

CLIMATE.

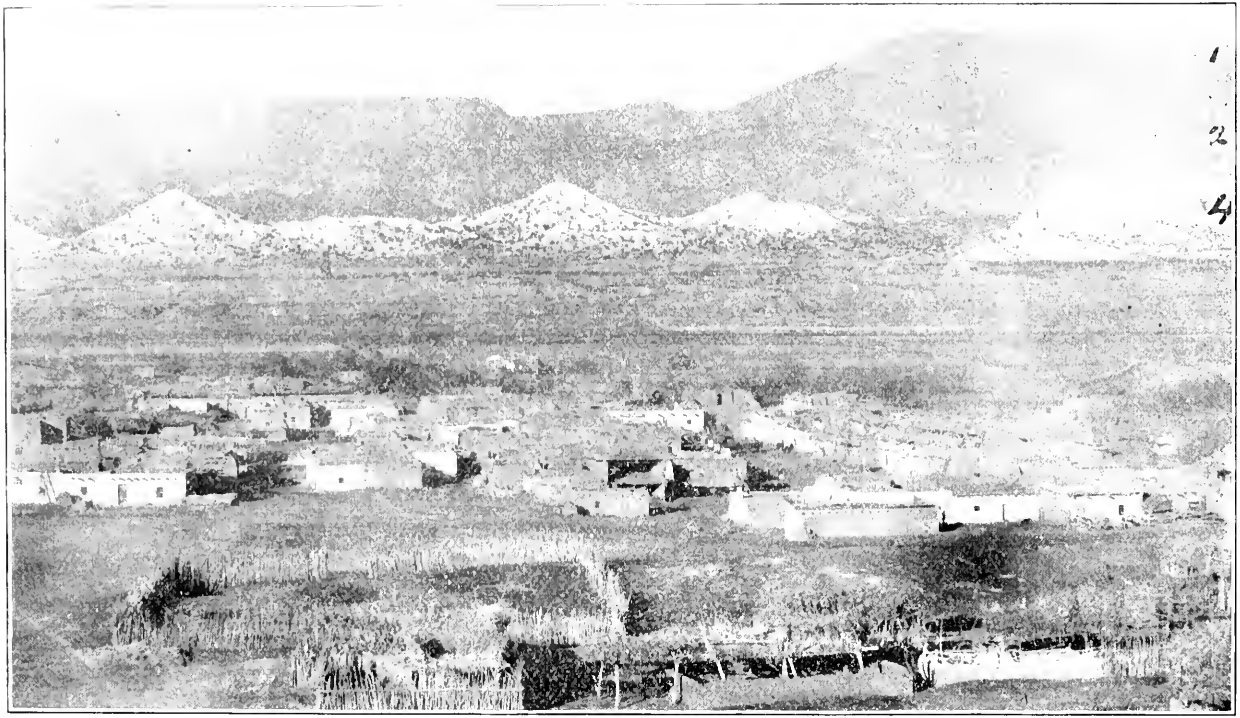
The altitude of this region, 5,000 to 9,000 feet above the sea, and the latitude thirty-five to thirty-six degrees north, combine to give it a climate which for mildness and equality has no superior in the world. Its location, near the center of the vast rainless region of the West, and its remoteness from any large body of water, give it an atmosphere almost totally devoid of moisture. At the same time, by reason of the latitude and altitude, the air is both warm and light, thus furnishing, in unlimited quantities, nature's sovereign remedy for all diseases of the lungs.

Soil.—The soil on the table lands, especially on the Tertiary formations, is poor. There is too much alkali. But if the water for irrigating purposes could be had, even the soil of these mesas, in a few years, could be made productive. It would require considerable labor and the use of fertilizers such as gypsum, burned lime, etc., but in the end it would pay.

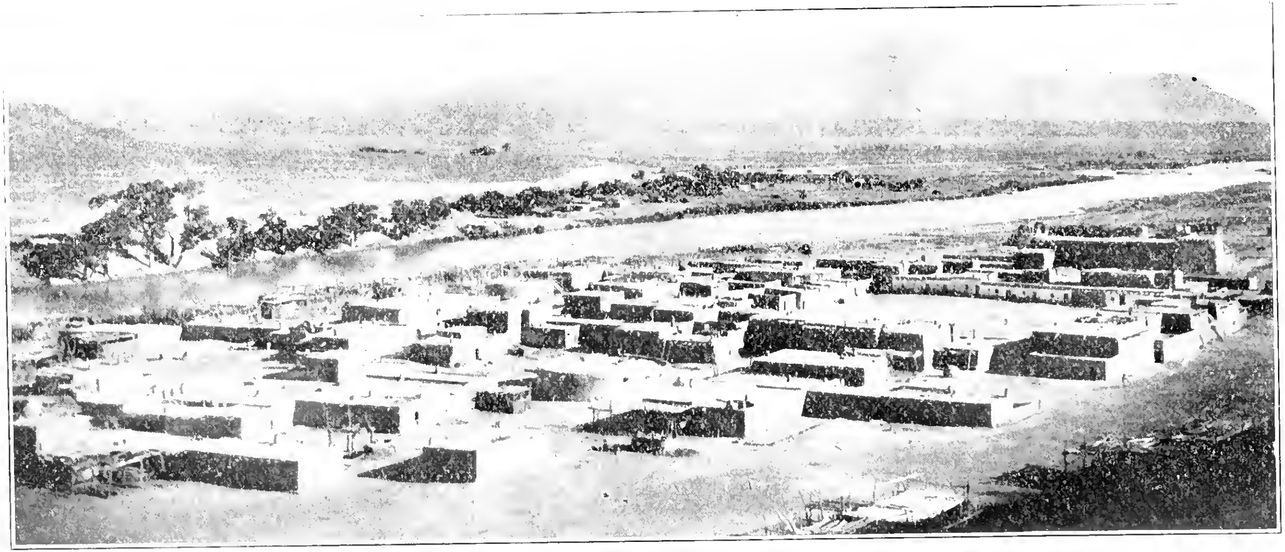
On the mountain plateaus the soil is good, especially in the Jemez Mountains in the Valle Grande country. This great valley, to interpret the Mexican, occupies a high altitude, averaging 9,000 feet. "It embraces 160,000 acres, and forms fine prairies with abundant grasses. On it also the fir and pine are most magnificently developed."

In the valleys the soil is, without exception, the best in the world. It surpasses even the soil of the Nile Valley. In speaking of the Rio Grande mud, Dr. Loew, in the U. S. Geological Surveys of the Territories west of the 100th meridian (Vol. III., p. 578-582) says:

"Irrigation with these mud-carrying waters furnishes the lands with a layer of the best virgin soil in a finely pulverized condition, and the belief of the farmer that the Rio Grande water is an efficacious fertilizing agent is fully warranted by the facts revealed by the chemical analysis.



Indian Village of Jemetz, Jemez Valley. Tertiary Buttes. Nacimiento Mountains.



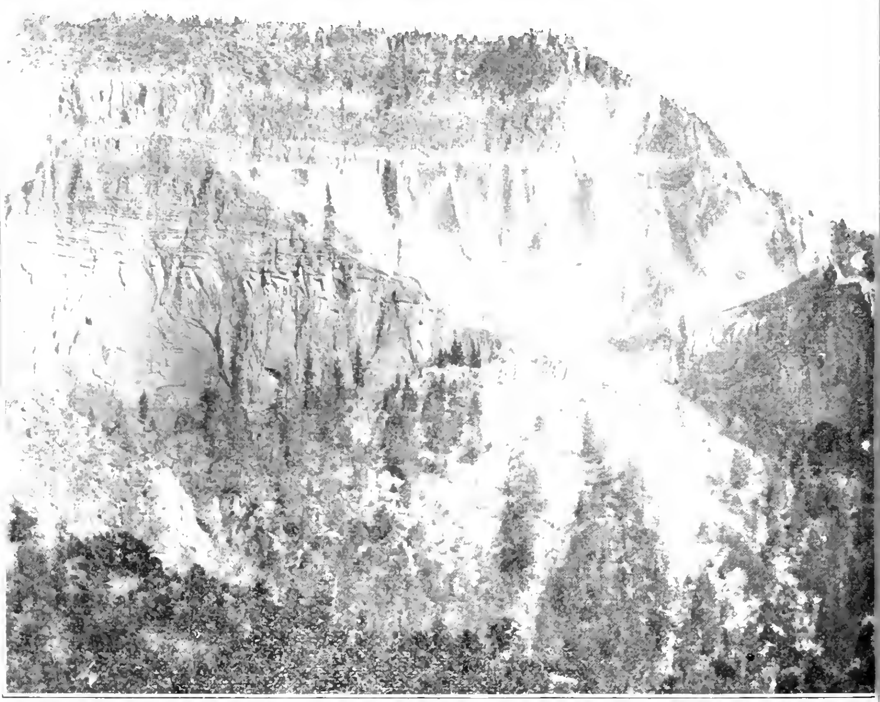
Indian Village of San Felipee. Rio Grande and San Dia Mountains.

Indeed the inhabitants of the Rio Grande will never require any other fertilizer than the waters of the Rio Grande Del Norte."

MINERAL RESOURCES.

Coal.—The Fort Union coal formation underlies most all the lands in this region, except the mountain districts. Its coal outcrops are quite a distance from the railroad and until just recently only Mexicans and Indians knew of its occurrence. The coal is a good quality and the seams are thick. It is reasonable to believe that the time is not far distant when coal will be mined there on a large scale.

Gypsum.—The Jurassic rocks, wherever found, are capped with gypsum from ten to forty feet in thickness. Owing to its thickness and its lack of



Picture showing Tufa near Jemez Hot Springs.

cover, it can be worked to a great advantage. With railroad facilities a great industry will be developed, for the raw material is of good quality.

Gold, Silver and Copper.—The mountains are crossed in all directions by mineral bearing veins; but to date the ores found are too low in grade to ship, the railroad being too far away, and they are not enough in quantity to pay to put a smelter on the ground to smelt them. Should a railroad be put up Jemez Valley, mining would at once become a paying business. Besides the ore in veins, placer gold is found in the Pleistocene deposits, but water for hydraulic mining is wanting. Could the necessary water be obtained, this region would without doubt become one of the leading placer mining districts of the west.

Medicinal Springs.—The springs of the region are numerous, most all are hot, and all possess medicinal properties. Among them are the famous Jemez Hot Springs, and the Sulphurs. These springs surpass those of Minnesota and California. They are visited by people from every part of the United States, and foreigners not infrequently visit them.

This region, with its building stone, with its gypsum, with its forests, with its medicinal springs, with its gold and silver veins and coal fields, and with its fertile soil and unequaled climate, is one of the best regions in New Mexico; and under proper handling, will become one of the wealth-producing regions of the country.

The Jemez Coal Fields.

Albert B. Reagan.

The Jemez coal fields are situated about twenty-five miles west of Bernalillo, thirty miles a little to the west of north of Albuquerque, and six miles south of the Jemez River at San Isidro in longitude 106° 50′ west, and in latitude 35° 30′ north. They cover an area of about twenty square miles.

The strata of this field show a predominance of soft yellow sandstones interbedded with clays and sandy shales. Interbedded with these are strata of brown coal which are freely exposed in the perpendicular walls of the mesas. These coal seams vary from two to twelve feet in thickness; and, along one fault in this respective coal area, seventy feet of coal are exposed at one view. In examining these coal fields, it was observed that in many instances the strata had been destroyed by fire; and the coal being burned out, the roofs had caved in by a succession of faulting, or had collapsed under the pressure. That the destroying agent was fire is attested not only by the clay accompanying the seams being turned to brick, but also by heaps of slag composed of silicates of iron and aluminum. This coal is bitumenous and Fort Union, or Laramie. It is very brittle, somewhat laminated, dull luster.

These coal fields are quite a distance from the railroad, and until just recently only Mexicans and Indians knew of the coal outcrops there. This coal is a good quality and the seams, as we have seen, are thick. The time, no doubt, is not far distant when coal will be mined there on a large scale the same as at Gallop at the western limit of the same coal horizon.

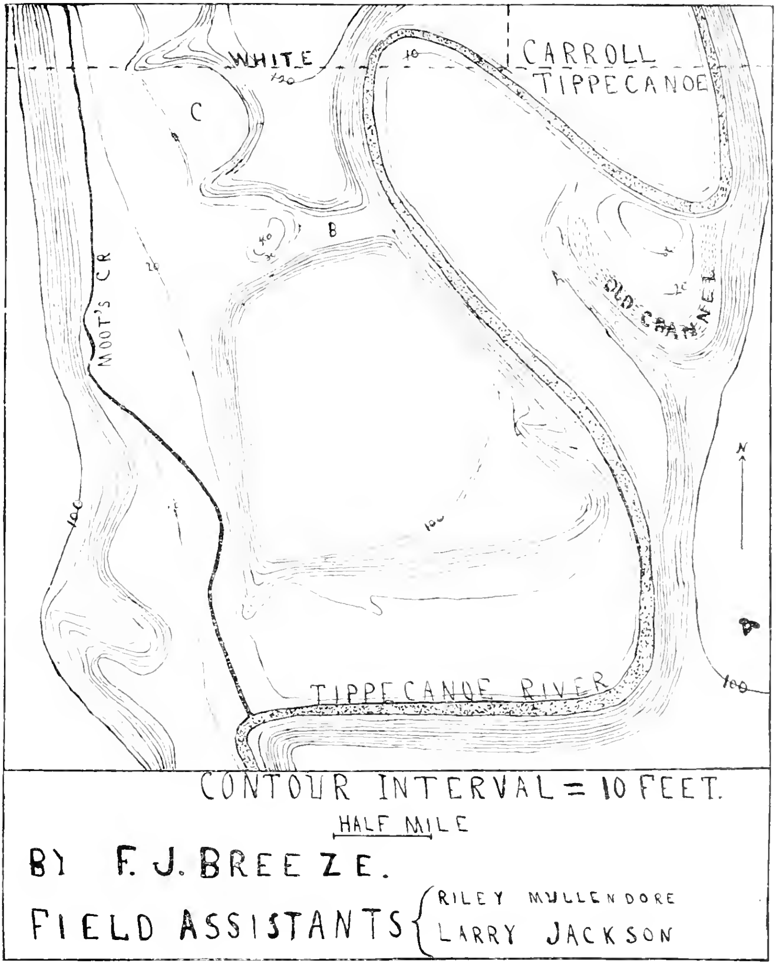
Some Topographic Features in the Lower Tippecanoe Valley.

Fred J. Breeze.

In the valley of the Tippecanoe about a mile below the Carroll--Tippecanoe line are two features of relief which perhaps deserve some attention.

On the east side of the river is a long, narrow ridge of gravelly material, about twenty-five feet high, a few yards wide, and three-fourths of a mile long. (See A on map.) It starts from a hundred foot bluff, and in a short distance slopes down to an elevation of twenty-five feet, and for the remaining distance is nearly level. On the up-river side of the ridge is an abandoned channel of comparative recency. This ridge is evidently a remnant of a large spur of upland which was gradually made narrower by the southward movement of a river bend, of which the present abandoned channel marks the southern limit. Before the spur had been entirely removed, the river straightened its course, thus forsaking the bend; and the remnant of the upland spur is this narrow ridge.

Just west of the ridge, on the other side of the river, is a gap joining the valley of the Tippecanoe with that of Moot's Creek, a tributary which empties about a mile below. (See B on map.) The floor of this gap is forty feet above the river, is nearly 200 yards wide, and is bounded on the north and south by bluffs sixty feet high. At first sight it seems that this gap was formerly the mouth of Moot's Creek; but investigation justifies



another explanation. For two or three miles above its mouth, Moot's Creek flows in a valley roughly parallel with that of the Tippecanoe. At many places the creek valley widens into crescentic hollows which are separated from each other by sharp-pointed, narrow ridges. The floors of these semi-circular areas are about twenty feet higher than the present flood-plain. One of these areas is marked C. Doubtless the gap B was one of the widened portions of the valley, and only a very narrow strip of upland separated it from the Tippecanoe Valley. Later, after Moot's Creek had swung to the west side of its valley, the Tippecanoe by its westward meander removed the dividing strip, thus forming the present gap.

The Action of Hydrogen Peroxide on Cuprous Chloride.

W. M. Blanchard.

This investigation was suggested by the results obtained in the study of the action of large volumes of water on cuprous chloride. Some time ago my attention was called to the fact that when a large volume of water is added to cuprous chloride the salt becomes orange colored. If this water is removed and a second quantity added the color of the salt deepens, and if this operation is carried on long enough, a few days being sufficient if the water is changed every few hours, the salt finally becomes a bright red and in all respects resembles cuprous oxide. Upon analysis the compound proved to be almost pure cuprous oxide.

A search through the literature at command was made but no such action as this was found recorded. A careful study of the reaction was then made. It was at first believed that the reaction took place according to this equation:

$$Cu_2Cl_2 + H_2O = Cu_2O + 2\ HCl.$$

It seemed that the first water added resulted in the conversion of a part of the cuprous chloride into cuprous oxide and hydroclorie acid and that no further change took place until this acid was removed, and more water added. But further investigation showed that this was not correct. The water removed was found to contain cupric chloride; this salt could be produced in this case only by oxidation, and the oxidation could result in all probability only from oxygen dissolved in the water.

By properly constructed apparatus it was shown that water which had been previously boiled for an hour and cooled in a current of hydrogen produced no change on cuprous chloride.

About this time I had access to Dammer's Handbook of Inorganic Chemistry and there I found a reference to this very reaction. It was expressed by the following equation:

$$2\ Cu_2Cl_2 + O = Cu_2O + 2\,CuCl_2.$$

A further study of the reaction proved this to be correct. The reaction, however, is not complete, for only about 97 per cent. of the cuprous chloride is changed, even when the process is carried on for several months and the compound shaken repeatedly with water in a stoppered bottle.

Since these results are produced by dissolved oxygen it seemed that the reaction might be hastened by running a current of oxygen into the water containing cuprous chloride in suspension, since in this case the oxygen could be replenished as fast as used up. The experiment was carried out, but instead of getting a red product, a blue one was obtained. This is probably the basic chloride described by Mailet[1] as formed when a current of moist air is passed over hot cuprous chloride.

This unexpected result led to a study of the action of hydrogen peroxide on cuprous chloride. The investigation is not complete; the results obtained up to date are as follows:

When hydrogen peroxide is added to cuprous chloride, the color of the salt immediately becomes a dirty green, and upon the addition of more peroxide, finally becomes a delicate blue. The compound appears very flocculent. If the reaction is carried out in a bottle or flask connected with a burette, a considerable amount of oxygen can be collected. The volume of oxygen evolved does not seem to bear any direct ratio to the amount of cuprous chloride used. If the reaction is carried out at 100° instead of at ordinary temperature, the reaction seems to be the same except that the evolution of the oxygen is much more rapid. The compound is evidently a basic chloride. It is insoluble in water, does not change in boiling with water, does not materially diminish in weight or change in color until heated to 250,° and is easily soluble in dilute acids and in ammonia. There is some evidence in favor of the following reaction:

$$3\ Cu_2Cl_2 + 6\ H_2O = 2\ Cu_2ClO.OH + 2\ CuCl_2 + 5\ H_2O + 3\ O$$

The reaction probably taking place in two stages. The blue compound would seem to have the composition:

$$\begin{matrix} Cu < OH & \\ & O \cdot 3\ H_2O \\ Cu < Cl & \end{matrix}$$

A curious fact was observed in connection with this study which seems to be true of other complex copper ions. If this blue compound is dissolved in ammonia and hydrogen peroxide added, a violent reaction takes

[1] Comp. rend. 62. 249.

place, accompanied by a rapid evolution of oxygen. The compound itself does not produce such a change, neither does ammonia, but only the solution of the one in the other. It was found that copper sulphate dissolved in ammonia will behave in the same manner.

Ripple Marks in Hudson Limestone of Jefferson County, Indiana.

Glenn Culbertson.

In the proceedings of the Indiana Academy of Science for 1901, and in a paper entitled: Concerning Well Defined Ripple Marks in Hudson River Limestone, Richmond, Indiana, Prof. Joseph Moore and Allen D. Hole describe Hudson limestone ripple marks near Richmond, Indiana.

In this paper I desire to give briefly the location and some points of description of similar markings in the Hudson limestone of Jefferson County, Indiana. In this county, to my knowledge, Hudson limestone ripple marks occur in five widely separated localities and at six different horizons. In all essential points the accurate and full description of the ripple marks at Richmond may be applied to those mentioned in this paper.

The geographical positions of the Jefferson County markings will be given in the order of their geological horizons, the Clinton limestone being used as a basis for measurements. Following this a few of the principal points of interest touching the ripple marks will be included.

The Wolf Run ripple marks are found at the roadside and in the creek bottom within 200 yards of the end of the Ryker's Ridge pike on Wolf Run in Madison Township. In this place there are two quite distinct series of markings. The upper is in a stratum approximately seventy feet below the Clinton outcropping on the neighboring slope. The lower is in a stratum some six or eight inches below the first. The upper series of marks are exposed over a space some 35x8 feet, while the lower is exposed over a surface of some three or four square yards. The trend of the crests of the upper marks is N. 70° E., and of the lower N. 50° E., approximately. I say approximately since there are many small irregularities in the trend of the crests. These crests are, however, essentially parallel. The stone in which all the markings spoken of in this paper occur is the blue, abundantly fossiliferous limestone, so characteristic of the lower and middle Hudson formation in the region of the Cincinnati geanticline. The fossils found in the various ripple marked limestones vary with the horizon in which they occur.

The thickness of the stratum containing the upper Wolf Run marks is from two to three inches, while that of the lower is from one and a half to two inches. The distance from crest to crest or wave length is in the upper series twenty-one inches, and in the lower eighteen inches, approximately. The depth of trough in the upper is one and a half inches, and in the lower one to one and a half inches.

The Clifty Creek series of markings occur in the bed of that stream at a point about one and one-fourth miles above the bridge on the Madison and Hanover pike. The ripple marks are exposed in this place at intervals for a distance of 200 yards. The trend of the crests here is N. 10°-15° E., quite a little irregularity being noticed. The distance from crest to crest is from thirty to thirty-six inches, and the depth of trough three inches. The thickness of stratum five to seven inches, and the approximate vertical distance below the Clinton limestone, 190 feet.

In the bed of the West Fork of Indian Kentucky Creek, one-third of a mile above Manville, a series of ripple marks are found extending some seventy-five yards where the stratum is unbroken. This series I shall call the Van Buren, since they are found but a short distance from the house of John Van Buren. The trend of crests here is N. 40° E.; wave length, thirty inches; depth of trough one and a half to two and a half inches; thickness of stratum, two to three and a half inches. The approximate vertical distance below the Clinton limestone is 342 feet.

In the creek bed, beneath the bridge across the east fork of Indian Kentucky Creek, and within 200 yards of Manville postoffice, a ripple marked layer of limestone from four to six inches thick is exposed at intervals for a distance of 130 yards. At low water the marks are here exposed over a space of 150x25 feet and as many as sixty consecutive crests may be counted. The trend here is approximately N. 10° E., the wave length thirty inches, the depth of trough two and a half inches, the vertical distance below the Clinton formation 350 feet. At this place the wide exposure, amounting at times to 300 or more square yards, affords an excellent opportunity for the study of the relations which the marks bear to each other. It is observed that, while the crests are not straight, but more or less curving in their outline, they are essentially parallel.

On Doe Run, about two miles from Brooksburg, a ripple marked limestone is exposed in the creek bed, over a space of a few square yards. The trend of crests here is approximately N. 45° E.; wave length, thirty-three to thirty-six inches; depth of trough, three inches; thickness of limestone, three to five inches. The vertical distance of this series of marks below the Clinton formation could not be determined so readily as in the other cases, since the outcropping Clinton is not found within a distance of several miles. An approximate vertical distance of 380 feet below Clinton was reckoned on the basis of an observed westerly dip of ten feet to the mile of the Clinton formation in other parts of the county.

The main facts in regard to these ripple marks are placed in tabular form below.

These Hudson limestone ripple marks are exceptional in that ripple marks are unusual in limestone, being found in sandstones and shales chiefly. They are exceptional also in the fact that they are of such large size. A few inches usually measures the distance from crest to crest of ripple marks. Since a ripple is a small wave, these limestone markings might well be called wave marks, were that term not preoccupied. These ripple marks indicate essentially seashore conditions during the period occupied in depositing some 300 feet of Hudson rocks and that the conditions finally resulting in the Cincinnati Geanticline or uplift at the close of the Ordovician, had long been present. The trend of these marks from N. 10° E. to N. 75° E., goes far towards indicating prevailing winds from the northwest or the southeast during that part of paleozoic time represented in the deposition of these rocks.

Location.	Trend.	Distance from Crest to Crest.	Depth of Trough.	Vertical Distance below Clinton Limestone.	Thickness of Limestone Stratum.
Upper Wolf Run Series	N., 75° E.	21 in.	1½ in.	70 ft.	2–3 in.
Lower Wolf Run Series	N., 50° E.	18 in.	1–1½ in.	70 ft. 8 in.	1½–2½ in.
Clifty Creek Series	N., 10°–15° E.	30–36 in.	2–3 in.	190 ft.	5–7 in.
Van Buren Series	N., 40° E.	30–36 in.	1½–2½ in.	340 ft.	2–3½ in.
Manville Bridge Series	N., 10° E.	30 in.	2½–3 in.	352 ft.	4–6 in.
Doe Run Series	N., 45° E.	33–36 in.	3 in.	375 ft.	3–5 in.

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Date Due